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Journal of COMPARATIVE ECONOMICS

Journal of Comparative Economics 31 (2003) 75–93

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Profit sharing, worker effort, and double-sided moral hazard in an efficiency wage model

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Received 9 July 2001; revised 15 October 2002

Chang, Juin-jen, Lai, Ching-chong, and Lin, Chung-cheng—Profit sharing, worker effort, and double-sided moral hazard in an efficiency wage model

This paper develops a double-sided moral hazard model to examine the productivity and employment effects of an intensifying profit-sharing scheme. We show that, in order to obtain the productivity-enhancing and employment-expanding effects, a profit-sharing scheme needs a supportive element of true sharing by the employer. If a double moral hazard exists for the worker's effort and the firm's declaration of true profits, a sharing scheme involving larger profit-related pay is not necessarily an effective policy for boosting work morale and employment. However, if the firm-side moral hazard problem is absent, the favorable effects of profit sharing are achieved. *Journal of Comparative Economics* **31** (1) (2003) 75–93. Institute of Economics, Academia Sinica, Nankang, Taipei 11529, Taiwan; Fu-Jen Catholic University, Taiwan; Sun Yat-Sen Institute for Social Sciences and Philosophy, Academia Sinica, Nankang, Taipei 11529, Taiwan; National Taiwan University, Taiwan.

JEL classification: J33; J41

Keywords: Profit sharing; Double moral hazard; Efficiency wages

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0147-5967/03/$ – see front matter
doi:10.1016/S0147-5967(02)00009-4

1. Introduction

Since team performance and unobservable disturbances determine jointly the level of a firm's output, the effort level of each worker cannot be observed exactly. Due to this feature of asymmetric information, workers tend not to work hard and shirking may be observed under traditional fixed-wage remuneration. This is the moral hazard or hidden-action problem that is well-known in the literature. Alchian and Demsetz (1972) claim that profit-sharing schemes, using mutual monitoring among workers, can create an appropriate arrangement to prevent workers from shirking, particularly when the cost of monitoring is high. Cable and Fitzroy (1980) and Blinder (1992) point out that sharing schemes can transform fundamentally the atmosphere of the workplace by eliminating the traditional conflict between workers and the firm, because cooperation raises the workers' effort due to maximization of joint wealth. In a series of articles, Weitzman (1983; 1984; 1985) advocates the replacement of traditional fixed-wage payment schemes with profit-sharing ones to stimulate work effort and increase employment. If these viewpoints are accepted, we would expect to observe improved worker productivity in a profit-sharing firm, which is Weitzman's soft-boiled mechanism.[1]

Empirical studies (Jones and Pliskin, 1991 and Kruse, 1993a and 1993b) do not find unequivocal support for this productivity-enhancing effect, and the variation in estimates is significant. Of 26 studies surveyed in Kruse (1993b), about ten percent report significant negative results, while another thirty percent indicate that the findings are positive, but insignificant. Kruse (1993b) also reports that productivity is not enhanced in over one-fourth of the firms that adopt profit-sharing, and that providing a larger share in the scheme is not associated invariably with a higher level of productivity. A plausible explanation for these results can be found in Meade (1986) and Wadhwani (1987). These authors claim that the merits of sharing programs should be balanced against some possibly damaging effects that have an adverse impact on workers' productivity. Specifically, profit-related pay must be large enough to provide sufficient incentive to induce workers to provide more effort. However, as argued by Sobel and Takahashi (1983), the true realization of profit is often known privately by the firm and is unobservable to employees. Therefore, the higher is the profit-sharing coefficient, the stronger is the incentive for firms to conceal the actual level of their profits. Hence, profit sharing itself leads to another firm-side moral hazard problem.

This firm-side moral hazard problem is recognized in many empirical studies. Kelly and Kelly (1991) and Gross and Bacher (1993) find that, in a sharing scheme, an improvement in the relationship between the employer and workers is achieved only if certain conditions are fulfilled.[2] Obviously, trust in management is an important factor. Mishra and Morrissey

[1] In addition to the soft-boiled effect, a sharing system enhances wage flexibility and allows the firm to use the wage offer, rather than the number of employees, to respond to a recession in the economy. Weitzman calls this effect the medium-boiled mechanism. In addition, a hard-boiled mechanism indicates that a profit-sharing scheme induces the profit-maximizing firm to hire labor; hence, aggregate employment increases. For details, see Katz (1986).

[2] In a review of the evidence concerning the Them (management) and Us (workers) attitude under sharing arrangements from 17 studies, Kelly and Kelly (1991) point out that only four studies provide clear-cut

(1990) point out that the perception of true sharing will determine how employees respond to the sharing scheme and the size of the share. Specifically, effort depends crucially on workers being treated fairly, and fair compensation must be based on the firm's true accounting profits. Unfortunately, most empirical studies do indicate that workers think they are treated unfairly. Consequently, as asserted by Estrin and Wadhwani (1990, p. 248), "far from reducing conflict between managers and workers, profit-sharing schemes will increase it, because there are incentives for managers to cheat in the definition of profits."

In such a double-sided moral hazard situation, several questions arise naturally. Could profit sharing lead employees to identify more closely with their company? Will a policy involving greater profit sharing induce a higher level of work effort and increase employment? Is a legislated profit-sharing system able to serve as a remedy against the problem of unemployment? Under what situations would employers voluntarily adopt a profit-sharing scheme? To address these questions, this paper sets up a theoretical model embodying two-sided hidden actions between the firm and its workers.[3]

The model used is, by nature, a shirking model of efficiency wages. The traditional shirking models assume that a firm cannot observe precisely its employees' effort; it faces a moral hazard problem in the labor market. Hence, the efficiency wage should rise to the level that generates high enough unemployment to motivate workers not to shirk. Differing from the usual efficiency wage models, this paper assumes that the true realization of profit is private information of the employer; hence, the possibility of concealment of the firm's true profit is introduced in a profit-sharing scheme. By taking account of this firm-side hidden action, our modified efficiency wage model allows us to deal with the double-sided moral hazard problem and to re-examine the effects of profit sharing on work effort and employment.

The firm-side moral hazard problem often gives rise to a credibility problem when repetitive interactions are considered. To highlight the credibility problem in a static framework, we allow the level of workers' effort and the firm's expropriation to be determined either in a simultaneous Nash game or in a sequential game. By extending this model, we derive several interesting results related to the emergence of a profit-sharing arrangement and to a reputational effect stemming from cheating on the part of the employer. First, a policy involving larger profit-related pay is not necessarily a sufficient incentive to boost worker effort and increase employment. However, if the firm-side moral hazard problem is absent, a rise in the sharing rate tends to stimulate work

evidence of lower levels of Them and Us attitudes among participants in sharing schemes, while most of the other studies find opposite results. Blanchflower and Oswald (1988) find that, compared with non-sharing establishments, workers' attitudes toward the quality of industrial relations are not more favorable among profit-sharing participants.

[3] The concept of double-sided moral hazard is familiar in many areas in economics. Cooper and Ross (1985) explore the incomplete insurance feature of warranties and the obscure relationship between the seller's product quality and the buyer's coverage in the lemons market. Mann and Wissink (1988) investigate the incentive aspects of money-back contracts that may lead both the seller and the buyer to provide first-best inputs. In franchising, Bhattacharyya, and Lafontaine (1995) find that two-sided moral hazard plays a crucial role in the design of contracts. More recently, Dow (2000) has compared two different ownership systems, i.e. outside ownership and joint ownership, and finds that outside ownership may not be superior to joint ownership in resolving the free-rider problem associated with a profit-sharing scheme if the double-sided moral hazard is present.

morale and hence alleviate the unemployment problem. Obviously, these results differ from Weitzman's optimistic viewpoint. Second, we find that, in the sequential case, the firm's expropriation is even more serious than in the Nash case. As a result, the level of work effort and employment are lower in the sequential equilibrium. Third, the credibility problem could be alleviated by reputation, and the credibility problem plays a crucial role in determining whether firms adopt profit-sharing schemes voluntarily. Finally, given that profit sharing can boost worker effort, unemployment may no longer be a necessary device to induce worker effort in a profit-sharing economy.

The rest of this paper is organized as follows. In Section 2, an efficiency wage model of double-sided hidden actions by the employer and the employees is developed. The respective optimal choices of effort and concealment of profits are determined in a Nash equilibrium. Section 3 discusses the firm's optimal employment and wage decisions and explores the effect of a legislated profit-sharing system on unemployment. Section 4 extends the basic model to provide a more complete picture of the workers' effort and the unemployment effects of profit sharing. Finally, some concluding remarks and discussions are presented in Section 5.

2. The double moral hazard problem

The analysis is undertaken within the framework of a two-stage game. During the first stage, a representative firm hires a number of identical workers to produce a single good. According to the fundamental tenet of efficiency wage theories, the firm can exert market power to set the money wage, w, unilaterally. In the profit-sharing scheme, the firm pays a fraction, s, of its profits to its workers. Our intent is to examine whether a profit-sharing scheme can induce higher levels of worker effort and employment relative to the traditional fixed-wage arrangement, and under what circumstances the profit-sharing scheme can have a favorable effect on the labor market. In this section, we follow Weitzman (1985) and Wadhwani (1987) and specify that s is set either by the government or by law so that it is treated as a policy parameter. Section 4 extends the model to endogenize the determination of the profit share.

During the second stage, employees take the remuneration system established during the first stage as given and decide how much effort, e, to provide. Because of team production and some unobservable disturbances, the firm cannot judge the level of effort that workers actually provide from realized output. Thus, workers have a motivation to shirk and enjoy on-the-job leisure. On the other hand, due to the fact that the true amount of profit realized is the firm's private information, under profit sharing, the firm is motivated to conceal the true profit and declares a fraction, h, of its profit.

We solve this two-stage game backwards starting with the second stage. Following Cooper and Ross (1985), and Mann and Wissink (1988), the double moral hazard problem is characterized as a Nash equilibrium. First, we discuss the employee's hidden action and derive the effort function of a representative worker in a typical firm i. Because the firm cannot observe the actual effort level of each individual worker and monitoring is costly, the employer will establish a partial monitoring mechanism to induce workers' exertion. According to the shirking-type efficiency wage model, if a worker does not work hard, he may get caught shirking and be dismissed as a punishment. For analytical convenience, we assume that the number of working hours is fixed and normalized to unity, while effort, e, is specified as the fraction of this fixed working time actually worked. The worker enjoys consumption from spending his income, y, and dislikes putting forth effort. For simplicity, the worker's utility function U is specified to be additively separable and linear in income and effort as follows:

$$U(y, e) = y - e.$$

This specification is common in the relevant literature (Shapiro and Stiglitz, 1984, and Dickens et al., 1990). Our main results are not altered qualitatively with a more general utility function $U(y, e)$ as long as the utility function is separable in income and effort, i.e. $U_{ye} = 0$.

Let p denote the probability of being fired if the worker gets caught shirking and let u be the unemployment rate. A worker in representative firm i faces three possible outcomes. First, he is still employed by firm i and receives expected income y_i^e with probability $(1 - p)$. Second, he is fired by the original firm for shirking, but finds another job for which he receives compensation y_r^e with probability $p(1 - u)$. Third, the worker is fired by the firm and becomes unemployed; hence, he receives unemployment benefits b and provides zero effort. The probability associated with this situation is pu. Firms are assumed to be identical and to pay the same compensation, i.e. $y_i^e = y_r^e = y^e$. Thus, the three states reduce to two, the one in which the worker is employed and receives compensation y^e with probability $(1 - pu)$ and the one in which he becomes unemployed, exerts no effort, and receives unemployment benefits b with probability pu. Therefore, the expected utility of a typical worker,[4] namely $V \equiv EU$, is

$$V = (1 - pu)\left(y^e - e\right) + pub. \tag{1}$$

It is plausible to assume that the worker would prefer to work rather than be unemployed; hence, we assume $y^e - e > b$.

To consider the profit-sharing schemes, suppose that the firm's production technology is characterized by $f(\bar{e}n)$ with $f' > 0$ and $f'' < 0$, where $\bar{e}$ and n stand for the average effort level of the firm's employees and the number of workers in the firm, respectively. Thus, the expected income of an employed worker, y^e, in the profit-sharing firm can be expressed as

$$y^e = w + sh\left[\frac{f(\bar{e}n) - wn}{n}\right]. \tag{2}$$

In addition, the probability that a shirking worker will be caught is negatively related to his effort level, according to the following form:

$$p = 1 - e.$$

This specification implies that the firm's detection technology is given. Such a simplification is convenient but not essential.

[4] Instead of dynamic shirking model of Shapiro and Stiglitz (1984), Pisauro (1991) develops a static framework to capture the workers' optimization problem. The worker's expected utility in Eq. (1) in our static model is similar to Pisauro (1991, Eq. (5)).

Substituting the detection probability and Eq. (2) into (1), the worker's expected utility is rewritten as

$$V = \left[1-(1-e)u\right]\left\{w + sh\left[\frac{f(\bar{e}n)-wn}{n}\right] - e\right\} + (1-e)ub. \tag{3}$$

The worker chooses optimal effort to maximize Eq. (3). To focus on our main points, we normalize by setting $b = 0$. Thus, the first-order condition for the worker's optimal choice of effort is

$$V_e = u\left[w + sh\left(\frac{f-wn}{n}\right) - e\right] + (1-u+eu)\left(sh\bar{e}_e f' - 1\right) = 0. \tag{4}$$

Following Miyazaki (1984), the average effort $\bar{e}$ is decomposed as

$$\bar{e} = \left(\frac{1}{n}\right)e + \left(\frac{n-1}{n}\right)\tilde{e}, \tag{5}$$

where $\tilde{e}$ denotes the average effort of all workers other than the typical worker under consideration. Differentiating Eq. (5) with respect to e yields

$$\bar{e}_e = \frac{1}{n} + \frac{n-1}{n}\tilde{e}_e.$$

The derivative $\tilde{e}_e$ portrays the typical employee's conjectural variation, which is the effect of change in his own effort based upon others' choices. For simplicity and following Miyazaki (1984), we assume that the worker has a Nash-type conjectural variation; i.e. each worker chooses his own effort, taking as given the choices of his peers. This implies $\tilde{e}_e = 0$ and hence $\bar{e}_e = 1/n$.

The effort function of the worker can be solved from Eqs. (4) and (5) with $\bar{e}_e = 1/n$ and we designate this as

$$e = \psi(h; w, s, u, n, \tilde{e}).$$

Since workers are identical *ex-ante*, we have $e = \bar{e} = \tilde{e}$. Using this relationship, the effort function is rewritten as

$$e = e(h; w, s, u, n), \tag{6}$$

where

$$e_h = \psi_h/(1-e_{\tilde{e}}) > 0, \qquad e_w = \psi_w/(1-e_{\tilde{e}}) > 0,$$
$$e_s = \psi_s/(1-e_{\tilde{e}}) > 0, \qquad e_u = \psi_u/(1-e_{\tilde{e}}) > 0,$$
$$e_n = sh\left[un(f/n - \bar{e}f') + (1-u+eu)(f' - \bar{e}nf'')\right]\big/(1-e_{\tilde{e}})n^2V_{ee} < 0,$$

with the restriction that $(1 - e_{\tilde{e}}) > 0$ due to the stability condition proposed by Romer (1996). Given the firm's declaration h, Eq. (6) is the reaction function of employees.

These comparative statics in Eq. (6) are intuitive. First, an increase in the ratio of the firm's declaration raises profit-linked earnings, leading to a higher opportunity cost for the worker of losing his job. Thus, the worker increases his effort in response to the increase in h. Second, the higher are the base wage and the sharing rate, the greater is the cost of job loss to the worker; hence, the worker will exert more effort to avoid dismissal. Third, as in Shapiro and Stiglitz (1984), unemployment serves as a discipline device to elicit workers' effort. As the unemployment rate rises, the worker encounters increasing difficulty in finding an alternative job if he is dismissed. Therefore, he will furnish more effort to avoid being fired. Fourth, a larger number of co-workers is associated with lower profit-linked earnings for each worker due to the diminishing marginal return on labor. Therefore, the incentive effect of the profit-sharing schemes is diluted. This phenomenon is similar to the familiar free rider problem derived by Kandel and Lazear (1992) in a theoretical model and observed by Kruse (1993b) in the empirical evidence.

We turn now to the firm-side moral hazard. Given a conjecture about the employees' effort, the firm chooses the fraction of profit, h, to declare, to maximize the following expected profit function:

$$\pi^e = (1 - sh)\big[f(en) - wn\big] - c(1 - h), \tag{7}$$

where c denotes the cost of concealment. We assume that the marginal cost of concealment is positive and increasing, i.e. $c' > 0$ and $c'' > 0$. As mentioned previously, the size of h reflects the extent to which the firm cheats by concealing its true profit so that h belongs to the interval $[0, 1]$. If $h = 1$, the firm is truthful and does not bear any cost of concealment, i.e. $c(0) = 0$. Otherwise, to hide some actual profits, the firm bears cost c to make its lie plausible. This concealment cost can be considered to be an accounting cost associated with fabricating documents.

The first-order condition of the firm's choice of optimal concealment is

$$\pi^e_h = -s(f - wn) + c' = 0. \tag{8}$$

The first term in Eq. (8) captures the firm's marginal benefit of concealment in terms of actual profit gained, and the second term reflects its marginal cost. Given the workers' effort, the firm's reaction function h from Eq. (8) can be represented as

$$h = h(e; w, s, n), \tag{9}$$

where

$$h_e = -snf'/c'' < 0, \qquad h_w = sn/c'' > 0,$$
$$h_s = -(f - wn)/c'' < 0, \qquad h_n = -s(\bar{e}f' - w)/c'' < 0.$$

Equation (9) indicates that h is a decreasing function of e, s, and n, but an increasing function of w. Intuitively, the more effort workers furnish, the more profits the firm acquires. In a profit-sharing economy, the firm must provide more profit-linked payments to its employees. Thus, the profit-maximizing firm raises the extent of its concealment to secure more of the profits. In addition, the higher is the profit-sharing coefficient, the stronger is the incentive to hide actual profits, so that an increase in s is associated with a decrease in h. The same reasoning explains the response of h to w and n.

Figure 1 provides visual pictures of two equilibria. In Fig. 1, the positively-sloped RF_e curve represents the worker's effort reaction function from Eq. (6). The negatively-sloped RF_h locus is the firm's reaction function for h from Eq. (9). The double-sided moral hazard equilibrium is determined by the intersection of the RF_e and RF_h curves. Figure 1 also

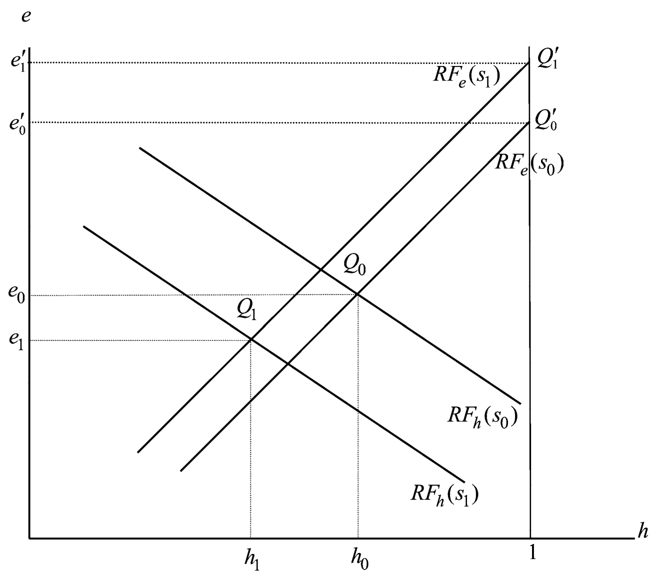

Fig. 1. The problem of double and single moral hazard.

depicts a single moral hazard equilibrium. As is found in the traditional efficiency wage model, the firm-side moral hazard is absent, i.e. $h = 1$, so that $h_e = h_w = h_s = h_n = 0$ in Eq. (9). This restriction makes the RF_h locus a vertical line, so that the single moral hazard equilibrium is characterized by the intersection of the RF_e locus and a vertical line at $h = 1$.

The two reaction functions from Eqs. (6) and (9) yield a Nash equilibrium with the following properties:

$$\left[e^*(w, s, n, u); h^*(w, s, n, u)\right], \tag{10}$$

where

$$\begin{aligned}
&e_w^* = (e_w + e_h h_w)/(1 - e_h h_e) > 0,\\
&e_s^* = (e_s + e_h h_s)/(1 - e_h h_e) \gtreqless 0, \quad \text{if } e_s \gtreqless -e_h h_s,\\
&e_n^* = (e_n + e_h h_n)/(1 - e_h h_e) < 0,\\
&e_u^* = e_u/(1 - e_h h_e) > 0,\\
&h_w^* = (h_w + h_e e_w)/(1 - e_h h_e) \gtreqless 0, \quad \text{if } h_w \gtreqless -h_e e_w,\\
&h_s^* = (h_s + h_e e_s)/(1 - e_h h_e) < 0,\\
&h_n^* = (h_n + h_e e_n)/(1 - e_h h_e) \gtreqless 0, \quad \text{if } h_n \gtreqless -h_e e_n,\\
&h_u^* = h_e e_u/(1 - e_h h_e) < 0.
\end{aligned} \tag{10a}$$

The comparative statics in expression (10a) provide our main result, namely an increase in the share coefficient has an ambiguous effect on workers' effort. Figure 1 illustrates this ambiguity. Suppose that, at the initial equilibrium, Q_0, workers provide effort e_0 and the firm declares the fraction h_0 of its actual profit. In response to a rise in the profit share from s_0 to s_1, the employees will put forth more effort due to a higher opportunity cost of dismissal. Work effort is induced by the incentive effect as the reaction locus shifts leftwards to $RF_e(s_1)$. However, a higher share coefficient implies that the firm must provide more profit-linked payments to its employed workers. This will induce a profit-maximizing firm to conceal a higher portion of its true profits so that the reaction locus shifts leftwards to $RF_h(s_1)$. Given the positive relationship between h and e on the RF_e locus, this shift gives rise to an opposition effect that reflects the workers' distrust of the firm and leads to a decrease in the level of effort along RF_e. Obviously, whether the work effort is increased or decreased depends on the relative magnitudes of these two shifts. In Fig. 1, the new equilibrium occurs at point Q_1 and work effort drops from e_0 to e_1, implying that the opposition effect dominates the incentive effect. Hence, a higher share coefficient is not necessarily an effective way of boosting worker effort. This result casts doubt on the soft-boiled incentive effect of the sharing system proposed by Weitzman (1983, 1984).

Under the single moral hazard case, Eq. (10a) yields:

$$e_s^*\big|_{h=1} = e_s|_{h=1} > 0. \tag{11}$$

Equation (11) indicates the incentive effect of sharing when the firm is trustworthy and reports profit honestly. With $h = 1$, the RF_h locus becomes a vertical line. At the initial equilibrium point Q_0', the level of work effort is e_0'. After the increase in the share coefficient, work effort increases to e_1'. The results are summarized in the following proposition.

Proposition 1. *If hidden actions exist in both the worker's effort and the firm's declaration of true profits, a higher share coefficient will not necessarily boost the worker's effort. However, if the firm is trustworthy and declares honestly its true profit, $h = 1$, a rise in the share coefficient increases the worker's effort.*

If there is no unemployment, i.e. $u = 0$, and the firm does not share its profit with the workers, i.e. $s = 0$, it follows from Eq. (4) that:

$$V_e|_{u=s=0} = -1 < 0.$$

This implies that, under full employment in a fixed-wage system, the workers will shirk. This result is a restatement of Shapiro and Stiglitz's (1984) argument that no shirking is inconsistent with full employment and that equilibrium unemployment is necessary as a worker discipline device. It conveys the essential feature of efficiency wage theories, namely, that the labor market equilibrium must be characterized by involuntary unemployment.

Some economists do not support Shapiro and Stiglitz's (1984) argument. Their criticism centers on whether there exist some arrangements that can elicit workers' effort without resorting to unemployment. Much of the debate focuses on bonding (Carmichael, 1985; Akerlof and Katz, 1989). In a bonding scheme, the worker must post a performance bond or pay an entrance fee for the opportunity to work. If the worker is caught shirking, the bond or employment fee is forfeited. Under such circumstances, the bonding mechanism can eliminate the need for unemployment as a discipline device.[5] In fact, sharing schemes may provide an alternative mechanism to achieve the same purpose. Substituting $u = 0$ and Eq. (9) into (4) yields:

$$V_e|_{u=0} = 0, \quad \text{if } sh(e, w, s, n)\bar{e}_e f' = 1.$$

This equation indicates that, in the presence of profit sharing, the worker may provide a positive effort, which is stated in the following proposition.

Proposition 2. *In the share economy, unemployment is not necessary as a worker discipline device.*

3. The employment effect of profit sharing

During the first stage, the representative firm chooses the levels of employment and wages to maximize its expected profit π^e, subject to the worker's effort function and its declaration function. Given Eq. (10), the firm's optimization problem can be described as

$$\max_{w,n} \quad \pi^e = (1 - sh)\big[f(en) - wn\big] - c(1 - h);$$
$$\text{s.t.} \quad e^* = e^*(w, s, n, u) \quad \text{and} \quad h^* = h^*(w, s, n, u). \tag{12}$$

Because the size of the firm is small, the firm chooses the levels of employment and wages under the belief that its decisions do not influence the unemployment rate. By imposing the first-order condition for an optimal choice of h from Eq. (8), the first-order conditions with respect to n and w are, respectively:

$$\big(e^* + ne_n^*\big)f' = w, \tag{13}$$
$$e_w^* n f' = n. \tag{14}$$

The second-order conditions require that

$$\pi_{nn}^e = \big(1 - sh^*\big)\big[\big(e^* + ne_n^*\big)f'' + 2e_n^* f'\big] < 0, \qquad \pi_{ww}^e = \big(1 - sh^*\big)\big(ne_w^*\big)^2 f'' < 0,$$

and

$$\Delta = \pi_{nn}^e \pi_{ww}^e - \big(\pi_{nw}^e\big)^2 = 2\big(1 - sh^*\big)^2\big(ne_w^*\big)^2 e_n^* f' f'' > 0.$$

Equations (13) and (14) are the usual marginal conditions indicating that the marginal benefits and marginal costs of employment and wages are equal, respectively. Combining both equations gives

$$e_w^* w / e^* = 1 - \eta < 1,$$

where $\eta = -\partial \ln e^* / \partial \ln n (> 0)$ is the elasticity of work effort with respect to employment.

[5] The bonding arrangement seems rare and unrealistic. Dow (2000) shows that, in equilibrium, entry fees may not be used due to the firm-side incentive constraint, even though they are feasible in principle. See Dickens et al. (1990) for a more complete discussion.

The basic efficiency wage model claims that the optimizing firm will set its wage offer at the level where the elasticity of work effort with respect to wages is unity, a result called the Solow condition by Akerlof and Yellen (1986). However, in their review of efficiency wage models, Akerlof and Yellen (1986) question whether an effort-wage elasticity of unity is too high in practice. Our model suggests that, in the presence of a sharing system, the effort-wage elasticity will be less than unity.[6] Hence, we state the following proposition.

Proposition 3. *In the presence of profit-sharing schemes, the profit-maximizing firm will set its wage at the level where the effort-wage elasticity is less than unity; thus, the Solow condition does not hold.*

We deal next with the determination of optimal employment and wages. To simplify the interpretation, we assume that the second and cross derivatives of the effort function with respect to w, s, n, and u are taken to be negligible. From Eqs. (13) and (14), we have functions

$$n = n(s, u) \quad \text{and} \quad w = w(s, u), \tag{15}$$

such that

$$n_s = -e_s^*/2e_n^* \gtreqless 0, \quad \text{if } e_s^* \gtreqless 0, \tag{15a}$$

$$n_u = -e_u^*/2e_n^* > 0, \tag{15b}$$

$$w_s = e_s^*(e^* - ne_n^*)/2ne_w^*e_n^* \gtreqless 0, \quad \text{if } e_s^* \lesseqgtr 0, \tag{15c}$$

$$w_u = e_u^*(e^* - ne_n^*)/2ne_w^*e_n^* < 0. \tag{15d}$$

Equations (15b) and (15d) indicate that, following an increase in the unemployment rate, the firm will increase the amount of labor it employs and lower its wage offer. The higher is the unemployment rate, the lower is the probability that a dismissed worker will find a new job so that the worker will provide more effort to avoid being fired. In response to such a worker's reaction, the firm will hire more workers at a lower wage.

Equations (15a) and (15c) indicate that an increase in the profit share has an ambiguous effect on the labor employed and the wage offered. The determining factor is the sign of e_s^*, i.e. whether an increase in the share rate has an expansionary or contractionary effect on work effort. As shown in Proposition 1, the sign of e_s^* is determined in turn by the relative shifts in reaction functions of the worker and the firm during the second stage. When an increase in the profit share increases work effort, the firm is motivated to hire more workers and pay a lower wage. By contrast, if a higher share ratio is associated with a lower level of work effort, the firm will make the opposite decision with regard to labor employed and the wage payment.

Freeman and Weitzman (1987) show that higher bonuses are correlated positively with higher employment. However, Wadhwani and Wall (1990) take an opposing view and argue that it is difficult to believe that the profit-sharing firms are in a regime of excess demand

[6] The Solow condition in our model is defined as the elasticity of work effort with respect to the base wage. In Wadhwani (1987), the Solow condition is defined as the elasticity of work effort with respect to full remuneration.

for labor throughout their sample period, which was characterized by high unemployment. Similarly, using French micro data, Cahuc and Dormont (1997) argue that an increase in the profit-share rate does not have a significant impact on labor demand. The ambiguous result in our model can provide a plausible way to reconcile these conflicting observations.

If the firm-side moral hazard problem is absent, from Eqs. (11) and (15a) with $h = 1$, we have:

$$n_s|_{h=1} = -\left[e_s^*|_{h=1}\right]/2e_n^* > 0.$$

Without moral hazard on the firm's side, effort is boosted by an increase in the profit-share coefficient, as indicated by Eq. (11). This incentive effect will, in turn, lead the firm to hire more employees.

The above discussion is summarized in the following proposition.

Proposition 4. *In the double moral hazard problem, the firm's decision to increase or decrease the number of workers it employs in response to an increase in the profit share will depend crucially on whether or not the increase in the profit share stimulates or depresses work effort. However, if the firm does not conceal its actions and declares its profits truthfully, a higher profit share motivates the firm to hire more workers.*

If we represent adequately the labor force and add up the labor demand of all identical firms, we can solve for the endogenous unemployment rate from the labor market equilibrium. When the unemployment rate is endogenized, Appendix A shows that a rise in the profit share may lead to an increase in unemployment, due to firm-side moral hazard. Such a result lends skepticism to the optimistic viewpoint that legislated profit sharing will increase labor demand and hence reduce unemployment. In our model, the labor market may be characterized by equilibrium unemployment, which is dramatically different from Weitzman's assertion that the introduction of economy-wide profit sharing will shift the economy into a state of excess demand for labor in the short run and full employment in the long run.

4. Extensions

Since several of our assumptions are debatable and should be relaxed, we consider three extensions.

4.1. Reputational effects

The static analysis indicates that the credibility of management is a key factor in determining the effort and employment effects of a profit-sharing scheme. However, the results may be modified if the game between the employer and the employees is played repeatedly. Kreps and Wilson (1982) argue that, in a repeated game, agents trade off the temptation to cheat against the loss of reputation stemming from cheating and the credibility problem may be less pronounced.

Reputational costs have dynamic aspects so that, in focusing on the macro-employment effects, we should modify our static model accordingly. Following Obstfeld (1994), we define the reputational cost as the loss of credibility in implementing arrangements or policies and add this cost to the firm's expected profit function. Hence, we have:

$$\pi^e = (1 - sh)\big[f(en) - wn\big] - c(1-h) - \phi\frac{(1-h)^2}{2}. \tag{16}$$

For the sake of exposition, the reputational costs are specified to be quadratic and to increase with $(1-h)$ in Eq. (16). The term ϕ is a coefficient that measures the extent of the loss of reputation from cheating.

The firm chooses h to maximize expected profit; the corresponding first-order condition is

$$\pi_h^e = -s(f - wn) + c' + \phi(1-h) = 0. \tag{17}$$

From Eq. (17), the firm's optimal disclosure function $\hat{h}$ is

$$\hat{h} = \hat{h}(e, s, n, w), \tag{18}$$

where

$$\hat{h}_e = -snf'/(c'' + \phi) < 0, \qquad \hat{h}_s = -(f - wn)/(c'' + \phi) < 0,$$
$$\hat{h}_n = -s(\bar{e}f' - w)/(c'' + \phi) < 0, \qquad \hat{h}_w = sn/(c'' + \phi) > 0.$$

By combining Eqs. (6) and (18), we can solve for the Nash equilibrium of effort, $\hat{e}^*$, and the fraction of the firm's profit disclosed, $\hat{h}^*$.

The effort impact of profit sharing will be

$$\hat{e}_s^* = \frac{e_s + e_h\hat{h}_s}{1 - e_h\hat{h}_e} = \left[e_s - \frac{e_h(f - wn)}{(c'' + \phi)}\right] \Big/ \left[1 + \frac{e_h snf'}{(c'' + \phi)}\right] \gtreqless 0,$$
$$\text{if} \quad e_s \gtreqless \frac{e_h(f - wn)}{(c'' + \phi)}. \tag{19}$$

Compared with Eq. (10a), expression (19) indicates that the incentive effect of profit sharing e_s is unchanged, while the opposition effect $e_h(f - wn)/(c'' + \phi)$ decreases with the intensity of the reputational costs ϕ. This means that the reputational effect may reduce or even eliminate firm-side moral hazard. We can use this result to discuss the dynamic credibility problem. Equation (19) indicates that the credibility problem could be eliminated when two parties play an infinite game in which the intensity of the reputational costs ϕ is higher. However, if the game is repeated a finite number of times only, the reputational effects, associated with a lower value of ϕ, may reduce the credibility problem, but may not eliminate it entirely. Once the value of ϕ is substantial enough for $\phi > [s(f - wn) - c']/(1-h)$ to hold in Eq. (17), the corner solution, $h = 1$, occurs. In such a situation, the firm will commit credibly to its profit-sharing scheme. Given $h = 1$, as stated in Proposition 1, the level of work effort will be positively correlated with the profit sharing.

4.2. The firm's willingness to adopt profit sharing

Sections 2 and 3 concentrate on the effects of a legislated profit-sharing system, but the firm's own motivation for adopting a profit-sharing scheme is not considered. This extension considers whether firms would voluntarily adopt a profit-sharing scheme $(s > 0)$ or choose a scheme with a fixed wage $(s = 0)$. Given that the firm chooses the profit-sharing parameter, the firm's optimization problem is to determine $w, n,$ and s to maximize expected profit in Eq. (16), subject to the worker's effort reaction function $\hat{e}^*$ and the firm's profit-declaring function $\hat{h}^*$ in a Nash equilibrium. Hence, the first-order conditions with respect to $w, n,$ and s, respectively, are:

$$\pi_n^e = (\hat{e}^* + n\hat{e}_n^*)f' - w = 0, \tag{20a}$$

$$\pi_w^e = \hat{e}_w^* n f' - n = 0, \tag{20b}$$

$$\pi_s^e = -\hat{h}^*(f - wn) + \left(1 - s\hat{h}^*\right) f' n \hat{e}_s^* = 0. \tag{20c}$$

In deriving Eqs. (20a), (20b), and (20c), the first-order condition of h, $s(f - wn) - c' - \phi(1 - h) = 0$, is imposed.

Equations (20a) and (20b) are analogous to Eqs. (13) and (14). Equation (20c) indicates that, if the credibility problem is serious, the profit-related wage payment will fail to motivate worker effort, i.e. $\hat{e}_s^* < 0$ in expression (19). If $\hat{e}_s^* < 0$, the sign of π_s^e is negative, implying that the firm will adopt a fixed wage system. By contrast, if the credibility problem is less severe and $\hat{e}_s^* > 0$, the firm will implement a profit-sharing scheme. This result indicates that the emergence of a profit-sharing system requires mutual trust between the employer and his employees.

4.3. The determination of worker effort and the firm's profit declaration in a sequential game

We have assumed that some unobservable disturbances exist in the economy and that these, as well as the effective work force, determine jointly the output and profit levels of the firm. This specification generates a situation in which employees cannot observe the firm's true profit and the employer cannot deduce an individual worker's effort from output so that this double-sided moral hazard problem is characterized as a Nash game. However, given the fact that the employer often has control rights, it may be reasonable to assume that the employer chooses the percentage of profit to report only after the workers choose their effort level. That is to say, the workers' effort and the firm's declaration are determined in a sequential game. Accordingly, the analytical framework of our model is extended from a two-stage game to a three-stage one. In the first stage, the firm chooses optimal levels of w and n. In the second stage, the worker internalizes the firm's possible activity of expropriation and chooses an optimal e. The firm's optimal profit declaration is determined in the third stage.

First, we solve the firm's profit-declaring function by backward induction. The maximization of Eq. (16) with respect to h leads to the firm's optimal disclosure $\hat{h}$ in Eq. (18). Given the function $\hat{h}$, the employee's optimization problem is to choose effort to maximize his expected utility $\widehat{V}$, i.e.:

$$\max_{e} \quad \widehat{V} = \big[1-(1-e)u\big]\left\{w + s\hat{h}\left[\frac{f(\bar{e}n)-wn}{n}\right] - e\right\};$$
$$\text{s.t.} \quad \hat{h} = \hat{h}(e,s,n,w).$$

The corresponding first-order condition is

$$\widehat{V}_e = u\left[w + s\hat{h}\left(\frac{f-wn}{n}\right) - e\right] + (1-u+eu)\big(s\hat{h}\bar{e}_e f' - 1\big) + (1-u+eu)s\hat{h}_e\left(\frac{f-wn}{n}\right) = 0. \tag{21}$$

In Eq. (21), the first two terms are equivalent to those in Eq. (4). The third term, $(1-u+eu)s\hat{h}_e((f-wn)/n)$, captures the worker's belief that the employer has a strong incentive to expropriate a significant percentage of profit once employees have chosen the effort level. The intuition is obvious. The more effort that workers provide, the more profit the firm achieves so that the profit-maximizing firm has an incentive to raise the extent of its concealment and secure more of the profit, i.e. $\hat{h}_e < 0$. Once workers internalize the employer's opportunistic behavior in their effort-supply decision, the marginal cost of work effort increases, which is analogous to the opposition effect in the Nash game, and worker effort decreases.

Compared with the Nash case, the sequential equilibrium involves an expropriation effect that adds an additional marginal cost of work effort and affects the employees' effort supply. Hence, work effort is lower in the sequential equilibrium than in Nash equilibrium. By substituting this relationship into Eq. (18), we find that the equilibrium level of h in the sequential equilibrium is also lower than that in Nash equilibrium because $\hat{h}_e < 0$. These results yield the following proposition.

Proposition 5. *The level of work effort is lower in the sequential equilibrium than in the Nash equilibrium. In addition, the firm-side moral hazard problem becomes more serious in the sequential case than in the Nash case.*

Furthermore, a higher profit-sharing rate s, higher true profit $(f - wn)$, and a more severe credibility problem captured by a lower reputational cost measurement, ϕ, will reinforce the expropriation effect.[7] This result confirms our argument that a high-powered incentive to implement profit sharing is associated with a high danger of moral hazard. In particular, if employees have little control over corporate returns, profit sharing is less likely to motivate workers to work harder. Under such circumstances, the magnitude of the effort effect will be small.

[7] From Eqs. (15), (A.4), and (A.5), the employment and unemployment effects of profit sharing depend crucially upon the impact of profit sharing on work effort. Therefore, from Proposition 5, profit sharing is more likely to increase employment and decrease the unemployment rate in the Nash game than in the sequential game.

In the sequential equilibrium, the effort effect of raising the profit-sharing parameter, namely $\partial e/\partial s|_{SE}$, can be obtained easily from Eq. (21) as

$$\left.\frac{\partial e}{\partial s}\right|_{SE} = -(X+Z)/n(1-e_{\tilde{e}})\widehat{V}_{ee} \gtreqless 0, \quad \text{if } X \gtreqless -Z,$$

where

$$X = \hat{h}\big[u(f-wn) + (1-u+eu)f'\big] > 0,$$
$$Z = (1-u+eu)sf'\hat{h}_s + \big(\hat{h}_e + s\hat{h}_{es}\big)(f-wn) < 0, \quad \text{and}$$
$$\widehat{V}_{ee} < 0,$$

due to the second-order conditions.[8] Intuitively, a rise in the profit-sharing rate leads to an expropriation effect that increases the marginal cost of effort supply. As a result, the incentive effect of profit sharing may be offset by the expropriation effect. This ambiguous effect of profit sharing is similar to that in the Nash equilibrium.

5. Concluding remarks and discussions

Received wisdom indicates that profit sharing can induce cooperation between the firm and its workers and, thus, boost worker effort and increase employment. However, empirical studies do not support this favorable effect of profit sharing. Meade (1986) and Wadhwani (1987) conclude that a potential danger may emerge from a sharing system, namely, that the firm is motivated to conceal its true profits and thereby increase the mutual distrust between itself and its workers. This paper has developed an efficiency wage model with a two-sided double moral hazard problem to analyze this issue. The results identify some interesting situations. First, if the worker's effort is unobservable and the firm can conceal its true profits, a higher share rate may either improve or worsen work effort. However, if the firm is trustworthy and declares honestly its true profit, a rise in the share coefficient unambiguously increases the worker's effort. Second, in the double moral hazard problem, an increase in the share rate has an ambiguous impact on employment and unemployment; the effect depends crucially on the effort effect of profit sharing. However, in the absence of the firm-side moral hazard, a higher profit share motivates the firm to hire more workers so that unemployment falls. Hence, in order to obtain productivity-enhancing and employment-expanding effects of profit-sharing, a general atmosphere of mutual trust between the firm and its workers is necessary; if in its absence, profit sharing may reduce rather than increase work effort. Therefore, Weitzman's optimistic view that legislated profit sharing will reduce unemployment is suspect.

This paper also shows that the credibility of management is a determining factor in the effort and employment effects of a profit-sharing scheme. Repeated interactions can serve to mitigate the credibility problem. In a repeated game, Kreps and Wilson (1982) argue that agents will trade off the temptation to cheat against the loss of reputation stemming

[8] From Eq. (18), we have $\hat{h}_{es} < 0$ provided that $c''' = 0$.

from cheating, leading to an equilibrium of cooperation in which point the credibility problem is less severe. Two other practical policies mitigate the credibility problem. First, inviting some representative workers to join the management board may induce the firm to commit credibly to its profit-sharing scheme. For example, firms in the former West Germany implement share arrangements. Second, a stock-based sharing scheme links workers' compensation to the firm's performance. For example, employee stock ownership plans provide shares in the firm directly or indirectly to employees. Such schemes increase the transparency of profit sharing because employees receive the same dividends as other shareholders. Shleifer (1998) provides empirical evidence that, in many countries, large corporations have large shareholders who are active in corporate governance and involved in operations and reforming the payment system.[9] For these reasons, a stock-based sharing scheme can protect employees somewhat against discretionary expropriation by the employer.[10]

Meade (1986) argues that, in a profit-sharing system, it is difficult to make a distinction between the distributable accounting profits to be shared with workers and the firm's cash flow even if the firm's profit is observable by the employees. Due to the difficulty in defining distributable profit and the impossibility of writing a complete and contingent contract, the sharing contract between the firm and its employees cannot specify a clear division of the surplus, even if the firm-side moral hazard problem is absent. As a result, of incomplete contracts, opportunistic behavior may arise. Meade claims that, by overestimating the deductions from gross profits needed to finance capital depreciation, the firm can shift part of its profit from labor shareholders to capital shareholders. Because transaction costs can be reduced by renegotiation, the credibility problem under an incomplete contract is more likely to be alleviated by repetition than would be the case with moral hazard. In other words, the static conclusions from our moral hazard model may be more robust than those in an incomplete contract model.[11]

Acknowledgments

We are indebted to John Bonin and three anonymous referees for constructive suggestions and insightful comments. Any errors or shortcomings are our responsibility.

Appendix A

This appendix presents a brief determination of the equilibrium unemployment rate. If m represents the number of identical firms, the aggregate demand for labor N^d can be

[9] This observation is contrary to the traditional view that corporate governance is often concentrated in the hands of managers, because ownership of capital is dispersed among small shareholders.

[10] We are grateful to the referees for bringing these practical observations to our attention.

[11] This comparison between moral hazard models and incomplete contract models was pointed out by an anonymous referee, to whom we are grateful.

defined as

$$N^d = mn(s, u). \tag{A.1}$$

If $\widehat{N}$ denotes the numerical size of the total labor force and N^s denotes the number of workers who can obtain a job, we have

$$N^s = (1-u)\widehat{N}. \tag{A.2}$$

Labor market equilibrium requires $N^d = N^s$, which can be expressed as

$$mn(s, u) = (1-u)\widehat{N}. \tag{A.3}$$

The equilibrium unemployment rate, u^*, can be solved from Eq. (A.3) as

$$u^* = u^*(s), \tag{A.4}$$

where $u_s^* = -mn_s/(\widehat{N} + mn_u) \gtreqless 0$, if $n_s \lesseqgtr 0$.

By substituting Eq. (A.4) into either (A.1) or (A.2), we can determine the market equilibrium employment N^*:

$$N^* = N^*(s), \tag{A.5}$$

where $N_s^* = mn_s\widehat{N}/(\widehat{N} + mn_u) \gtreqless 0$, if $n_s \gtreqless 0$. Equations (A.4) and (A.5) indicate that an increase in the profit-sharing rate may lead to a rise in the unemployment rate and a fall in total employment when mutually hidden actions between the firm and its workers are considered.

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