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# Profit Sharing, Risk Sharing, and Firm Size: Implications of Efficiency Wages

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ABSTRACT. By taking account of output fluctuations, this paper constructs a synthesis of profit-sharing and efficiency-wage models to highlight the role of the risk attitudes of the firm and its employees. We show, contrary to the traditional efficiency wage theory, that in a profit-sharing economy unemployment is no longer a necessary device to induce work effort and, consequently, the labor market equilibrium may be characterized by full employment. Such a result is more likely to be true when the economy is characterized by small-sized firms. In addition, we also provide a preliminary sketch of the situations in which the firm chooses a profit-sharing program or a fixed-wage one, and discuss how a firm determines its pay parameters and employment in response to output fluctuations.

KEY WORDS: Profit sharing, Risk sharing, Efficiency wages, Firm size

JEL CLASSIFICATION: J33, J41, D82, J21

## 1. Introduction

Profit-sharing schemes have been advocated by Weitzman (1983, 1984, 1985, 1986) and other economists as a way out of the West's unemployment problem. The arguments put forward for profit sharing are twofold. First, the microeconomic argument is that if profit sharing could create a better work incentive and greater identification with firms, workers might be encouraged to work harder, thereby enhancing productivity. Weitzman labels this the ''soft-boiled'' argument. Second, the macroeconomic argument is that, when faced with income fluctuations, profit-sharing schemes may make wages more flexible, and this tends to reduce unemployment during recessions. Weitzman refers to this as the ''medium-boiled'' argument. Furthermore, the Weitzman ''hard-boiled'' argument is that, at the same level of total remuneration, the marginal cost of labor falls and the profit-sharing firm will always find it profitable to employ more labor. Economy-wide profit sharing then creates a persistent excess demand for labor, which ensures that the economy remains at full employment.[1]

Enthusiasm for profit sharing is not universal. The theoretical and empirical studies both report mixed results regarding the favorable effects of profit sharing on economic performance (see, e.g., Kruse, 1993a, b). Many economists and policy-makers claim that the discussions in previous studies divert attention from the real issues (Estrin et al., 1987). For example, Blanchflower and Oswald (1987) argue that the problem of risk allocation between workers and the firm in profit-sharing schemes is ignored by Weitzman and nearly all the other macroeconomists who focus on this topic. However, empirical observation suggests that the attitudes toward risk of firms and employees obviously constitute an important element in the formation of profit-sharing schemes. Cooper (1986) and Estrin et al. (1987) point out that profit sharing would expose workers to considerable income fluctuations, which they would not desire.[2] Ichino (1994) makes an empirical investigation and finds that profit-sharing systems are often introduced as risk-sharing devices by firms. Based on these facts, it is worthwhile developing a framework that incorporates the risk attitudes of firms and workers into Weitzman's share economy, in order to use it to shed light on the role of sharing schemes in the face of income fluctuations. As addressed by Cooper (1986, pp. 425–426) in a frequently-cited article, ''(profit sharing) is a good story without a detailed explicit model – a

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good starting point, but nowhere near complete. We need an explicit model...of the interaction of the type of labor contract with the magnitude of those fluctuations. ...[W]e need to take this into account in a full-fledged cost-benefit analysis of the Weitzman proposal''.

To respond to Cooper's argument and provide a more complete picture of a profit-sharing system, this paper sets up a theoretical model that synthesizes profit-sharing remuneration and the shirking-type efficiency wage theory proposed by Shapiro and Stiglitz (1984).[3] In a way that differs from the usual efficiency wage model, we allow both *the firm and its employees to be risk averse*, and employees exert effort according to *the received compensation and risk costs that they incur*. Accordingly, firms can unilaterally set base wages, sharing coefficients, and the level of employment in order to induce work effort and diversify risks. Such modeling allows us to develop tractable analyses of several aspects of profit sharing. First, it enables us to address the issue of how work effort is related to the risk attitude and the size of firms. Specifically, we show that, contrary to the traditional efficiency wage theory, in a profit-sharing economy unemployment is no longer a necessary device to induce work effort and, consequently, the labor market equilibrium could be characterized by full employment. Of interest, due to the free-rider problem (i.e. the $1/n$ problem), the outcome is more likely to be true when the economy is characterized by small-sized firms. It is also shown that when the risk premium associated with income fluctuations is taken into account, the policy of implementing a larger sharing program is not invariably associated with a higher level of productivity. This result obviously fails to support Weitzman's soft-boiled argument. In addition, in a share economy there is a mixed relationship between firm size and productivity.[4] These findings are important, particularly when the empirical studies do not support the favorable macro-effects of profit sharing and when the Weitzman propositions are criticized due to the lack of an appropriate model that can examine both the micro- and macro effects of profit sharing.

Second, such modeling can provide a primary sketch of the situations in which the firm chooses a profit-sharing program versus a fixed-wage one. In a series of papers, Weitzman (1984, 1985, 1986) highlights many of the macroeconomic merits of profit sharing (e.g., a lowering of the natural rate of unemployment), and argues that profit sharing-based compensation should be tax-exempt. However, a question arises in Blanchflower and Oswald (1987) and Nordhaus (1986): If profit sharing is so beneficial, firms ought to see that it is in their own best interests to adopt it. Why, then, is it necessary to subsidize it? Weitzman replies that the macroeconomic consequences of firms' behaviors for low unemployment are the ''macroeconomic externality'' which is not captured in the rewards of individual firms. The sharing scheme is thereby advocated without regard for its incentives and solely on the grounds of its macroeconomic virtues. In departing from such reasoning, this paper will show that the existence of profit sharing may be rooted in the *private and internal self-interest* of firms.

Third, our model is able to examine how a firm determines its pay parameters and employment in response to income fluctuations, when firms and employees have different capacities to bear risks. Blanchflower and Oswald (1987), Jackman (1988), and Wadhwani and Wall (1990) have concentrated their efforts on the wage and employment effects of profit sharing, but the risk attitude corresponding to income fluctuations is abstracted from their analyses. In this study, we find that if firms are risk averse and workers are risk neutral, firms facing a larger fluctuation in output will increase their profit-sharing ratios and employment in order to diversify the risk among their workers while at the same time decreasing the base wage. However, if the firm is risk neutral and workers are risk averse, an increased fluctuation in output will increase the fixed base wage and decrease the firm's demand for labor, while also having an ambiguous effect on the profit-sharing coefficient. These results cast some doubt on the medium-boiled argument proposed by Weitzman.

The remainder of this paper is organized as follows. In Section 2, we first present the efficiency wage model with profit-related payments and output fluctuations and then examine how risk sharing motivates the choice of payment contract. Section 3 investigates how a firm determines its pay parameters and employment in response to the fluctuations. Finally, Section 4 concludes.

## 2. The model

Consider an economy in which each of many identical firms hires a number of identical workers to perform some task. The number of employees within a firm is denoted as $n$, which also corresponds to the size of the firm. To induce work effort, the incentive devices firms utilize are both the profit-linked pay and the threat of dismissal.

### 2.1. *The optimization problem of the worker*

The worker enjoys consumption goods by spending income $Y$, and dislikes putting forth effort $e$. Effort $e$ $(0 \leq e \leq 1)$ is specified as the fraction of working hours (the number of working hours is normalized at 1) that the worker actually works. Accordingly, the worker's utility function is $U^{W} = U^{W}(Y-e)$, $\partial U^{W}/\partial(Y-e) > 0$ and $\partial^2 U^{W}/\partial(Y-e)^2 < 0$. In the profit-sharing scheme, the worker's total remuneration consists of the base wage $w$ plus a per capita share of profit $s\pi/n$ (i.e., $Y = w + s\pi/n$), where $s$ is the employees' profit share, $n$ the number of employees, and $\pi$ is the firm's profit before allocating the share attributable to employees.

By normalizing the price level to unity, the representative firm's pre-distribution profit is:

$$\pi = [R(\bar{e}n) + \theta] - wn \quad \text{and} \quad R' > 0,\ R'' < 0 \tag{1}$$

where $R$ is the firm's revenue function and $R + \theta$ is its total revenue. The term $\theta$ is a stochastic disturbance which is distributed normally with a zero mean and variance $\sigma^2$. It can be viewed as the variation in aggregate demand. The term $\bar{e}$ is the average effort of all the firm's workers, and $\bar{e}n$ is thus the actual hours worked or the effective labor force of the firm. When workers' compensation is related to the firm's profit, employees have to face the risk of fluctuations in income due to the random variable $\theta$.

In order to capture the risk prospects, the worker's expected utility can be represented by the *certainty equivalent* function if the worker has constant-absolute-risk-aversion utility:

$$U^{W}(\mathrm{CE}) = w + s\left[\frac{R(\bar{e}n) - wn}{n}\right] - \frac{\gamma}{2}\left(\frac{s}{n}\right)^2 \sigma^2 - e \tag{2}$$

where $\gamma$ is the coefficient of absolute risk aversion.[5]

The model we use is essentially a static framework of efficiency wage theories and is similar to that in Lin et al. (2002). Let $p$ denote the probability of being fired when the worker is caught shirking, and $u$ denote the unemployment rate, which also is the probability that the fired worker cannot find another job. There are three states of nature that an employed worker may face. First, with probability $(1–p)$, s/he is still employed by the original employer. Under such a situation, her/his certainty equivalent utility is $U^{W}(\mathrm{CE})$. Second, with the probability $p(1\text{-}u)$, s/he is dismissed due to shirking but finds another job at an alternative certainty equivalent utility $U^{W}_{*}(\mathrm{CE})$. Third, with the probability $pu$, s/he is fired and cannot find any job. Accordingly, s/he becomes unemployed and enjoys all-day leisure, and hence her/his utility is nil (i.e. $U^{W}(\mathrm{CE}) = 0$).[6] In addition, firms are assumed to be identical and to provide the same remuneration, and workers' risk aversions are symmetric across all firms. This implies that the certainty equivalent utilities are also identical in all firms (i.e., $U^{W} = U^{W}_{*}$). The three states are thus reduced to two. The expected utility of an employed worker, denoted by $V^{W}$, is:

$$V^{W} = (1-pu)\left[w + s\left(\frac{R(\bar{e}n) - wn}{n}\right) - \frac{\gamma}{2}\left(\frac{s}{n}\right)^2 \sigma^2 - e\right] \tag{3}$$

The probability of being fired $p$ is presumed to decrease at a decreasing rate with the effort level, i.e.: $p = p(e)$ with $p' < 0$ and $p'' > 0$. In order to distinguish two relevant scenarios with respect to compensation systems, we further assume that:

$$p = 1 - \varepsilon \cdot e^{\phi} \tag{4}$$

where $\varepsilon = \varepsilon_1$ in the case where the firm adopts the fixed wage system and $\varepsilon = \varepsilon_2$ in the case where the firm adopts the profit-sharing scheme.

Three points should be noted. First, in (4) we restrict $0 < \phi < 1$ in order to satisfy the characteristics $p' < 0$ and $p'' > 0$. Second, as argued by Tyson (1979), profit sharing is a particular kind of group incentive scheme, with rewards for performance assessed at the level of the enterprise and distributed to all employees. Under such a group incentive scheme, an individual's pay depends on the efforts of his peers as well as himself, and people will be motivated to monitor the effort supply of their fellow-employees more keenly. The peer pressure is likely to reinforce the discipline effect of detection and increase the effort output of workers under profit sharing. Therefore, it is plausible to specify that $\varepsilon_2 \geq \varepsilon_1$. Third, the detection probability $p$ may also depend on the firm size $n$. As argued by Rebitzer and Taylor (1995), given the fact that supervisory resources available to the firm are fixed, all else being equal, an increase in the size of a firm's work force will increase the difficulty associated with getting caught shirking. Consequently, the incentive to correct shirking is also subject to the *1/n* effect. Although this effect is abstracted from this model, the consideration of such an additional effect will not qualitatively alter our main findings. I am grateful to an anonymous referee for bringing these points to my attention.

Accordingly, from (1) to (4), the expected utility of the worker is:

$$V^{\mathrm{W}} = [1 - p(e)u]\left[w + s\left(\frac{R(\bar{e}n) - wn}{n}\right) - \frac{\gamma}{2}\left(\frac{s}{n}\right)^2 \sigma^2 - e\right] \tag{5}$$

The worker's optimization problem is to choose the level of effort to maximize her/his expected utility (5). Recalling that $\varepsilon = \varepsilon_1$ if the firm adopts the fixed wage system (i.e., $s = 0$) and $\varepsilon = \varepsilon_2$ if the firm adopts the profit-sharing scheme, the first-order condition is:

$$V_e^{\mathrm{W}} = \varepsilon\phi e^{\phi-1} u\left[w + s\left(\frac{R(\bar{e}n) - wn}{n}\right) - \frac{\gamma}{2}\left(\frac{s}{n}\right)^2 \sigma^2 - e\right] + [1 - p(e)u][s\bar{e}_e R'(\bar{e}n) - 1] = 0 \tag{6}$$

where $\varepsilon\phi e^{\phi-1} u\left[w + s\left(\frac{R(\bar{e}n)-wn}{n}\right) - \frac{\gamma}{2}\left(\frac{s}{n}\right)^2\sigma^2 - e\right] + [1 - p(e)u]s\bar{e}_e R'(\bar{e}n)$ is the worker's marginal benefit from increasing the level of effort and $[1 - p(e)u]$ is the marginal cost of increasing the level of effort. It is important to remind the reader that in a fixed-wage economy ($s = 0$), the firm size $n$ will not enter (6) or play any role. However, in a share economy, the firm size will affect the optimal level of work effort via the profit-sharing scheme. To obtain an interior solution for work effort, we assume that $s\bar{e}_e R'(\bar{e}n) < 1$ in the share economy with unemployment. Accordingly, $V_{ee}^{\mathrm{W}} = 2\varepsilon\phi e^{\phi-1}u(s\bar{e}_e R' - 1) + \varepsilon\phi(\phi - 1)e^{\phi-2}uV^{\mathrm{W}}(\mathrm{CE}) + (1 - pu)s(\bar{e}_e)^2 nR'' < 0$ is true and the second-order condition is satisfied.

The term $\bar{e}_e$ shown in (6) is the contribution of extra effort from a typical worker in relation to the average effort of the firm's workers. From the vantage point of an individual worker, the average effort $\bar{e}$ is defined as:

$$\bar{e} = \frac{1}{n}e + \frac{n-1}{n}\tilde{e} \tag{7}$$

where $\tilde{e}$ is the average effort of all of the firm's workers other than the individual worker we are considering. 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 $\bar{e}_e = 1/n$. Obviously, when the number of workers within the firm $n$ (i.e. the size of firm) is substantially large, the so-called *free rider problem* will choke off the incentive effect of profit sharing since each worker will share a less profit-linked earning associated with a larger number of workers. That is, the incentive to the worker of profit-sharing schemes is more likely to be diluted in a large firm. Cugno and Ferrero (1991) and Kruse (1993b, pp. 80–81) call this the $1/n$ effect.

In a fixed-wage economy ($s = 0$ and $\varepsilon = \varepsilon_1$), (6) reduces to $V_e^{\mathrm{W}}\big|_{s=u=0} = -1 < 0$ if the labor market is in full employment (i.e., $u = 0$). This implies that the worker will shirk all of the paid-for hours ($e = 0$) when there is no unemployment. That is, *full employment is inconsistent with any positive effort level*. This outcome is similar to the no-shirking condition, proposed by Shapiro and Stiglitz (1984), implying that the labor market equilibrium must be characterized by unemployment in a fixed-wage economy. Some economists, including Katz (1986) and Carmichael (1990), do not unanimously agree with Shapiro and Stiglitz's (1984) argument. Their criticism concentrates on whether there exist some arrangements, which can elicit worker effort without resorting to unemployment. Much of the debate on this critique focuses on the issue of bonding, for instance, Becker and Stigler (1974), Carmichael (1985), and Akerlof and Katz (1989). However, Dickens et al. (1990) claim that the bonding arrangement appears both unrealistic and dubious.

In this model, the sharing schemes ($s > 0$ and $\varepsilon = \varepsilon_2$) may be a possible mechanism in full employment. For ease of illustration, we utilize Figures 1 and 2 to investigate this issue. It follows from (6) that, as shown in Figure 1a, the marginal cost of increasing the level of effort (indicated by MC) is increasing in $e$ and its marginal benefit (indicated by MB) is decreasing in $e$, due to the second-order condition being valid. Obviously, in a share economy, the external factor – unemployment ($u$) and the internal factor – the $1/n$ effect of profit sharing (captured by $\bar{e}_e$) play important roles in terms of affecting the work incentive. Figure 1a indicates that, given some values of $u$ and $\bar{e}_e$, we can solve an interior solution for work effort $e^*$, thereby satisfying MB = MC (as indicated by the point $E$ in Figure 1a), provided that the condition $s\bar{e}_e R'(\bar{e}n) < 1$ is met.

Figure 1b indicates that, as unemployment $u$ rises, the MC locus will shift downward and the MB locus will shift upward. As a result, a higher work effort is induced by the discipline effect stemming from unemployment. This result, as we will see later, is confirmed by (10f). However, when the free-rider problem caused by profit sharing is considered more intensively ($\bar{e}_e$ becomes smaller due to a larger size of $n$), the MB curve will shift back downward (see equation (6)) and this will somewhat lead the optimal work effort to decrease. Note that, by referring to (10f), it is found that unemployment still acts as a worker discipline device in inducing effort ($\partial e/\partial u > 0$) even though the profit-sharing incentive is choked off completely by the free rider problem, i.e. $\bar{e}_e \to 0$.

However, in departing from the argument of Shapiro and Stiglitz (1984), equilibrium unemployment is found to no longer be a necessary device to induce work effort. In an extreme case where $u = 0$, in equation (6) the marginal benefit and the marginal cost will reduce to $s\bar{e}_e R'$ and 1, respectively. That is, in the presence of full employment, the optimal condition becomes:

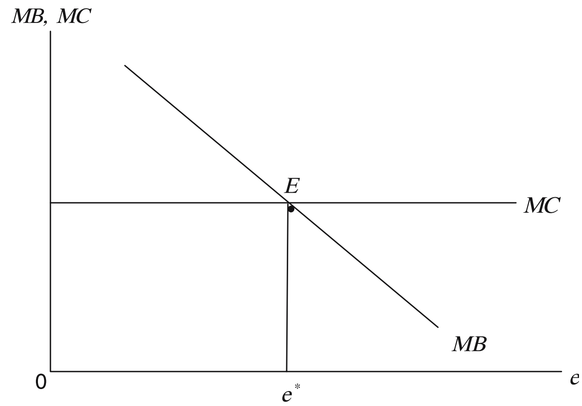

Figure 2. Profit sharing as a worker discipline device.

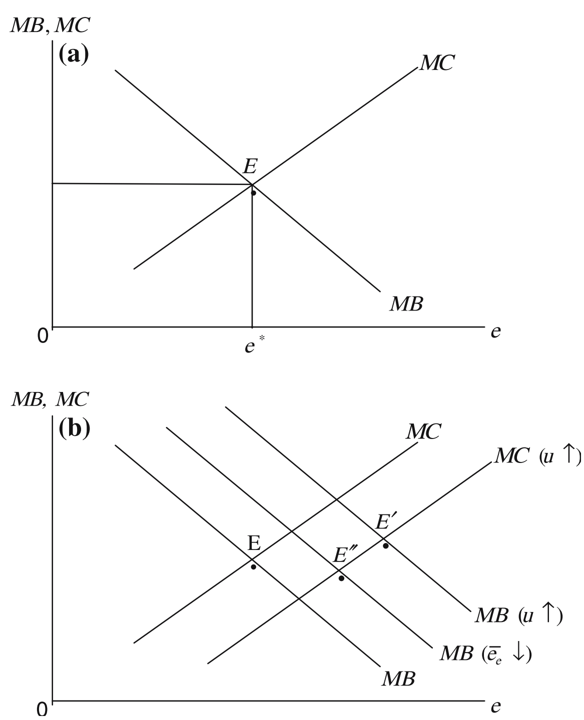

Figure 1. The optimal level of work effort.

$$s\bar{e}_e R' = 1. \tag{8}$$

In such a case, Figure 2 shows that the MB locus is still downward sloping, but the MC locus turns out to be a horizontal line. Equation (8) reveals that, in the presence of the sharing scheme, workers may furnish a positive level of effort for an extraneous sharing even without unemployment as a discipline device. Given $\bar{e}_e = 1/n$ and that the marginal revenue $R'$ is decreasing in $n$, this result leads to the following proposition:

*Proposition 1. In the share economy,*

(i) *unemployment is no longer a necessary device to induce work effort. The labor market equilibrium could be characterized by full employment;*
(ii) *the outcome stated in (i) is more likely to be true when the economy is characterized by small-sized firms.*

By comparing (8) with (6), we find that, given $u = 0$, the detection probability $p$ and base wages $w$ do *not* enter the optimal condition of work effort in order to play any role. The basic argument regarding efficiency wages disappears. By contrast, the incentive effect of profit sharing $s\bar{e}_e R'$ (and hence the size of firms $n$, as well) plays a decisive role in terms of affecting work effort. Of interest, in order to enable profit sharing to become a possible contractual solution leading to more efficient outcomes, the firm size must be small enough.

It is useful to provide numerical examples for (8) in order to have a more complete picture for Proposition 1. To this end, we further assume that the revenue function takes the form $R = a(\bar{e}n)^{\alpha}$, where $a$ is a productivity parameter and $\alpha$ must be less than unity in order to satisfy the features $R' > 0$ and $R'' < 0$. This specification is similar to Gomme (1999) and Ansar et al. (1997) and is identical to Bowles and Boyer (1988) and Levine (1989) if $\alpha = 1$. Moreover, let $\tilde{n}$ denote the corresponding critical values such that the optimal $e^*$ is substantially low and hence can be ignored, say $e^* < 1/100$. Accordingly, given $a = 20$ and $\alpha = 5/6$, we can calculate from (8) that if the sharing ratio $s = 0.4$, the critical size of the firm is $\tilde{n} = 10$ (the corresponding $e^* = 0.0087 < 1/100$), implying that the optimal $e^*$ is positive as long as the firm size is less than 10 even if the economy is characterized by full employment. By analogy, if $s = 0.5$, then the critical size $\tilde{n} = 12$ (the corresponding $e^* = 0.00934 < 1/100$), and if $s = 0.6$, then $\tilde{n} = 14$ (the corresponding $e^* = 0.00946 < 1/100$).[7] These results imply that when the sharing ratio is higher, the profit-sharing scheme facing the free-rider problem is more likely to be a possible mechanism in terms of inducing a positive level of work effort when in the presence of full employment ($u = 0$).

The productivity parameter $a$ also plays a role in affecting the incentive effectiveness of profit sharing and, accordingly, the critical firm size $\tilde{n}$. It follows from (6) that, given that $s = 0.5$ and $\alpha = 5/6$, we then have: (i) if $a = 10$, then the critical size of the firm is $\tilde{n} = 7$; and (ii) if $a = 30$, then $\tilde{n} = 17$. These results reveal that, the higher the productivity parameter, the larger the critical level of $\tilde{n}$. As argued by Conyon and Freeman (2001), when output results largely come from employee activity, the incentive effect of profit sharing will increase. Therefore, the profit-sharing scheme can tolerate a higher degree of the free-rider problem and, as a result, the critical $\tilde{n}$ increases with the productivity parameter $a$.

Given that the worker has a Nash-type conjectural variation, the effort function can be solved from (6) and (7):

$$e = \varphi(w, s, n, \sigma^2, u, \tilde{e}) \tag{9}$$

Since workers are identical, the symmetric equilibrium ascertains that $e = \bar{e} = \tilde{e}$. By imposing this condition on (9), the reduced form of the worker's effort function is:

$$e = e(w, s, n, \sigma^2, u) \tag{10a}$$

where

$$e_{\mathrm{w}} = \frac{-\varepsilon\phi e^{\phi-1}u(1-s)}{(1-e_{\tilde{e}})V_{ee}^{\mathrm{W}}} > 0, \tag{10b}$$

$$e_{\mathrm{s}} = \frac{-1}{(1-e_{\tilde{e}})V_{ee}^{\mathrm{W}}}\left[(1-pu)\bar{e}_e R' + \varepsilon\phi e^{\phi-1}u\left(\frac{R-wn}{n}\right) - \gamma\varepsilon\phi e^{\phi-1}u\sigma^2\frac{s}{n^2}\right] \gtreqless 0, \tag{10c}$$

$$e_n = \frac{1}{(1 - e_{\tilde{e}})V_{ee}^{\mathrm{W}}}\left[(1 - pu)s\left(\frac{R'}{n^2} - \bar{e}\bar{e}_e R''\right) + \varepsilon\phi e^{\phi-1}u\frac{s}{n}\left(\frac{R}{n} - \bar{e}R'\right) - \gamma\varepsilon\phi e^{\phi-1}u\sigma^2\frac{s^2}{n^3}\right] \gtreqless 0, \tag{10d}$$

$$e_{\sigma^2} = \frac{\varepsilon\phi e^{\phi-1}u}{(1 - e_{\tilde{e}})V_{ee}^{\mathrm{W}}}\left[\frac{\gamma}{2}\left(\frac{s}{n}\right)^2\right] < 0, \tag{10e}$$

$$e_u = \frac{-1}{(1 - e_{\tilde{e}})V_{ee}^{\mathrm{W}}}[\varepsilon\phi e^{\phi-1}U^{\mathrm{W}}(\mathrm{CE}) + p(1 - s\bar{e}_e R')] > 0. \tag{10f}$$

In the above equations, we restrict $(1 - e_{\tilde{e}}) > 0$ due to the stability condition proposed by Romer (1996, pp. 295–296).

The comparative statics revealed in (10a) can be understood intuitively. First (10b) states that the higher the base wages, the greater the cost to the worker by way of job loss. Hence, s/he will exert more effort. Second, the result $e_u > 0$ in (10f) conveys the basic result of efficiency wage theory: a higher unemployment rate increases the work effort. Third (10e) indicates that, due to the variation in aggregate demand, a profit-sharing program exposes workers to the risk of income volatility. For a risk-averse worker, higher risk costs will decrease the opportunity cost of loafing and will encourage shirking.

Fourth (10d) provides a more interesting result. Given a diminishing marginal return to labor (i.e., $R/n > \bar{e}R'$ due to $R' > 0$ and $R'' < 0$), more co-workers in the sharing firm, on the one hand, decrease the profit-sharing incentive, and, on the other hand, diversify the risk associated with income fluctuations. These two conflicting effects lead to an ambiguous effect of firm size on work effort.

The ambiguous result of (10c) is different from that of Cugno and Ferrero (1991) when the risk premium associated with fluctuations in income is incorporated into the efficiency wage model. The intuition is straightforward. An increase in the coefficient of sharing will increase the actual profit-linked earning, and hence lead to a higher opportunity cost of losing the job. However, as in the argument put forward by Blanchflower and Oswald (1987), Estrin et al. (1987), and Pissarides (1987), given the variation in aggregate demand, it also increases the worker's risk costs associated with those income fluctuations and gives rise to a disincentive effect in relation to worker effort. Based on 26 surveys, Kruse (1993b) finds that about ten percent of the surveys indicate that the sharing ratio and the worker's effort exhibit a significant negative relationship, while another 30% indicate that the worker's effort is positively but insignificantly related to the sharing coefficient.[8] Kruse (1993b, p. 152) also finds that productivity is not enhanced in the cases of more than one-fourth of the profit-sharing adopters.

We use the following proposition to summarize the main finding above:

*Proposition 2. In the share economy facing business fluctuations, there is a mixed relationship between firm size and productivity and, in contrast to Weitzman's soft-boiled argument, the policy of a larger-sized sharing program is not invariably associated with a higher level of productivity.*

### 2.2. *The optimization problem of the firm*

Following Hart (1983), we assume that firms can be risk averse and that their utility is $U^{\mathrm{F}} = U^{\mathrm{F}}(\pi^*)$, where $\pi^*$ is the post-distribution profit and equals $(1 - s)\pi$. Accordingly, the firm's risk preference is specified in terms of a certainty-equivalent measurement $V^{\mathrm{F}}$:

$$V^{\mathrm{F}} = (1 - s)[R(en) - wn] - \frac{v}{2}(1 - s)^2\sigma^2 \tag{11}$$

where $v$ is the coefficient of absolute risk aversion and measures the firm's risk aversion.

The firm's optimization problem is to choose the levels of the base wage, profit-sharing ratio, and employment so as to maximize its certainty equivalence (11). Since the scale of the firm is small, the firm makes its employment decisions in the belief that it cannot influence the unemployment rate. Taking the first differentiation of (11) with respect to $w$, $s$, and $n$, we have:

$$V_{\mathrm{w}}^{\mathrm{F}} = (1 - s)n[e_{\mathrm{w}}R'(en) - 1] = 0 \tag{12}$$

$$V_{\mathrm{s}}^{\mathrm{F}} = -[R(en) - wn] + (1-s)e_{\mathrm{s}}R'n + v(1-s)\sigma^2 = 0, \tag{13}$$

$$V_n^{\mathrm{F}} = (1-s)[(e + e_n n)R'(en) - w] = 0. \tag{14}$$

In addition, we assume that the second-order conditions should be satisfied.[9]

As mentioned in the Introduction, Blanchflower and Oswald (1987) and Nordhaus (1986) raise the following questions: If profit sharing is so beneficial, then firms ought to see that it is in their own best interest. Why, then, is it necessary to subsidize it? Weitzman replies that the sharing scheme is advocated, not because of its incentives, but solely on the grounds of its external macroeconomic virtues. In what follows, we attempt to show that the existence of profit sharing may be rooted in the private self-interest of firms and, as a result, we put forward the following proposition:

*Proposition 3. By virtue of the risk sharing in relation to revenue fluctuations* ($v > 0$) *and the stimulating effect on worker effort* ($e_s > 0$), *the firm is willing to adopt profit-sharing schemes voluntarily. The existence of profit sharing could be rooted in the private self-interest of firms. Specifically,*

(i) *in the presence of full employment, the economy may shift to the pure profit-sharing system provided that the firm size is sufficiently small.*
(ii) *If firms are risk neutral and workers have a sufficiently large coefficient of risk aversion, the fixed wage system is adopted.*

*Proof*: If follows immediately from (13) that there exists an interior solution s > 0 provided that the conditions $v > 0$ and $e_{\mathrm{s}} > 0$ hold. In addition, substituting $u = 0$ into (10b) yields $e_{\mathrm{w}}|_{u=0} = 0$, implying that the base wage no longer has a stimulating effect on worker effort. With this result, (12) becomes $V_{\mathrm{w}}^{\mathrm{F}}|_{u=0} = -(1-s)n < 0$. This implies that a higher base wage only raises the firm's compensation cost but leaves revenue intact and, consequently, profit sharing will replace the fixed wage to serve as a work motivator.

If the firm is risk neutral ($v = 0$) and employees are sufficiently risk averse (i.e., $\gamma > \{p'u[(R - wn)/n] - (1 - pu)\bar{e}_e R'\}n^2/p'us\sigma^2$) such that $e_s < 0$ in (10c), profit sharing will lose its advantages. As such (13) is reduced to $V_{\mathrm{s}}^{\mathrm{F}}|_{v=0, e_{\mathrm{s}}<0} = -(R - wn) + (1-s)e_s R'n < 0$, implying that it is optimal for firms to set $s = 0$ and to choose a fixed wage contract.

In the presence of full employment, profit sharing becomes the only incentive in terms of inducing work effort, and therefore the economy will shift to the pure profit-sharing system. Moreover, Proposition 3(ii) reveals that if, on the one hand, firms are risk neutral, they can bear risk without incurring any cost and hence do not need to share the risk with their employees. On the other hand, owing to the workers' aversion to risk, profit-sharing programs will give rise to a disincentive effect in regard to the worker's effort (i.e., $e_{\mathrm{s}} < 0$). Given these effects, a fixed-wage system will prevail in the economy.

## 3. Comparative statics

We next investigate the impact of an increase in revenue fluctuations on the base wage, sharing ratio and employment. To simplify the analysis, we follow Schmidt-Sørensen (1991) and assume that the second-derivatives and cross-derivatives of the effort function are negligible.

Total differentiating (12)–(14), we have

$$\begin{bmatrix} V_{\mathrm{ww}}^{\mathrm{F}} & V_{\mathrm{ws}}^{\mathrm{F}} & V_{\mathrm{wn}}^{\mathrm{F}} \\ V_{\mathrm{sw}}^{\mathrm{F}} & V_{\mathrm{ss}}^{\mathrm{F}} & V_{\mathrm{sn}}^{\mathrm{F}} \\ V_{\mathrm{nw}}^{\mathrm{F}} & V_{\mathrm{ns}}^{\mathrm{F}} & V_{\mathrm{nn}}^{\mathrm{F}} \end{bmatrix} \begin{bmatrix} dw \\ ds \\ dn \end{bmatrix} = \begin{bmatrix} -[(1-s)e_{\mathrm{w}}n^2R''e_{\sigma^2}]d\sigma^2 \\ \{[nR' - (1-s)e_{\mathrm{s}}n^2R'']e_{\sigma^2} - v(1-s)\}d\sigma^2 \\ -(1-s)[R' + nR''(e + ne_n)]e_{\sigma^2}d\sigma^2 \end{bmatrix}, \tag{15}$$

where $V_{\mathrm{ws}}^{\mathrm{F}} = V_{\mathrm{sw}}^{\mathrm{F}} = (1-s)e_{\mathrm{w}}e_{\mathrm{s}}n^2R''$, $V_{\mathrm{sn}}^{\mathrm{F}} = V_{\mathrm{ns}}^{\mathrm{F}} = (1-s)e_{\mathrm{s}}[R' + nR''(e + ne_n)]$, and $V_{\mathrm{nw}}^{\mathrm{F}} = V_{\mathrm{wn}}^{\mathrm{F}} = e_{\mathrm{w}}n(1-s)(e + ne_n)R''$. By Cramer's rule, the comparative statics of an increase in $\sigma^2$ on the base wage, the sharing coefficient, and employment, respectively, is:

$$\frac{\partial w}{\partial \sigma^2} = \frac{-e_{\mathrm{w}}(1-s)^2(e - ne_n)nR'R''}{\Omega} \times [e_{\sigma^2}(e_{\mathrm{s}}nR' + v\sigma^2) + (1-s)e_{\mathrm{s}}v], \tag{16}$$

$$\frac{\partial s}{\partial \sigma^2} = \frac{(e_w)^2(1-s)^2 n^2 R' R''}{\Omega} \times [e_{\sigma^2} R'(2e_n n + (1-s)e_s) - 2(1-s)e_n v], \quad (17)$$

$$\frac{\partial n}{\partial \sigma^2} = \frac{(e_w)^2(1-s)^2 n^2 R' R''}{\Omega} \times [e_{\sigma^2}(e_s n R' + v\sigma^2) + (1-s)e_s v]. \quad (18)$$

Obviously, the effects of an increase in revenue fluctuations on $w$, $s$, and $n$ are crucially related to the risk attitudes of both the firm and employees. It is, however, more interesting to discuss the above comparative statics by distinguishing between the following two cases:

### 3.1. *(i) The firm is risk averse ($v > 0$) but employees are risk neutral ($\gamma = 0$)*

It follows from (5) that if workers are risk neutral, employees can bear risk without any risk premium. In such a case, a higher sharing parameter can definitely entice work effort (i.e., $e_s|_{\gamma=0} > 0$ in (10c)), and a rise in employment encourages shirking with certainty (i.e., $e_n|_{\gamma=0} < 0$ in (10d)). At the same time, an increase in output fluctuations has no impact on the worker effort (i.e. $e_{\sigma^2}|_{\gamma=0} = 0$ in (10e)). Substituting these relationships into (16)–(18), we have:

$$\frac{\partial w}{\partial \sigma^2} = \frac{-e_w(1-s)^2(e - ne_n)nR'R''}{\Omega}[(1-s)e_s v] < 0,$$

$$\frac{\partial s}{\partial \sigma^2} = \frac{(e_w)^2(1-s)^2 n^2 R' R''}{\Omega}[-2(1-s)e_n v] > 0,$$

$$\frac{\partial n}{\partial \sigma^2} = \frac{(e_w)^2(1-s)^2 n^2 R' R''}{\Omega}[(1-s)e_s v] > 0.$$

The above equations lead to the following proposition:

*Proposition 4. If firms are risk averse and workers are risk neutral, firms facing a larger output fluctuation will increase their sharing ratio and employment in order to diversify the risk among their workers but will decrease the base wage.*

These results of Proposition 4 are quite intuitive. Since risk-neutral workers can bear risk without incurring premiums, income volatility has no impact on employees' effort. When the firm incurs a larger output fluctuation, the risk-averse firm will raise the profit-sharing ratio and hire more employees in order to spread the risk of revenue volatility among its employees. As sharing parameters are raised, in order to decrease the firm's wage costs, the other work motivator – the fixed base wage – can therefore be cut. In other words, profit-sharing systems may be introduced as risk-sharing devices by firms when they perceive more uncertainty regarding profits and when the risk cost associated with fluctuations is increased.

Blanchflower and Oswald (1988) find that profit-sharing programs are relatively common in the highly volatile mineral and chemical industries in UK. Using evidence from the motion picture industry in America, Weinstein (1996) and Chisholm (1997) present the following argument: when the principal is more risk averse than his/her agents, a more risky firm will increase the likelihood that the principal will offer the agents a share contract in order to spread the risk. It is important to note that the implication of Proposition 4 may be restrictive since it is based on the assumption that firms are risk averse and that workers are risk neutral, which does not seem to be appealing. Nevertheless, by referring to (10e) and (17), we can more safely conclude that our result is true if the extent of the workers' absolute risk aversion $\gamma$ is sufficiently low (hence, $e_{\sigma^2}$ becomes smaller) and the extent of the firms' absolute risk aversion $v$ is sufficiently high such that $|2(1-s)e_n v| > |e_{\sigma^2} R'(2e_n n + (1-s)e_s)|$ and hence $\frac{\partial s}{\partial \sigma^2} > 0$. In other words, in the absence of infinite risk aversion on the part of workers, some risk will be shared with workers as an industry becomes more volatile.

### 3.2. *(ii) The firm is risk neutral ($v = 0$) and workers are risk averse ($\gamma > 0$)*

Since, the risk-averse worker dislikes income fluctuations and incurs risk costs, a higher sharing parameter not only creates a stronger incentive effect but also exposes employed workers to a more significant amount of income risk. Equation (10e) reveals that a larger variation in aggregate demand will encourage shirking. From (10c) and (10d), the impacts of a rise in the sharing coefficient and in the level of employment on work effort are both ambiguous. However, in order to satisfy the second-order conditions (see note 9), we should specify that $e_s > 0$ and $e_n < 0$ for optimal interior solutions in this case. Substituting these relationships into (16)–(18), these comparative statics can be rewritten as:

$$\frac{\partial w}{\partial \sigma^2} = \frac{-e_w(1-s)^2(e-ne_n)nR'R''}{\Omega}(e_{\sigma^2}e_s nR') > 0,$$

$$\frac{\partial s}{\partial \sigma^2} = \frac{(e_w)^2(1-s)^2 n^2 R'R''}{\Omega}[e_{\sigma^2}R'(2e_n n + (1-s)e_s)] \gtreqless 0,$$

$$\frac{\partial n}{\partial \sigma^2} = \frac{(e_w)^2(1-s)^2 n^2 R'R''}{\Omega}(e_{\sigma^2}e_s nR') < 0.$$

Accordingly, we have:

*Proposition 5. If the firm is risk neutral and workers are risk averse, a rise in the output fluctuation will increase the fixed base wage and decrease the firm's labor demand, but will have an ambiguous effect on the profit-sharing coefficient.*

A graphical illustration is helpful to our understanding of the comparative results stated in Proposition 4. In both Figures 3 and 4, the pairs of $s$ and $w$ that satisfy the optimal conditions of the determination of the base wage, sharing ratios, and employment are represented by the $WW$, $SS$, and $NN$ schedules, respectively. From equation (16) it is clear that the slopes of these curves are:

$$\frac{\partial s}{\partial w}|_{WW} = -\frac{e_w}{e_s} < 0,$$

$$\frac{\partial s}{\partial w}|_{SS} = -\frac{(1-s)e_w e_s n^2 R''}{V_{ss}^F} < 0, \text{ and}$$ [10]

$$\frac{\partial s}{\partial w}|_{NN} = -\frac{e_w(e+ne_n)nR''}{e_s[R'+nR''(e+ne_n)]} > 0.$$

Two points should be addressed at this stage. First, the slope of SS is greater than that of $WW$ owing to the second-order condition $\Omega_1 > 0$ (referred to in note 9). Second, with $s$ on the vertical axis and $w$ on the horizontal axis, the remaining endogenous variable $n$ should be altered in order to satisfy the optimum conditions reported in (12)–(14). Specifically, employment will adjust so as to move the economy to a point where all of the $WW$, $SS$, and $NN$ schedules intersect.

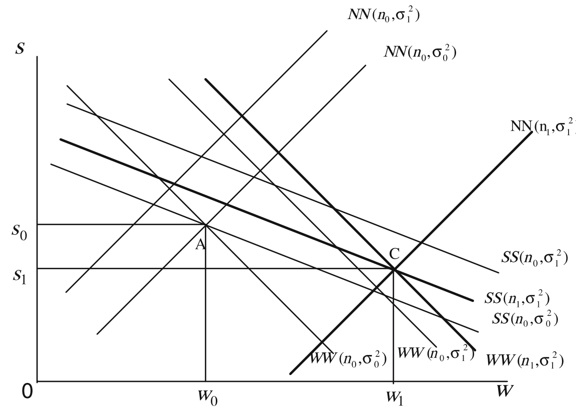


Figure 3. The effects of an increase in income fluctuations: Case (i).

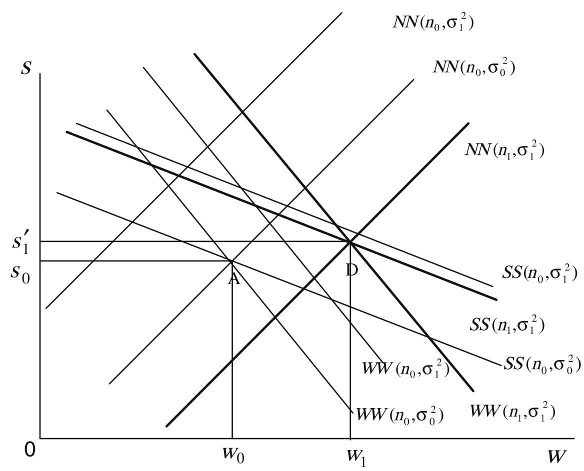


Figure 4. The effects of an increase in income fluctuations: Case (ii).

In both Figures 3 and 4, we assume that initially the income volatility is $\sigma_0^2$ and that the base wage, the sharing ratio, and employment are $w_0$, $s_0$, and $n_0$, respectively. The initial equilibrium is at point $A$ which is the intersection of the curves $WW(n_0, \sigma_0^2)$, $SS(n_0, \sigma_0^2)$, and $NN(n_0, \sigma_0^2)$. In response to an increase in income fluctuations from $\sigma_0^2$ to $\sigma_1^2$, $WW(n_0, \sigma_0^2)$ and $SS(n_0, \sigma_0^2)$ shift rightwards to $WW(n_0, \sigma_1^2)$ and

$SS(n_0, \sigma_1^2)$, respectively, while $NN(n_0, \sigma_0^2)$ shifts leftwards to $NN(n_0, \sigma_1^2)$. In order to satisfy all optimal conditions in (12)–(14), a decline in employment from $n_0$ to $n_1$ is required.[11] This decreased employment will shift both $WW(n_0, \sigma_1^2)$ and $NN(n_0, \sigma_1^2)$ rightwards to $WW(n_1, \sigma_1^2)$ and $NN(n_1, \sigma_1^2)$, respectively, while the $SS(n_0, \sigma_1^2)$ locus shifts leftwards to the $SS(n_1, \sigma_1^2)$ curve. [12] The final equilibrium point could either be point $C$ in Figure 3 or point $D$ in Figure 4. Referring to both figures, it can be concluded that a larger fluctuation in aggregate demand will increase the base wage and decrease the level of employment, while having an ambiguous impact on the sharing ratio.

If we adequately represent 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. However, for our purposes, there is no need to undertake such an analysis. Nevertheless, the detailed derivation is available upon request.

## 4. Concluding remarks

This paper has explicitly developed an efficiency wage model, which considers the link between profit sharing and fluctuations in output. Based on this model, we have found that the risk attitudes of firms and workers are the crucial elements in determining the workers' effort and the firms' choice of payment method.

Some interesting findings are established in the analysis. First of all, in contrast to the traditional efficiency wage theories, unemployment is no longer a necessary device to induce work effort in a profit-sharing economy. When full employment is present, profit-sharing compensation may act as a possible worker discipline device and the economy will shift to the pure profit-sharing system. These results are more likely to be true when there are a lot of small businesses in the economy. However, if firms are risk neutral and workers are more risk averse, the fixed-wage system will prevail. Second, a higher profit-sharing coefficient is not necessarily a sufficient motivator to boost work effort, particularly when employees are more risk averse. This finding is a possible reconciliation of the conflicting results in the empirical studies. Third, if firms are risk averse and workers are risk neutral, firms facing a larger output fluctuation will increase their profit-sharing ratio and employment in order to diversify the risk among their workers, but will decrease the base wage. If the firm is risk neutral and workers are risk averse, an increase in the output fluctuations will increase the fixed base wage and decrease the firm's demand for labor, but will have an ambiguous effect on the profit-sharing coefficient.

## Notes

[1] Nordhaus (1986), Pissarides (1987), and Estrin and Wadhwani (1990) provide an excellent and comprehensive review of profit sharing.

[2] In the agricultural literature, risk sharing between the landlord and tiller has been suggested as a possible motivation for sharecropping. Those studies include Stiglitz (1974), Newbery (1977), Shavell (1979), and more recently Agrawal (1999).

[3] There are several versions of efficiency wage theories. They range from nutritional concerns to social norms. See Akerlof and Yellen (1986) and Katz (1986) for comprehensive surveys.

[4] By focusing on Weitzman's medium-boiled and hard-boiled effects, John (1991) provides a cautionary suggestion by stating that the stabilization effect of profit-sharing schemes on employment is very sensitive to the specifications of the labor market. Levine (1989) and Andrew (1991) further show that share contracts can result in less, and not more, employment stability and cause an increase in unemployment.

[5] Specifically, the negative exponential utility form $U^{\mathrm{W}} = -\exp[-\gamma(Y - e)]$ can yield the worker's certainty equivalence reported in (2) (see Layard and Walters, 1978; Holmstrom and Milgrom, 1991; Zábojník, 1996 for details).

[6] For simplicity, we assume that shirkers are denied unemployment compensation, as in, for example, Goerke (2002).

[7] The numerical analysis is performed based on the symmetric equilibrium $e = \bar{e} = \tilde{e}$, as we will assume below.

[8] For example, Jones and Pliskin (1991) and Kruse (1993a) find that employees in the sharing firm could perform with lower productivity.

[9] The second-order conditions are given by:

$$V_{\mathrm{ww}}^{\mathrm{F}} = (1-s)(e_{\mathrm{w}})^2 n^2 R'' < 0,$$
$$V_{\mathrm{ss}}^{\mathrm{F}} = ne_{\mathrm{s}}[-2R' + (1-s)e_{\mathrm{s}} nR''] - v\sigma^2 < 0,$$
$$V_{\mathrm{nn}}^{\mathrm{F}} = (1-s)[2e_n R' + (e + ne_n)^2 R''] < 0,$$

$$\begin{aligned}\Omega_1 &= V_{\mathrm{ww}}^{\mathrm{F}} V_{\mathrm{ss}}^{\mathrm{F}} - (V_{\mathrm{ws}}^{\mathrm{F}})^2 \\ &= -(1-s)(e_{\mathrm{w}})^2 n^2 R''(2ne_{\mathrm{s}} R' + v\sigma^2) > 0,\end{aligned}$$

$$\Omega_2 = V^{F}_{ww} V^{F}_{nn} - (V^{F}_{wn})^2 = 2e_n(1-s)^2(e_w)^2 n^2 R' R'' > 0,$$

$$\Omega_3 = V^{F}_{nn} V^{F}_{ss} - (V^{F}_{ns})^2 = -(1-s)\{(1-s)(e_s)^2 R' \times (R' + 2enR'') + (2ne_s R' + v\sigma^2) \times [2e_n R' + (e+ne_n)^2 R'']\} > 0,$$

$$\Omega = V^{F}_{ww}\Omega_3 + V^{F}_{ss}\Omega_2 + V^{F}_{nn}\Omega_1 = -(1-s)^2(e_w)^2 n^2 R' R'' \times \{e_s R'[4e_n n + (1-s)e_s] + 2e_n v\sigma^2\} < 0.$$

[10] It is assumed that $R' + nR''(e + ne_n) > 0$. Under the revenue functional form $R(en) = a(en)^{\alpha}$ we specify previously, this assumption holds.

[11] If the level of employed labor is given at $n_0$, we can obtain $\partial w/\partial\sigma^2|_{n=n_0} = (1-s)e_w \;\; e_s e_{\sigma^2} n^3 R' R''/\Omega_1 > 0$ and $\partial s/\partial\sigma^2|_{n=n_0} = (1-s)(e_w)^2 \;\; e_{\sigma^2} n^3 R' R''/\Omega_1 > 0$ from (12) and (13). Substituting these two results into (14) and using the implicit function theorem, we can deduce that:

$$\partial n/\partial\sigma^2 = \frac{(1-s)^2(e_w)^2 e_{\sigma^2} n^2 R' R''}{V^{F}_{nn}\Omega_1} \{e_s[R' + nR''(e+ne_n)] - e_w n(e+ne_n)R''\} < 0$$

[12] From (15) we can easily obtain: $\partial w/\partial n|_{WW} = \frac{-(e+ne_n)}{e_w n} < 0$, $\partial w/\partial n|_{SS} = \frac{-[R' + nR''(e+ne_n)]}{e_w n^2 R''} > 0$, and $\partial w/\partial n|_{NN} = \frac{-[2e_n R' + R''(e+ne_n)^2]}{e_w n R''(e+ne_n)} < 0$

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