The Incentive Power of Employee Ownership through Stock Purchase Plan

Nicolas DUMAS*
Paris Center For Law and Economics
Paris II (Panthéon-Assas) University

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Abstract

The article is a first step toward a incentive theory of Employee Stock Purchase Plan (ESPP). It is argued that ESPP is particularly relevant when the employer wants the employees to reveal suggestions that would improve the production process or the output quality. It is show that offering ESPP can be as efficient as suggestion pay and performance pay, and that it can outperform profit sharing. This contrasts Holmström's interpretation that separating ownership and control is efficient.

Firms have various motives to implement employee ownership. First of all, governments often offer some tax benefits for the employer, the employees or both. Indeed, employee ownership is often seen favorably by the politicians because it extends the democratic principles inside the firm. The European Union has also been an important advocate of employee ownership through the PEPPER reports. Furthermore, employee ownership is considered as a substitute to public and institutional investment in the sens that it allows the capital to remain domestic. This was indeed the main motive behind the recent Macron Law in France since it counterbalanced the withdrawal from traditional shareholders. Earlier, employees had also played an important role as investors during the privatization of public firms such as France Telecom and even more clearly during the transition period in communist economies such as Estonia (*Jones* et *Mygind*, 1999; *DeVaro* et *Kato*, 2011). In a similar fashion, some firms use stock ownership as a solution to hostile takeovers (*Beatty*, 1994; *Shivdasani*, 1993; *Aubert et al.*, 2014; *Kruse et al.*, 2010). When the positions of both the employer and the employees are threatened, it may be in their interest to collude by purchasing shares thereby preventing the takeover.

As convincing as they may be, those determinants cannot be the sole motives for firms to implement some kind of shared ownership. Employees have owned shares for centuries, long before tax incentives were implemented and hostile takeovers were a significant threat. Proudhon was indeed a proponent of such

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practices and some applications were observed during the nineteenth century in the UK (John Lewis Partnership), in France (Familistère de Guise), in Italy (Legacoop) and in the US (Rand McNally).

Firms implement employee ownership for its benefits on industrial relations as well. John Bates Clark was already a proponent of this mechanism. According to him, performance pay stimulates grievance because the employees always ask a higher reward for their work. Profit sharing, however, favors cooperation. This cooperation is partial though, since the employees are still tempted to ask a larger share. According to Clark, stock ownership is the only mean to reach the complete cooperation from the employees. Furthermore some authors argue that stock ownership develops the feeling of belonging to the organization that would inhibit the union power. Indeed, the unionization rate is lower in ESOP companies (*Freeman* et *Kleiner*, 1990; *Mitchell et al.*, 1989). Stock ownership may also be beneficial for the firm performance on other grounds. From the compensating differential theory view point, it may attract new workers, especially in the US where it is a mean to save for retirement. It may also be a mean to screen the most efficient workers as they expect higher returns than the less efficient ones.

Finally, an alternative explanation to this practice draws from the incentive theory. Stock ownership aligns the employees' interest with the employer's one. So offering stock should yield more productive behaviors. Arguably, such a scheme would be particularly efficient when the employees are to undertake tasks that cannot be contracted upon. In a complex world one may not be able to write a contract that specifies all the task that the employees shall undertake and the rewards for each of them. Oppositely, offering a claim on the profits ensures that the employees benefit from exerting effort in tasks that are not explicitly stated. Such an extra effort is often referred to as "employee involvement" in the literature. One important aspect of employee involvement is what could be called "suggestion schemes" which encompass suggestion box, quality circles and workshop meetings. Such schemes aim at collecting ideas from the employees that would improve the production process or the production quality. Indeed, there are some evidence of its complementary with employee ownership (*McNabb* et *Whitfield*, 1998; *Pendleton* et *Robinson*, 2010; *Kalmi* et *Klinedinst*, 2006; *Chi et al.*, 2011).

Numerous authors have estimated the effect of stock ownership on firm financial performance and productivity, however with mixed results (*Jones* et *Kato*, 1993, 1995; *Conte et al.*, 1996; *Blasi et al.*, 1996; *Kruse*, 2002; *Bacha et al.*, 2009; *Blasi et al.*, 2013a,b). The main explanation that has been put forward is the free-rider problem. This phenomenon appears when the gains of a partnership are shared among the workers because, by reducing their individual effort, the employees reduce the amount they get less than proportionally. This behavior has been studied primarily under a profit sharing scheme (e.g. *Kandel* et *Lazear*, 1992) but it is legitimate to think that it would emerge under stock ownership as well. Indeed, with both schemes, the employees have a claim on the firm profits.

In this article, I show that this is not necessarily the case. The reason lies on the means by which employees acquire shares. This can happen in three ways : the attribution of stock options, the attribution of free shares, and the

implementation of an Employee Stock Purchase Plan (ESPP). I will mostly focus on ESPP in what follows. It is known in the United Kingdom as Save As You Earn (SAYE) or in France as *augmentations de capital réservées aux salariés*. The main characteristic of the plan is that the employees are given the possibility to purchase some shares for a given maximal amount and a given price. Both are set in advance. The employer usually offers a discount on the market price and may contribute to the employees demand by offering a proportional amount of shares. Each employee can announce the number of shares that he is willing to purchase during a subscription period which length is set in advance as well.

As I have pointed out, stock ownership is supposedly more efficient when it aims at stimulating employees ideas in suggestion schemes. Hence, in what follows, I will assume that participation in such scheme is a task that the employee can undertake, even though the model can be interpreted in a broader sense.

This article contributes to the literature in several way. First of all, it yields a testable theory of the efficiency of stock ownership as compared to profit sharing. While there has been numerous studies on the efficiency of shared capitalism, the explanation of the difference in efficiency between the two mechanism is seldom provided and tested. Second, even though my model does not question Holmström theory of the firm, it nuances his interpretation on the efficiency to dissociate ownership and labour (what he calls the capitalistic firm).
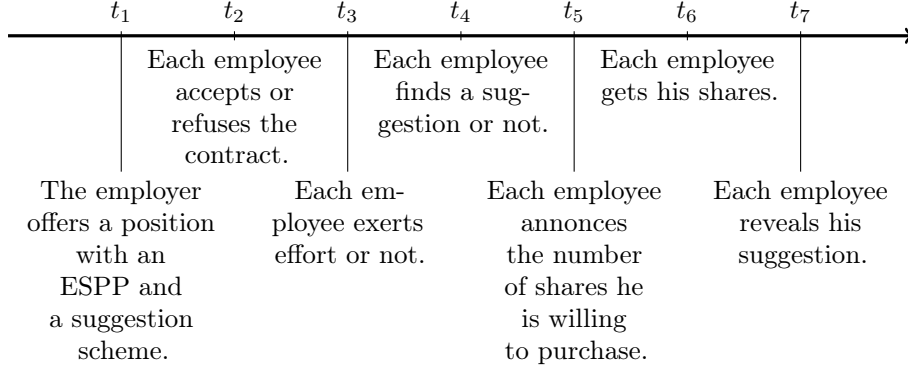
The remaining of this article will be organized as follows. The first section presents an original model of ESPP which is our main contribution. The following sections develop models of suggestion pay, performance pay and linear profit sharing and compares the results to the ones of ESPP.

1 Employee stock purchase plan

There is one employer and n homogeneous employees indexed i. All are risk neutral. The employer initially owns the totality of the firm that is divided in m shares. The employees exert effort in two tasks: production and suggestion. However, it is assumed that there is no hazard in the production task, and that the employees are paid a fixed wage. Therefore, the production task can be omitted.

Employees cannot communicate with one another, nor can they (and the employer) observe their colleagues' effort and suggestions. Each employee can find at most one suggestion. He exerts an effort $a \in \{0, 1\}$ that increases the probability p_a to find a suggestion ($p_1 > p_0$). Providing effort also induces a linear disutility $\psi \times a_i$. The profits Π_s rise with the number of suggestion s that have been implemented ($\Pi_s > \Pi_{s-1}$). Thereby, the suggestion are always beneficial. An additional suggestion rises the firm profits by the same amount $\Pi_s - \Pi_{s-1}$, no matter who it came from. However, no assumptions are made on the concavity of Π_s with respect to s. Therefore, the suggestions from different employees can either be complements (if $\Pi_s - \Pi_{s-1} > \Pi_{s-1} - \Pi_{s-2}$) or substitutes (if $\Pi_s - \Pi_{s-1} < \Pi_{s-1} - \Pi_{s-2}$). Following the assumptions made so far, the number of suggestions found follows a binomial distribution. Hence, the probability to find s suggestions is $\mathscr{B}(s;\, n,\, p_1) = \frac{n!}{s!(n-s)!} p_1^s (1 - p_1)^{n-s}$.

Figure 1: Timing

| t_1 | t_2 | t_3 | t_4 | t_5 | t_6 | t_7 |

Each employee accepts or refuses the contract.

Each employee finds a suggestion or not.

Each employee gets his shares.

The employer offers a position with an ESPP and a suggestion scheme.

Each employee exerts effort or not.

Each employee annonces the number of shares he is willing to purchase.

Each employee reveals his suggestion.

The chronology of the game is presented figure 1. The subscription period goes from t_1 to t_5. At t_1 the employees are offered to purchase some stock up to $\hat{\alpha}\%$ of the firm at a given unit price κ. The "market capitalization" is therefore $V = \kappa \times m$. The employees are not individually restricted in the number of shares they can purchase. Nonetheless, the sum of shares purchased cannot exceed $\hat{\alpha}$. When this happens, it is assumed that the employer trims each demand following a *trimming rule* known from the start by the employees. This rule consists in reducing the highest demands first such that (1) the demands sum to $\hat{\alpha}$ and (2) it maximizes the number of employees whose demand are totally fulfilled. The employees have to announce the number of shares they want before the end of the subscription period. Since the suggestion in instructive about the future value of the firm, it is in the employees' interest to provide effort until they find a suggestion or, if they do not, until the end of the subscription period. It is also in their interest to decide how many shares they are willing to purchase depending on whether or not they found a suggestion. Finally, if they employees do not trust the employer, they will be willing to reveal their suggestion only after the shares have been purchased. In order to limit the number of corner solutions, it is assumed that the employees have no financial constraint. Including such a constraint affect the feasibility of the mechanism but not the efficiency.

The model is solved by backward induction focusing on the case where the scheme is designed so that each employee provides effort $a = 1$. In t_6 each the employer applies (if necessary) the *trimming rule* depending on the individual demands. Again, each employee's demand depends on whether he found a suggestion or not. There are s employees who have a suggestion and $n - s$ employees who do not. Since employees are homogeneous, the demands of all employees who have a suggestion will be the same and the demands of all employees who do not will be the same. Denoting the former demand $\overline{\alpha}$ and the later demand $\underline{\alpha}$, we know that the trimming rule will apply when $s\,\overline{\alpha} + (n - s)\,\underline{\alpha} \geq \hat{\alpha}$. Hence, the trimming rule yields the following possibilities :

Lemma 1.

1. *If* $\min\{\overline{\alpha}, \underline{\alpha}\} > \frac{\hat{\alpha}}{n}$*, then each employee gets* $\frac{\hat{\alpha}}{n}$ *no matter if he had a suggestion or not.*

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2. *If $\overline{\alpha} > \underline{\alpha}$, $\underline{\alpha} \leq \frac{\hat{\alpha}}{n}$ and $\overline{\alpha} > \frac{\hat{\alpha} - (n-s)\underline{\alpha}}{s}$ then each employee who has no suggestion gets what he asked, and the each employee who has a suggestion gets $\frac{\hat{\alpha} - (n-s)\underline{\alpha}}{s}$.*

3. *If $\underline{\alpha} > \overline{\alpha}$, $\overline{\alpha} \leq \frac{\hat{\alpha}}{n}$ and $\overline{\alpha} > \frac{\hat{\alpha} - s\overline{\alpha}}{n-s}$ then each employee who has no suggestion gets $\frac{\hat{\alpha} - s\overline{\alpha}}{n-s}$, and each employee who has a suggestion gets what he wants.*

In t_5, each employee chooses the number of shares he demands. We can distinguish three cases summarized in lemma 2.

Lemma 2.

1. *If $\sum_{s=0}^{n-1} \mathscr{B}(s; n-1, p_1) \Pi_s \geq V$, each employee always ask $\hat{\alpha}$ no matter if he found a suggestion or not. He eventually gets $\frac{\hat{\alpha}}{n}$.*

2. *If $\sum_{s=0}^{n-1} \mathscr{B}(s; n-1, p_1) \Pi_s < V \leq \frac{n p_1}{1-(1-p_1)^n} \sum_{s=1}^{n} \mathscr{B}(s-1; n-1, p_1) \Pi_s \frac{1}{s}$, each employee ask $\hat{\alpha}$ if he has a suggestion and 0 otherwise. He eventually gets $\frac{\hat{\alpha}}{s}$ if he has a suggestion.*

3. *If $\frac{n p_1}{1-(1-p_1)^n} \sum_{s=1}^{n} \mathscr{B}(s-1; n-1, p_1) \Pi_s \frac{1}{s} < V$, each employee always ask 0 no matter if he found a suggestion or not.*

Proof. Suppose that all employees who have no suggestion ask no shares and that all employees who have a suggestion ask $\overline{\alpha}$ such that $s\overline{\alpha} < \tilde{\alpha}$ (i.e. all employees would receive their whole demands). Then the expected utility of an employee who has a suggestion would be

$$\overline{\alpha} \sum_{s=1}^{n} \mathscr{B}(s; n, p_1)(\Pi_s - V)$$

It is clear that this is not a Nash equilibrium since all employees who have a suggestion would be better off by asking a higher share. Therefore, each of them will increase his demand. Eventually, the sum of demands $s\overline{\alpha}$ will exceed $\tilde{\alpha}$ and the trimming rule will apply. Therefore, all employees who have a suggestion will get

$$\hat{\alpha} \sum_{s=1}^{n} \mathscr{B}(s; n, p_1)(\Pi_s - V)\frac{1}{s} \tag{1}$$

Of course, the employees will ask some shares if this expected utility is greater than 0. So the employee who have a suggestion would ask some shares, knowing that the employees who don't have a suggestion purchase no shares if

$$\hat{\alpha} \sum_{s=1}^{n} \mathscr{B}(s; n, p_1)(\Pi_s - V)\frac{1}{s} \geq 0$$

Since $\hat{\alpha} > 0$, this can be rewritten as

$$V \leq \frac{n p_1}{1-(1-p_1)^n} \sum_{s=1}^{n} \mathscr{B}(s-1; n-1, p_1) \Pi_s \frac{1}{s}$$

This can only happen when the employees who have no suggestion ask no shares. So we have to derive the condition for this to happens. Observe that

$$0 \qquad\qquad \sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right) \Pi_s \qquad \frac{n\,p_1}{1-(1-p_1)^n} \sum_{s=1}^{n} \mathscr{B}\left(s-1;\, n-1,\, p_1\right) \Pi_s \frac{1}{s}$$

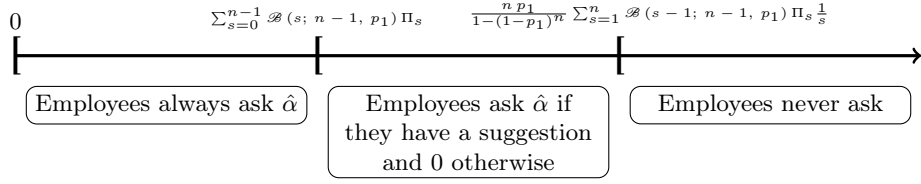| Employees always ask $\hat{\alpha}$ | Employees ask $\hat{\alpha}$ if they have a suggestion and 0 otherwise | Employees never ask |

Figure 2: Demands reaction to market capitalization

the employees who have a suggestion derive a higher utility of buying shares than the one who don't. Therefore, if the employees who have no suggestions ask some shares, so will the ones who have a suggestion. In the similar fashion as before, the employees will then increase their demands such that eventually $s\overline{\alpha} > \tilde{\alpha}$ and $(n-s)\underline{\alpha} > \tilde{\alpha}$. Hence, they will all receive $\frac{\tilde{\alpha}}{n}$. If an employee has no suggestion and asks some shares, his expected utility will be

$$\frac{\hat{\alpha}}{n} \sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right) \left(\Pi_s - V\right)$$

So he will not purchase any shares if

$$\frac{\hat{\alpha}}{n} \sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right) \left(\Pi_s - V\right) < 0$$

That is to say, if $\sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right) \Pi_s < V$ $\qquad\qquad\qquad \square$

The lemma 2 can be represented as in figure 2. The interpretation is intuitive. When the market capitalization (i.e. the share price) is sufficiently low, then it is in the employees' interest to ask some shares no matter if they have a suggestion or not. When the price rises, then the employees who have no suggestion are discouraged to ask shares, while the employees who have a suggestion keep on asking $\hat{\alpha}$. Finally, when the market capitalization is excessively high, no employee ask shares.

Of course, there is no point for the employer to set a market capitalization so that no employee purchase shares. In this case, the employees would have no gains and no incentives to provide effort. In a similar fashion, it is intuitive that setting a price in the first interval is not efficient since it would also reward the employees who make no suggestion. Therefore, I will focus on the second interval to derive the optimal values. I will show in the next section that there is little loss of generality in proceeding this way.

In t_3, the employees decide whether or not to exert effort, knowing that the market capitalization is in the second interval and anticipating their demands. They know that they would ask no share and make no gains if they have no suggestion (which occurs with a probability $(1-p_a)$). Conversely, as I have shown expression 1, they know that their expected utility will be

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$\sum_{s=1}^{n} \mathscr{B}(s-1;\, n-1,\, p_1)\, (\Pi_s - V)\, \frac{\hat{\alpha}}{s}$ if they have a suggestion (which occurs with a probability p_a). For the employees to exert effort, their utility of doing so has to be no lower than their utility when they do not exert effort. Therefore, the following incentive constraint has to be satisfied

$$p_1 \sum_{s=1}^{n} \mathscr{B}(s-1;\, n-1,\, p_1)\, (\Pi_s - V)\, \frac{\hat{\alpha}}{s} - \psi \geq p_0 \sum_{s=1}^{n} \mathscr{B}(s-1;\, n-1,\, p_1)\, (\Pi_s - V)\, \frac{\hat{\alpha}}{s}$$

This expression can be written in a simpler way

$$\frac{1}{n\, p_1} \sum_{s=1}^{n} \mathscr{B}(s;\, n,\, p_1)\, (\Pi_s - V)\, \hat{\alpha} - \frac{\psi}{p_1 - p_0} \geq 0 \qquad (ICES)$$

Moreover, for the employees to accept the contract, their expected utility has to be greater than their outside opportunity, which I normalize to 0. Hence, the following participation constraint has to be satisfied as well

$$\frac{1}{n} \sum_{s=1}^{n} \mathscr{B}(s;\, n,\, p_1)\, (\Pi_s - V)\, \hat{\alpha} - \psi \geq 0 \qquad (PCES)$$

Of course, the shares offered to the employees cannot be negative. Moreover, it cannot be above the exogenous threshold $\tilde{\alpha}$ (typically 50% of the firm). So the following constraint must be satisfied

$$\hat{\alpha} \geq 0 \qquad (MINES1)$$

$$\hat{\alpha} \leq \tilde{\alpha} \qquad (MAXES)$$

I will also account for the fact that the firm cannot sell shares bellow a certain price. Indeed, in most countries, the price cannot be set below 20% of the market price. Therefore, the market capitalization has to satisfy the following constraint

$$V \geq \tilde{V} \qquad (MINES2)$$

Finally, the two following conditions have to be satisfied for the market capitalization to be in the second interval :

$$\frac{1}{n} \sum_{s=0}^{n-1} \mathscr{B}(s;\, n-1,\, p_1)\, (\Pi_s - V)\, \hat{\alpha} \leq 0 \qquad (DES1)$$

$$\sum_{s=1}^{n} \mathscr{B}(s;\, n,\, p_1)\, (\Pi_s - V)\, \frac{\hat{\alpha}}{s} \geq 0 \qquad (DES2)$$

If no suggestion are submitted (with a probability $(1 - p_1)^n$), the firm value remains at its *status quo* level Π_0 and no shares are being purchased. If one suggestion or more are found, that the global shares demand will be fulfilled up to $\hat{\alpha}$. The employer will then get a monetary transfer $\hat{\alpha}V$ that results from the sell. Hence, he chooses $\hat{\alpha}$ and V to solve :

$$\max_{\{\hat{\alpha}, V\}} \quad \sum_{s=1}^{n} \mathscr{B}(s;\, n,\, p_1)\, ((1 - \hat{\alpha})\, \Pi_s + \hat{\alpha}V) + (1 - p_1)^n\, \Pi_0$$
$$\text{w.r.t} \quad ICES,\ PCES,\ MINES1,\ MAXES,\ MINES2,\ DES1,\ DES2$$

Before solving the employer's program, observe that $MINES1$, $PCES$ and $DES2$ are implied by $ICES$. Therefore, they can be omitted, and *ex post* check should prove that they are always satisfied.

In order to ensure the concavity of the program, we can apply a simple variable change with $v = \hat{\alpha}V$. The remaining constraints can then be rewritten as

$$\frac{1}{n\,p_1} \sum_{s=1}^{n} \mathscr{B}\left(s;\, n,\, p_1\right)\left(\hat{\alpha}\Pi_s - v\right) - \frac{\psi}{p_1 - p_0} \geq 0 \qquad (ICES')$$

$$\frac{1}{n} \sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right)\left(\Pi_s \hat{\alpha} - v\right) \leq 0 \qquad (DES1')$$

$$-\frac{v}{\hat{\alpha}} + \tilde{V} \leq 0 \qquad (MINES2')$$

Finally, the employers program can becomes

$$\max_{\{\hat{\alpha}, v\}} \quad \sum_{s=1}^{n} \mathscr{B}\left(s;\, n,\, p_1\right)\left(\left(\Pi_s - \Pi_s\hat{\alpha}\right) + v\right) + \left(1 - p_1\right)^n \Pi_0$$
$$\text{w.r.t} \qquad ICES',\ MAXES,\ MINES2',\ DES1'$$

The Lagrangian for this program is

$$
\begin{aligned}
\mathscr{L} \;=\; & \sum_{s=1}^{n} \mathscr{B}\left(s;\, n,\, p_1\right)\left(\Pi_s - \Pi_s\hat{\alpha} + v\right) + \left(1 - p_1\right)^n \Pi_0 \\
& + \lambda_{ICES'}\left(\frac{1}{n\,p_1} \sum_{s=1}^{n} \mathscr{B}\left(s;\, n,\, p_1\right)\left(\hat{\alpha}\Pi_s - v\right) - \frac{\psi}{p_1 - p_0}\right) \\
& - \lambda_{DES1'}\left(\frac{1}{n} \sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right)\left(\Pi_s\hat{\alpha} - v\right)\right) \\
& - \lambda_{MAXES}\left(\hat{\alpha} - \tilde{\alpha}\right) - \lambda_{MINES2'}\left(-\frac{v}{\hat{\alpha}} + \tilde{V}\right)
\end{aligned}
$$

and to first order condition with respect to v gives

$$
\begin{aligned}
\frac{\partial \mathscr{L}}{\partial v} \;=\; & \sum_{s=1}^{n} \mathscr{B}\left(s;\, n,\, p_1\right) - \lambda_{ICES'}\frac{1}{n\,p_1}\sum_{s=1}^{n} \mathscr{B}\left(s;\, n,\, p_1\right) \\
& + \lambda_{DES1'}\left(\frac{1}{n}\sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right)\right) \\
& + \lambda_{MINES2P'}\frac{1}{\hat{\alpha}} = 0
\end{aligned}
$$

Given this condition, suppose that $ICES'$ is not binding. Then we would have $\lambda_{DES1'} < 0$ or $\lambda_{MINES2'} < 0$, which would violate the slackness conditions. Therefore, we necessarily have

$$\frac{1}{n\,p_1}\sum_{s=1}^{n} \mathscr{B}\left(s;\, n,\, p_1\right)\left(\hat{\alpha}\Pi_s - v\right) - \frac{\psi}{p_1 - p_0} = 0$$

We can solve this expression for $\hat{\alpha}$, which gives

$$\hat{\alpha} = \frac{\frac{\psi\, n\, p_1}{p_1 - p_0} + \sum_{s=1}^{n} \mathscr{B}\left(s;\, n,\, p_1\right) v}{\sum_{s=1}^{n} \mathscr{B}\left(s;\, n,\, p_1\right) \Pi_s}$$

or, given that $v = \hat{\alpha} V$

$$\hat{\alpha} = \frac{\psi\, n\, p_1}{(p_1 - p_0) \sum_{s=1}^{n} \mathscr{B}\left(s;\, n,\, p_1\right) \left(\Pi_s - V\right)} \tag{2}$$

Since the constraint is necessarily binding, we can substitute the value of $\hat{\alpha}$ in the employer's utility and maximize with respect to V only. However, observe that the substitution yields the following employer's utility

$$EV = \sum_{s=0}^{n} \mathscr{B}\left(s;\, n,\, p_1\right) \Pi_s - \frac{\psi\, n\, p_1}{p_1 - p_0} \tag{3}$$

This utility does not depend on V. Therefore, it corresponds to his utility at the equilibrium and the employer can set any $\{\hat{\alpha}, V\}$ as long as they satisfy 2 and the initial constraints. By substitution of the value of $\hat{\alpha}$, the initial constraints can be rewritten as

$$V \leq \frac{1}{1 - (1 - p_1)^n} \left(\sum_{s=1}^{n} \mathscr{B}\left(s;\, n,\, p_1\right) \Pi_s - \frac{\psi\, n\, p_1}{\tilde{\alpha}\, (p_1 - p_0)} \right) \tag{4}$$

$$\tilde{V} \leq V \tag{5}$$

and

$$\sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right) \Pi_s \leq V \tag{6}$$
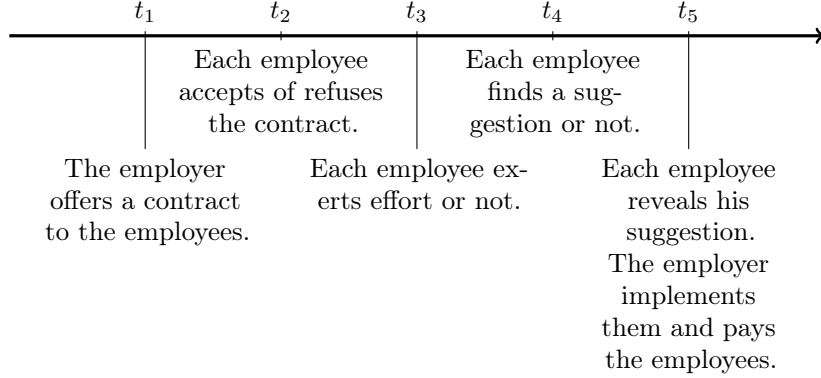
In other word, the employer can proceed in two steps. First he sets any market capitalization such that it satisfies 4, 5 and 6. Then he sets the number of shares proposed to be equal to 2. However, observe that the scheme can only be implemented when :

$$\frac{1}{1 - (1 - p_1)^n} \left(\sum_{s=1}^{n} \mathscr{B}\left(s;\, n,\, p_1\right) \Pi_s - \frac{\psi\, n\, p_1}{\tilde{\alpha}\, (p_1 - p_0)} \right) >$$

$$\max\left\{ \tilde{V},\, \sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right) \Pi_s \right\} \tag{7}$$

2 Paying for suggestion

It seems pretty intuitive that, if the employer wants the employees to provide suggestion, then paying for suggestion would be an efficient scheme. However the demonstrations is useful for a benchmark purpose.

Figure 3: Timing

t_1 t_2 t_3 t_4 t_5

Each employee accepts of refuses the contract.

Each employee finds a suggestion or not.

The employer offers a contract to the employees.

Each employee exerts effort or not.

Each employee reveals his suggestion. The employer implements them and pays the employees.

The timing of the game is summarized figure 3. Each employee gets a transfer t_1 if he reveals a suggestion and t_0 otherwise. When a suggestion is found, the employer is committed to pay t_1 to each of the employees who revealed a suggestion and t_0 to the others. His expected utility is thus:

$$EV_S(s, t_1, t_0) = \sum_{s=0}^{n} \mathscr{B}(s;\, n,\, p_1)(\Pi_s - s\, t_1 - (n-s)\, t_0) \qquad (EVS)$$

For the employee to accept the contract, his utility has to be greater than his outside opportunity which is normalized to 0. The following participation constraint has to be satisfied:

$$p_1\, t_1 + (1 - p_1)\, t_0 - \psi \geq 0 \qquad (PCS)$$

It must also be in the employee's interest to provide effort. So the following incentive constraint has to be satisfied as well:

$$p_1\, t_1 + (1 - p_1)\, t_0 - \psi \geq p_0\, t_1 + (1 - p_0)\, t_0 \qquad (ICS)$$

Finally, it is assumed that the legal context forbids negative transfers. Accordingly, two additional non negativity constraints must be added:

$$t_1 \geq 0 \qquad (MINS1)$$
$$t_0 \geq 0 \qquad (MINS0)$$

The transfers t_1 and t_0 chosen by the employer solve

$$\max_{\{t_1,\, t_0\}} \quad \sum_{s=0}^{n} \mathscr{B}(s;\, n,\, p_1)(\Pi_s - s\, t_1 - (n-s)\, t_0)$$
$$\text{w.r.t} \qquad PCS,\ ICS,\ MINS1,\ MINS0$$

The constraints PCS and $MINS1$ are implied by ICS and $MINS0$ and can be omitted. Therefore, denoting λ_{ICS} and λ_{MinS0} the respective multiplier, the lagrangian is given by

$$\mathscr{L} = \sum_{s=0}^{n} \mathscr{B}(s;\, n,\, p_1)(\Pi_s - s\, t_1 - (n-s)\, t_0)$$
$$+ \lambda_{ICS}\left(t_1 - t_0 - \frac{\psi}{p_1 - p_0}\right) + \lambda_{MINS0}\, t_0$$

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Moreover, the first order and slackness conditions are given by
$$\begin{cases} \frac{\partial \mathscr{L}}{\partial t_1} = & -\sum_{s=0}^{n} \mathscr{B}(s;\, n,\, p_1)\, s + \lambda_{ICS} = 0 \\ \frac{\partial \mathscr{L}}{\partial t_0} = & -\sum_{s=0}^{n} \mathscr{B}(s;\, n,\, p_1)\, (n-s) - \lambda_{ICS} + \lambda_{MINS0} = 0 \end{cases}$$
and
$$\begin{cases} -\lambda_{ICS}\left(t_1 - t_0 - \frac{\psi}{p_1 - p_0}\right) = 0 \\ -\lambda_{MINS0}\, t_0 = 0 \\ \lambda_{ICS} \geq 0 \\ \lambda_{MINS0} \geq 0 \end{cases}$$

Solving the first order conditions yields

$$\lambda_{ICS} = n\, p_1$$

$$\lambda_{MINS0} = n$$

Hence, $\lambda_{ICS} > 0$ and $\lambda_{NNS0} > 0$ and the respective constraints are binding. The values of t_1 and t_0 are
$$\begin{cases} t_1 = \frac{\psi}{p_1 - p_0} \\ t_0 = 0 \end{cases}$$

By substitution of the equilibrium values in the employer's utility function, we get his utility at the equilibrium

$$EV_S^{\star} = \sum_{s=0}^{n} \mathscr{B}(s;\, n,\, p_1)\, \Pi_s - \frac{\psi\, n\, p_1}{p_1 - p_0}$$

Therefore, as long as ESPP can be implemented (i.e. as long as 7 is satisfied), it performs as well as suggestion pay.

3 Paying for collective performance

The timing of the game remains the same as in the previous section. However, the transfer t_s that each employee receives now depends on the firm performance, which, in turn, also depends the number of suggestions that his $n-1$ colleagues submitted. The incentive compatibility constraint is

$$\sum_{s=0}^{n} \mathscr{B}(s;\, n,\, p_1)\, t_s - \psi \geq p_0 \sum_{s=1}^{n} \mathscr{B}(s-1;\, n-1,\, p_1)\, t_s$$
$$+ (1 - p_0) \sum_{s=0}^{n-1} \mathscr{B}(s;\, n-1,\, p_1)\, t_s \qquad (ICP)$$

and the participation constraint is given by

$$\sum_{s=0}^{n} \mathscr{B}(s;\, n,\, p_1)\, t_s - \psi \geq 0 \qquad (PCP)$$

Moreover, the non negativity constraint have to apply in all cases:

$$t_s \geq 0 \quad \forall s \in \{0, n\} \qquad (MINP)$$

The transfers $t_1, ..., t_n$ are chosen by the employer to solve

$$\max_{\{t_1,...,t_s\}} \quad \sum_{s=0}^{n} \mathscr{B}\left(s;\, n,\, p_1\right)\left(\Pi_s - n\, t_s\right)$$
$$\text{w.r.t} \quad ICP,\, PCP,\, MINP$$

Again, the participation constraint can be omitted. Therefore, denoting λ_{ICP} and ξ_s the multiplier of the incentive constraint and the sth non negativity constraint respectively, the lagrangian can be written

$$
\mathscr{L} = \sum_{s=0}^{n} \mathscr{B}\left(s;\, n,\, p_1\right)\left(\Pi_s - n\, t_s\right) + \lambda_{ICP}\left(\sum_{s=1}^{n} \mathscr{B}\left(s-1;\, n-1,\, p_1\right) t_s\right.
$$
$$
\left. -\sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right) t_s - \frac{\psi}{p_1 - p_0}\right) + \sum_{s=0}^{n} \xi_s\, t_s
$$

The first order conditions are

$$
\frac{\partial \mathscr{L}}{\partial t_n} = -p_1^n\, n + \lambda_{ICP}\, p_1^{n-1} + \xi_n = 0
$$
$$
\frac{\partial \mathscr{L}}{\partial t_0} = -\left(1 - p_1\right)^n n - \lambda_{ICP}\left(1 - p_1\right)^{n-1} + \xi_0 = 0
$$

and, for all j in $\{i, ..., n-1\}$,

$$
\frac{\partial \mathscr{L}}{\partial t_j} = -\mathscr{B}\left(j;\, n,\, p_1\right) n
$$
$$
+ \lambda_{ICP}\left(-\mathscr{B}\left(j;\, n-1,\, p_1\right) + \mathscr{B}\left(j-1;\, n-1,\, p_1\right)\right) + \xi_j = 0
$$

Assume there exists a j such that $\xi_j = 0$, then we would have $\xi_n < 0$ which violates the slackness conditions. Similarly, if $\xi_0 = 0$, then $\lambda_{ICP} = -p_1 n < 0$. Now, assume that $\xi_n = 0$. Then we have $t_n > 0$ and $\lambda_{ICP} = p_1 n > 0$. Therefore,

$$
\xi_0 = \left(1 - p_1\right)^n n + p_1\, n\left(1 - p_1\right)^{n-1} > 0
$$

and

$$
\xi_j = \mathscr{B}\left(j;\, n,\, p_1\right)\left(\left(n-j\right)\left(1 + \frac{p_1}{\left(1 - p_1\right)}\right)\right) > 0
$$

Hence, $t_n = \frac{\psi\, p_1}{p_1^n\left(p_1 - p_0\right)}$, $t_0 = 0$ and $t_j = 0$ for all j in $\{1, ..., n-1\}$. By substitution in the employers utility, again we get

$$
EV_P^\star = \sum_{s=0}^{n} \mathscr{B}\left(s;\, n,\, p_1\right)\Pi_s - \frac{\psi\, n\, p_1}{p_1 - p_0}
$$

Which is equivalent to the case of ESPP and suggestion pay. This is actually very similar to *Holmström's* result (1982) : paying for performance entails the first best result by punishing all employees if the outcome is lower than the first best outcome and by rewarding all employees otherwise. Observe that the employees are rewarded less often than they would if they were paid for suggestion. Indeed, they only get the reward when all employees find a suggestion. To compensate this risk borne by each employees, the transfer when paying for performance is higher than the one of suggestion pay.

4 Linear profit sharing

With linear profit sharing, the chronology remains the same as in figure 3. The employees now get a fixed share of the profits. Denote α the overall share that the employer concedes. Therefore, each employee gets an equal share $\frac{\alpha}{n}$. The probabilities to find a suggestion remain the same such that the incentive constraint now writes as :

$$\sum_{s=0}^{n} \mathscr{B}\left(s;\, n,\, p_1\right) \left(\frac{\alpha}{n}\Pi_s\right) - \psi \geq p_0 \sum_{s=1}^{n} \mathscr{B}\left(s-1;\, n-1,\, p_1\right) \left(\frac{\alpha}{n}\Pi_s\right)$$

$$+ (1-p_0) \sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right) \left(\frac{\alpha}{n}\Pi_s\right)$$

Which we can rewrite in a more convenient way

$$\frac{\alpha}{n} \sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right) \left(\Pi_{s+1} - \Pi_s\right) - \frac{\psi}{p_1 - p_0} \geq 0 \qquad (ICPS)$$

The participation constraint is now

$$\frac{\alpha}{n} \sum_{s=0}^{n} \mathscr{B}\left(s;\, n,\, p_1\right) \Pi_s - \psi \geq 0 \qquad (PCPS)$$

And of course, the share offered has to be between 0 and 1

$$\alpha \leq 1 \qquad (MAXPS1)$$

$$\alpha \geq 0 \qquad (MINPS0)$$

The employer's program is thus

$$\max_{\alpha} \qquad \sum_{s=0}^{n} \mathscr{B}\left(s;\, n,\, p_1\right) \left((1-\alpha)\Pi_s\right)$$
$$\text{w.r.t} \quad ICPS,\, PCPS,\, MAXPS1,\, MINPS0$$

and the Lagrangian is given by

$$\mathscr{L} = \sum_{s=0}^{n} \mathscr{B}\left(s;\, n,\, p_1\right) (1-\alpha)\Pi_s$$

$$+ \lambda_{ICPS} \left(\frac{\alpha}{n} \sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right) \left(\Pi_{s+1} - \Pi_s\right) - \frac{\psi}{p_1 - p_0}\right)$$

Therefore, we have the following first-order condition

$$\frac{\partial \mathscr{L}}{\partial \alpha} = -\sum_{s=0}^{n} \mathscr{B}\left(s;\, n,\, p_1\right) \Pi_s + \lambda_{ICPS} \left(\frac{1}{n} \sum_{s=0}^{n-1} \mathscr{B}\left(s;\, n-1,\, p_1\right) \left(\Pi_{s+1} - \Pi_s\right)\right) = 0$$

Which we can solve for λ_{ICPS}

$$\lambda_{ICPS} = \frac{n \sum_{s=0}^{n} \mathscr{B}\left(s; n, p_1\right) \Pi_s}{\sum_{s=0}^{n-1} \mathscr{B}\left(s; n-1, p_1\right)\left(\Pi_{s+1} - \Pi_s\right)}$$

We have $\lambda_{ICPS} > 0$ since Π_s is non decreasing in s. Therefore, the incentive constraint is binding and we can solve it in equality for α. We get

$$\alpha = \frac{\psi \, n}{\left(p_1 - p_0\right) \sum_{s=0}^{n-1} \mathscr{B}\left(s; n-1, p_1\right)\left(\Pi_{s+1} - \Pi_s\right)}$$

Eventually, the employer's utility is then

$$EV_{PS}^{\star} = \sum_{s=0}^{n} \mathscr{B}\left(s; n, p_1\right) \Pi_s - \sum_{s=0}^{n} \mathscr{B}\left(s; n, p_1\right) \Pi_s \frac{\psi \, n}{\left(p_1 - p_0\right) \sum_{s=0}^{n-1} \mathscr{B}\left(s; n-1, p_1\right)\left(\Pi_{s+1} - \Pi_s\right)}$$

Theorem 3. *As long as ESPP is implementable, it outperforms linear profit sharing*

Proof. ESPP outperforms profit sharing if

$$\sum_{s=0}^{n} \mathscr{B}\left(s; n, p_1\right) \Pi_s - \frac{\psi}{p_1 - p_0} n \, p_1 >$$

$$\sum_{s=0}^{n} \mathscr{B}\left(s; n, p_1\right) \Pi_s - \sum_{s=0}^{n} \mathscr{B}\left(s; n, p_1\right) \Pi_s \frac{\psi \, n}{\left(p_1 - p_0\right) \sum_{s=0}^{n-1} \mathscr{B}\left(s; n-1, p_1\right)\left(\Pi_{s+1} - \Pi_s\right)}$$

Simplifying, we have

$$\frac{\psi}{p_1 - p_0} n \, p_1 < \sum_{s=0}^{n} \mathscr{B}\left(s; n, p_1\right) \Pi_s \frac{\psi \, n}{\left(p_1 - p_0\right) \sum_{s=0}^{n-1} \mathscr{B}\left(s; n-1, p_1\right)\left(\Pi_{s+1} - \Pi_s\right)}$$

or, rearranging the terms

$$\sum_{s=1}^{n} \mathscr{B}\left(s-1; n-1, p_1\right) \Pi_s p_1 - \sum_{s=0}^{n-1} \mathscr{B}\left(s; n-1, p_1\right) \Pi_s p_1 < \sum_{s=0}^{n} \mathscr{B}\left(s; n, p_1\right) \Pi_s$$

Note that

$$\mathscr{B}\left(s-1; n-1, p_1\right) = \frac{(n-1)!}{(s-1)!(n-s)!} p_1^{s-1}\left(1-p_1\right)^{n-s} = \frac{1}{p_1} \sum_{s=0}^{n} \mathscr{B}\left(s; n, p_1\right) \frac{s}{n}$$

Hence, the condition for ESPP to outperform profit sharing is

$$\sum_{s=1}^{n} \mathscr{B}\left(s; n, p_1\right) \Pi_s \frac{s}{n} - \sum_{s=0}^{n-1} \mathscr{B}\left(s; n-1, p_1\right) \Pi_s p_1 < \sum_{s=0}^{n} \mathscr{B}\left(s; n, p_1\right) \Pi_s$$

which we can rewrite

$$-\sum_{s=0}^{n-1} \mathscr{B}\left(s; n-1, p_1\right) \Pi_s p_1 < \sum_{s=0}^{n} \mathscr{B}\left(s; n, p_1\right) \Pi_s \left(1 - \frac{s}{n}\right)$$

Since $1 - \frac{s}{n} \geq 0$, this is necessarily satisfied. $\qquad \square$

Conclusion

This paper was dedicated to developing the first steps toward an incentive theory of Employee Stock Purchase Plans. I have provided an original theory and compared its results to more traditional models. My results show that ESPP can be as efficient as suggestion pay and performance pay. Moreover, when it can be implemented, it outperforms profit sharing. This testable results may explain the difference of efficiency observed in the shared capitalism literature between employee ownership and profit sharing on firm performance. Furthermore, while Holmström advocates a separation between ownership and labor, I show that employee shared ownership can be efficient as well. While the interpretation of the model was considering suggestions schemes, the applicability is wider.

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