Why Do Firms Use Incentives That Have No Incentive Effects?*

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Abstract

Firms often pay individuals for group-level, industry-level, or even economy-wide performance even though agency theory suggests these contracts provide minimal incentive and lead to inefficient risk bearing. This paper derives a simple model that illustrates why firms might choose to implement stock options, profit sharing, and other pay instruments that reward (or penalize) “luck.” The model relies on two key assumptions: 1) firms incur cost when adjusting the terms of employment contracts, and 2) agents’ outside opportunities are correlated with their firms’ performance. I explore how firm-performance-based pay will respond to variation in risk aversion, workers’ reservation utility, and the correlation between a firm’s performance and that of the economy as a whole. I also discuss how the model fits with widely distributed stock options (especially in risky businesses such as high technology), executive compensation, and profit sharing, as well as how the model helps explain the popularity of such financial instruments as tracking stocks and certain venture capital funds. The model suggests that, while agency theory has focused on incentive compatibility, the often overlooked participation constraint can help explain many common compensation schemes.

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1 Introduction

Many compensation plans reward or punish agents for factors they cannot control. An often-discussed example of this phenomenon is executive compensation (where stock options are not generally indexed to the overall market). However, many firms also offer firm-wide stock options and profit sharing plans that provide even less incentive than executive plans – after all, most workers can expect to reap a very minimal amount of personal gain from their contribution to firm value or profits. Given the free-rider problems associated with group compensation plans, their prevalence is puzzling. Standard explanations for their use include behavioral reasons (morale, teamwork, norms, etc.) and tax considerations. I consider an alternative explanation that reconciles standard agency models with profit sharing.¹

Where much of the previous agency literature has concentrated on inducing optimal effort, I consider the importance of the generally overlooked participation constraint. I study a model where agents’ outside opportunities are correlated with firm profits or stock price, and where both turnover and adjusting the pay scheme parameters are costly. Given these assumptions, the firm may find it most profitable to pay the agent in a way that is correlated with the outside options presented by the outside labor market (despite the requisite risk premium) rather than pay a fixed wage that insures participation in all states.

The model derived below starts from the assumption that wage adjustments are costly, but that workers are willing to make part of their pay contingent on firm performance if they are compensated for the corresponding risk. After signing a contract with the principal, the agent receives an outside offer that is based on the state of the economy. Depending on the particular circumstances, the firm will choose one of three contracts. First, the firm may pay a fixed wage (or use “spot markets”). In this case, upon being faced with the outside offer, the firm adjusts the wage to market wages, though doing so may lead to information gathering, negotiation, and turnover costs. Second, the firm can structure the original contract such that enough of the agent’s pay is contingent on the firm’s realization of profits that the worker’s participation constraint is always met exactly. Since profits are imperfectly correlated with the economy (and, hence, with the worker’s outside options) pay based on firm performance will not, ex post, be the same as the worker’s outside opportunity. This passes some risk along to the employee. Finally, the firm can make some amount of pay contingent on firm profits, but lower the risk premium by setting the guaranteed portion of compensation such that the worker earns rents in some states of the economy. The firm has to find the optimal trade-off between the risk premium associated with

¹I will use the term “profit sharing” to refer to any compensation plan based on a large group’s performance.
variable compensation and the rents associated with fixed compensation. The firm can opt to use a spot labor market if these two costs become too onerous, though it incurs other transaction costs if it chooses to do so.

This paper formalizes a model of why firms might choose profit sharing or other incentives based on firm-wide performance (even if those incentives have no effect on the actions of employees), and considers factors that may affect the adoption and importance of such plans. I do not mean to suggest that this “stabilization” effect of profit sharing is an entirely new idea. The model is similar in many ways to the Weitzman (1984) share economy, but I focus on optimal firm choices (instead of social planning), voluntary turnover (instead of displacement), and reconciling the real world with agency theory (rather than attempting to prescribe policy to increase macroeconomic welfare.) Also, the model in this paper formalizes much of the intuitive discussion (and is consistent with the empirical findings) of sharecropping in Alston and Higgs (1982).

Harris and Holmstrom (1982), Thomas and Worrall (1988), and Beaudry and DiNardo (1991) also formulate models where wages are sensitive to market rates and firms have to balance compensation and turnover costs. These models show how firms might adjust their pay systems to market forces, while insulating agents from much of the risk. Like Harris and Holmstrom (1982), I study optimal contracts when parties to the contract expect to receive updated information about agents’ market value. While their model focuses on learning the agent’s actual ability, I study the effects of changes in demand for workers overall. However, Harris and Holmstrom (1982) and the other papers assume that contracts can be readily adjusted to compete with spot market wages and, as a result, they cannot explain the use of any pay instrument tied to firm performance.

Lazear’s (1999) model is similar to the model in this paper in that it addresses the issue of why firms would want to make pay sensitive to firm performance if that pay has no effect on agents’ actions. His model justifies this practice when a firm wants to extract information from an agent. However, as Lazear (1999) mentions (and as I discuss in Section 5.1 below), this model cannot explain profit sharing and stock option plans that are available to a large number of employees.

The rest of this paper proceeds as follows. Sections 2 and 3, respectively, describe the model and three possible equilibrium contracts. Section 4 analyzes comparative statics. I explore how the decision whether or not to make pay a function of firm performance and, if relevant, the amount of firm-performance-based pay are affected by such factors as the correlation between the firm’s success and market wages, the variance in workers’ reservation wage, and agents’ risk aversion. I consider how consistent the model is with stock option schemes, executive compensation contracts, and traditional profit sharing in Section 5. I discuss the model’s ability to explain a pay phenomenon that is at odds with previous agency theories – the high level of stock options in risky industries.
such as the technology sector. I also relate the model to the rise of tracking stocks and to venture capital funds currently being explored by some large technology companies. Finally, Section 6 summarizes and discusses possible extensions.

2 The Model

A risk neutral firm hires a risk averse worker whose effort is verifiable and contractible. The worker’s utility is $U = E[wages] - rVar[wages]$. The firm’s expected gross profits (that is, before agent compensation) are $\theta$ if there is a worker during the production phase, so net profits are $\theta$ less payments to the worker. $\theta \in \{\theta_h, \theta_l\}$ where $\theta_l$ is normalized to 0. Short of closing down, there is nothing the firm or worker can do to affect expected gross profits. Maximizing profits is equivalent to minimizing labor costs.

The game unfolds in the following four stages (see timeline in Figure 1):

1. The firm offers a contract to the worker that specifies a fixed wage ($w$) and a share of the firm’s gross profits ($b$). If the worker accepts the contract, then both parties prepare for production.

2. The worker receives an outside offer of either $s_h$ or $s_l$ (where $s_h > s_l$). $s_h$ and $s_l$ may be correlated with $\theta$, as described below.\(^2\)

3. By incurring costs of $k$, the firm can either adjust the terms of the contract or, if the worker leaves, replace the worker at a wage of $s_h$ or $s_l$. The costs may reflect the opportunity cost of search, loss of specific human capital acquired during the preparation stage, and/or the costs of learning the current reservation wage.

4. Production takes place, $\theta$ is revealed, and contracts are settled.

Though $\theta$ is not revealed until the end of the game, the outside offer ($s_h$ or $s_l$) acts as a signal and is revealed to all parties. Properties of the signal and, given the signal, the expected value of $\theta$ include

\(^2\)In the interests of focusing on the most relevant issues, I have simplified the outside offer process. A potential enhancement to the model would have workers receive a random draw from an outside offer distribution where the outside offer distribution is related to the signal. Then the firm would have to choose its wage and bonus so as to minimize costs of compensation, loss of employees, and, possibly, renegotiation costs. Such an enhancement would be a labor market application similar to Rochet and Stole (1999). Also, while the outside offers in this model only reveal information about the state of the economy, others have explored the private information used in or revealed by outside offers. See, for example, Lazear (1986). Finally, note that, like Harris and Holmstrom (1982) and others, I assume that the employee cannot credibly precommit not to accept outside offers.
The firm can pay the worker, either in part or in full, through a fixed wage (w). w cannot be made contingent on the signal when the contract is initially written, nor can w be costlessly adjusted to reflect the signal once it is revealed. The firm can pay a fixed wage of $s_h$ in order to guarantee the agent’s participation in either state or the parties can write a contract based on the value of $\theta$. Therefore, an employment contract consists of one or both of a fixed wage (w) paid in all states and a bonus (b) paid in the event that $\theta = \theta_h$.\footnote{By assuming pay can only be made contingent on $\theta$, I am assuming that, among the measures the agent is willing}
of the signal, the pair \( w \) and \( b \) must meet two participation constraints. If \( s = s_h \), then the worker will stay with the firm if

\[
s_h \leq w + bp_h - rb^2p_h(1 - p_h).
\] (2)

Similarly, if \( s = s_l \), then the worker will stay if

\[
s_l \leq w + bp_l - rb^2p_l(1 - p_l).
\] (3)

Hereafter, I refer to (2) and (3) as the “bull constraint” and the “bear constraint”, respectively.4

The firm can use two different strategies to make both participation constraints bind. First, it can adjust the wage to exactly meet the outside offer after the signal is revealed. Alternatively, it can select a positive \( b \) such that the agent earns her reservation wage in expected value, regardless of the signal. Because both of these choices impose costs on the firm, it may prove profitable to pay the employee in such a way that her participation constraint does not always bind.

3 Three Possible Outcomes

The previous section illustrated that there are three possible contracts the firm may choose to offer the agent. Depending on the market parameters, any of these three may be optimal from the firm’s perspective. In this section, I describe each of these three regimes and then consider the conditions under which any particular outcome will be profit maximizing.

3.1 Spot Labor Markets

The firm may offer a wage of \( s_l \) and then spend \( k \) to adjust the wage up to \( s_h \) if the more favorable signal is observed.5 In such circumstances, the firm is transacting in a spot labor market. The

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4 For extreme values of \( b \), the model has the potentially problematic feature that the agent’s utility is decreasing in \( b \). However, allowing \( \theta \) to be a normal random variable with constant variance and a mean that depends on \( s \) yields exactly the same results while insuring the agent’s utility is always increasing in expected wealth. I present the simpler version because such a change increases the complexity of the analysis and the discussion with no effect on the results.

5 I am assuming that the firm prefers to keep operating, even when the low signal is observed, either because it is still profitable or continuity is valuable. Also, the firm may prefer to set the wage to \( s_h \) and lower it when an
firm pays no risk premium or rents to the worker, but it sometimes incurs the transaction costs of changing wages. The profits of a spot labor market strategy are gross profits minus wages minus transaction costs. Expected gross profits, which are not affected by the employment contract, are $p\theta_h$. Wages are $s_h$ when a good signal is observed (which occurs with probability $q$) and $s_l$ when the low signal is observed. Transaction costs are $k$ times the probability that wages have to be adjusted (which occurs when a high signal is observed.) This occurs with probability $q$. Profits in a spot market regime can therefore be expressed

$$\Pi_{sm} = p\theta_h - qs_h - (1 - q) s_l - qk. \tag{4}$$

(4) applies when the firm uses spot markets and no profit sharing. This is the highest possible level of profits if the firm uses the spot market, because the firm is paying no risk costs and no rents. If the firm were to add an element of profit sharing, it would not save any adjustment costs, but would incur risk or rent sharing costs.

### 3.2 Dual Binding Participation Constraints (DPC)

Spot markets lead to potentially substantial transaction costs. The firm can avoid these costs, and keep all the surplus from the relationship, if it chooses $w$ and $b$ such that, for both realizations of the signal, the employee is exactly indifferent between staying at the firm and leaving. That is, the firm can choose the wage and a share of profits such that the the bull and bear participation constraints (i.e., (2) and (3)) hold with equality. Combining the two constraints when they bind yields

$$s_h - s_l = b(p_h - p_l) - rb^2[p_h(1 - p_h) - p_l(1 - p_l)]. \tag{5}$$

I impose the following assumption to make the analysis more tractable:

$$p_h + p_l = 1. \tag{6}$$

An example of this special case is when the unconditional probabilities of both the high state and the high signal are $\frac{1}{2}$ (that is, $q = p = \frac{1}{2}$.) This simplifies the analysis by making the expected unfavorable signal is observed. But, even when that is optimal, it has no effect on the following results, so I ignore the possibility of wage decreases.
Given (6), (5) implies that the optimal bonus is

\[ b = \frac{s_h - s_l}{(2p_h - 1)}. \] (7)

The bonus increases with the difference between the two possible reservation utilities because the firm wants to lower the base wage it has to pay in the low signal state. Also, the bonus decreases as the difference between the probabilities of the good state prevailing under the two signals (that is, \( p_h - p_l \)) increases, so as to keep total expected bonus payments constant. However, these comparative statics results rely on any changes to the exogenous parameters not changing which type of equilibrium holds. Changes could lead to a new equilibrium where the bonus no longer solves (7).

In a case where two participation constraints bind (DPC hereafter), profits and the guaranteed wage are

\[ \Pi^{dpc} = p\theta_h - s_h + \frac{\mu}{p_h - p_l} (s_h - s_l) (p_h - p) - \frac{\mu}{p_h - p_l} r p_h (1 - p_h) \] (8)

and

\[ w = s_h + \frac{\mu}{p_h - p_l} (s_h - s_l) r p_h (1 - p_h) - p_h. \] (9)

The term that includes \( r p_h (1 - p_h) \) now represents the risk premium necessary to induce the worker to accept a given level of profit sharing. If this risk cost is prohibitive (e.g., when \( r \) is large), then the firm may choose to use the spot labor market (as discussed in the previous subsection) or it may choose not to keep the worker bound by her participation constraint in all states (as discussed in the following subsection.)

3.3 Single Binding Participation Constraint (SPC)

The previous subsections considered two ways in which the firm can extract all the surplus from its relationship with the agent. However, these strategies involve either transaction costs (spot

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6This assumption makes the calculations and discussion that follow much simpler, with no apparent effects on the results. I relaxed this assumption and then solved for the optimal contract and for which type of equilibrium would prevail using many parameter sets. I then determined how the contract and type of equilibrium changed when the main parameters of interest varied. The results were entirely consistent with the results in the rest of the paper, with a minor exception that is noted in Section 4.3.
markets) or compensating the worker for risk (DPC.) There may be situations where the firm is better off with a less extreme strategy. If the firm sets $w$ and $b$ so as to maximize profits while insuring the worker’s participation when the signal is high, the firm may choose to pay rents to the worker when the signal is low. This is because, were the firm to drive the worker down to her participation constraint given a low signal, it would have to pay her more in risk premium than the expected rents if the worker is overpaid when the signal is low. I refer to an equilibrium where a single participation constraint binds as an SPC equilibrium.\footnote{It is trivial to show that the firm would never offer a contract where the participation constraint only binds when the low signal is observed.}

Note that the firm can avoid all transaction and risk costs by setting $w = s_h$ and $b = 0$. Such a contract would satisfy the bull constraint exactly and enable the agent to earn rents of $s_h - s_l$ in periods when the bear constraint is in place. However, it may be optimal for the firm to save some of these rents by passing along some of the risk to the agent.

The firm will choose $b$ and $w$ so as to maximize $\Pi = p(\theta_h - b) - w$, subject to the bull constraint. After generating the first-order condition and rearranging terms, the optimal bonus can be written

$$b = \frac{p_h - p}{2rp_h(1 - p_h)}.$$ \hfill (10)

Some simple comparative statics emerge. The optimal bonus is decreasing in $p$ and increasing in $p_h$ because a decrease in $p$ or an increase in $p_h$ makes the signal more informative and, therefore, transfers less risk to the agent. The bonus is also decreasing in $r$, because the firm should shoulder more of the risk when the agent is relatively risk averse.

After some simple manipulation, profits and the guaranteed wage in an SPC equilibrium can be expressed

$$\Pi^{spc} = p\theta_h - s_h + \frac{(p_h - p)^2}{4rp_h(1 - p_h)}$$ \hfill (11)

and

$$w = s_h + \frac{p^2 - p_h^2}{4rp_h(1 - p_h)}.$$ \hfill (12)

The profit and wage terms now includes both a risk premium and rents that the worker receives if the signal is unfavorable. The relative importance of transaction costs, rents, and the risk premium determine the optimality (and feasibility) of each of the three possible contract types, as discussed in the next subsection.
3.4 Which of the Three Possibilities Will Hold?

When does the optimal contract make just the bull participation constraint bind and when does it make both the bull and bear constraints bind? If the bear constraint holds but does not bind when $b$ is the optimal SPC bonus (i.e., (10)), an SPC regime will hold. This is because, in order to get the bear participation constraint to bind, $w$ would have to be lowered and $b$ would have to increase. But any change in the bonus from (10) lowers profits and the firm will prefer to pay the worker the necessary rents rather than impose additional risk on the agent. However, if the bear constraint does not hold when $b$ is the optimal SPC bonus, then an SPC equilibrium is not feasible. In this case, the firm prefers to pay the full risk premium necessary to get both participation constraints to hold with equality to sharing some of the surplus with the worker.

By combining the bull and bear constraints, substituting the optimal SPC bonus, and rearranging terms, I find that an SPC equilibrium dominates a DPC equilibrium when

$$s_h - s_l > \frac{(p_h - p)(2p_h - 1)}{2rp_h(1 - p_h)}.$$  \hspace{1cm} (13)

This condition specifies when the risk premium necessary to make the worker’s participation constraint bind in all states is so high that the firm would prefer to pay the worker more than her reservation wage in some states. The next section investigates how some of the key parameters affect this trade-off between risk bearing costs and rents.

The trade-off between risk costs and rents applies only when choosing between the regimes with no adjustment costs (i.e., DPC and SPC.) If the profits under the optimal zero adjustment plan are lower than those in a spot market, then the firm will opt for the spot market. The firm’s preferred contract emerges from combining and comparing the previously derived profit functions for each of the three types of contracts, $\Pi^{sm}$, $\Pi^{dpc}$, and $\Pi^{spc}$. The spot labor market is preferred to the SPC equilibrium when

$$-q_k - p s_h - (1 - p) s_l > -s_h + \frac{(p_h - p)^2}{4rp_h(1 - p_h)},$$  \hspace{1cm} (14)

and the spot market is preferred to the DPC equilibrium when

$$-q_k - p s_h - (1 - p) s_l > -s_h + \frac{\mu}{p_h - p_l} \frac{s_h - s_l}{p_h - p_l} (p_h - p) - \frac{\mu s_h - s_l}{p_h - p_l} r p_h (1 - p_h).$$  \hspace{1cm} (15)

Because gross profits are unrelated to the type of contract, these conditions simply determine which type of contract yields the lowest labor costs.

The next section investigates how changes in the exogenous parameters (such as the quality of the signal, the reservation wages, and the agent’s risk aversion) affect which regime prevails, the optimal level of profit sharing, and the profits of the firm.
4 Comparative Statics

4.1 Signal Quality

This section considers how the quality of the signal (specifically, \( p_h \)) affects the firm’s optimal contract. I establish two main results. First, as the quality of the signal improves, the likelihood that the firm will choose to use profit sharing instead of spot markets increases and, if profit sharing is optimal, a better signal induces the firm to lower (and eventually eliminate) the rents it shares. The second (and related) finding is that, as the signal goes from completely uninformative to perfect, the level of profit sharing is likely to be zero initially, increase to a peak, and eventually fall.

**Proposition 1**

1. If the signal is completely uninformative, the firm sets \( b = 0 \).

2. The adoption of profit sharing is increasing in signal quality. That is, if profit sharing is used for \( p_h \), profit sharing is used for any signal quality greater than \( p_h \).

3. If profit sharing is optimal, then an SPC equilibrium holds for sufficiently uninformative signals. However, a DPC equilibrium holds above some critical signal quality.

4. If the signal is somewhat but imperfectly informative (that is, if \( 1 > p_h > p_l \)), then the firm will either use spot markets or some positive level of profit sharing.

**Proof.** Part 1: If \( p_h = p_l \) (that is, if the signal is unrelated to the agent’s outside opportunities,) then, because \( s_h > s_l \), (2) can only hold if (3) does not bind. Combining this with the fact that \( p_h = p \) when \( p_h = p_l \), (10) implies \( b = 0 \).

Part 2: Because the derivatives of (11) and (8) with respect to \( p_h \) are positive, increasing the signal quality makes any profit sharing arrangement more profitable. But (4) suggests that any change in \( p_h \) that does not affect the overall probability of a good outcome or a good signal will not have an effect on spot market prices.

Part 3: Consider the case where the signal provides very little information. That is, \( p_h - p_l = \varepsilon \), where \( \varepsilon \) is very small, or, in other words \( p_h = \frac{1}{2} + \varepsilon \). Then the lim\( \varepsilon \to 0 \) \( \Pi = -\infty \) in any DPC equilibrium. Now consider a candidate SPC equilibrium. For small enough \( \varepsilon \), \( p_h \) must be sufficiently close to \( p \) that (13) will hold, insuring that the SPC equilibrium is sustainable. Therefore, for \( \varepsilon \) small enough, any optimal action by the firm where \( b > 0 \) will be an SPC regime. Now consider the case where \( p_h = 1 - \varepsilon \), so the signal is nearly flawless. As \( \varepsilon \) gets arbitrarily small, \( b \) gets very large and \( w \) gets very small at any SPC equilibrium. For sufficiently high \( p_h \), (3) will be violated and an equilibrium will have to be DPC.
Part 4: Allow the signal to convey information, so \( p_h > p_l \), but sufficiently little that an SPC equilibrium holds. Suppose the firm selects the minimum cost contract that retains employees but uses no profit sharing. So \( b = 0 \) and \( w = s_h \). Then \( \Pi = p\theta_h - s_h \). But switching to a positive bonus would change profits to (11), which would be an improvement. QED.

The proposition starts by establishing the somewhat obvious, but intuitively appealing, result that the firm would not want to tie the agent’s pay to a measure that is not correlated with either output or outside opportunities. At the other extreme, consider the case where the signal is perfect – that is, \( p_h = 1 \) and, given the assumption that \( p_h + p_l = 1, p_l = 0 \). Then the risk premium disappears and the solution is to pay a fixed wage of \( s_l \) and a bonus of \( s_h - s_l \) when profits are high. Since profits are only high when the signal is high, workers are paid exactly their reservation wage with no risk premium and no turnover. As part 3 of the proposition shows, for any sufficiently good signal, the firm will not pay the worker any rents.

There can be two transitions in regime as the signal improves from uninformative to perfect – from spot markets to SPC to DPC. For very poor signals, profit sharing is a relatively expensive means of retaining workers. In fact, firms may choose to incur wage adjustment costs periodically, rather than pay the necessary rents during bad times or the risk premium workers would demand from profit sharing. When the signal provides very little information, it is more intuitive to restate the condition under which an SPC regime is preferred to the spot market (that is, (14)) in terms of which regime has lower labor costs and to use \( q \) (which will be very nearly \( \frac{1}{2} \) when the signal is uninformative.) The firm will use spot markets approximately\(^8\) when

\[
qk + qs_h + (1 - q)s_l < s_h.
\] (16)

Intuitively, for a bad enough signal, the firm will opt to use spot markets if the difference between the two reservation wages gets sufficiently large or if the costs of adjusting the wage are small. That is, spot markets become a more attractive option when the firm faces a relatively uninformative signal, when \( s_l \) decreases (holding \( s_h \) fixed), and when \( k \) decreases. But as the signal becomes more informative, the risk premium decreases. The firm may decide to pay a risk premium and some rents to the worker in a SPC regime rather than pay the adjustment costs associated with using spot markets.

The second transition can occur as the signal improves when the firm is in an SPC state. A better signal leads the firm to use a higher level of profit sharing at a lower premium, driving the worker to be bound by the lower participation constraint. The logical next step intuitively, then,

\(^8\)I say “approximately” because the following condition does not include a term that approaches zero as \( p_h \) approaches \( p \).
Figure 2: Signal Quality Effect on Bonus

Figure 3: Signal Quality Effect on Profit
might be to think that the bonus (i.e., the amount of profit sharing) increases monotonically in the quality of the signal. But, as shown below, this need not be the case.

**Proposition 2** The agent’s expected bonus is increasing in signal quality in an SPC state and decreasing in signal quality in a DPC state. In either state, profits (total payments to the worker) are increasing (decreasing) in signal quality. The guaranteed wage is decreasing in signal quality in any SPC and is increasing in signal quality above some threshold \( p_h \) in a DPC state.

The proof follows from simple comparative statics and is omitted. The proposition suggests that the optimal level of profit sharing takes an interesting course in the case where the firm transitions from spot market to SPC to DPC as signal quality improves. Specifically, the firm engages in spot markets with no profit sharing for poor signals because the turnover costs are outweighed by the risk sharing and rents necessary to retain employees. Then profit sharing \( (b) \) takes a discrete jump up upon reaching some level where the firm switches to a SPC regime. Profit sharing continues to increase with signal quality because the employee is willing to bear more of the risk as the signal gets better.

But then the bonus hits a point where the lower participation constraint binds and the only profit sharing equilibrium is DPC. As the signal improves within a DPC regime, the firm *lowers* the bonus because the necessary risk premium gets smaller as the signal gets better. This decrease in contingent pay as idiosyncratic risk decreases distinguishes the model from standard agency models that predict a universally positive correlation between risk and incentive pay. As discussed in Section 5.1, this may explain why firms in relatively risky industries are relatively likely to offer stock options to all employees. An example of this non-monotonic effect of signal quality on profit sharing is shown graphically in Figure 2.\(^9\)

Because the worker’s productivity is constant, profits are driven by labor costs. When the agent is paid less, profits are higher and vice-versa. Because a better signal reduces rents and risk, profits increase with signal quality. Figure 3 shows the monotonic rise in profits as the signal improves and once profit sharing takes over from spot markets. This monotonic relationship results from the rents paid to the agent decreasing in signal quality in the DPC regime and the risk premium paid to the employee decreasing in signal quality in the SPC regime.

\(^9\)All figures assume \( k = 0.5 \) and \( \theta_h = 3 \). When not being used as the varying parameter, \( r = 1, s_h = 1.25, s_l = 0.75, \) and \( p_h = 0.75. \)
4.2 Variance in Reservation Utility

While the quality of the signal is an important consideration, the signal is irrelevant if the worker’s reservation utility is invariant. This section considers how the firm responds to changes in the variance of the worker’s outside options (“reservation variance”), which is captured in the model by $s_h - s_l$. I establish three main results. First, as reservation utility becomes more variable, the firm is likely to transition from a DPC regime to an SPC regime and, ultimately, to spot markets. Second, as reservation utility becomes more variable, profit sharing increases to a plateau, then stays constant before returning to zero for high enough variance. Third, profits weakly decrease in reservation variance.

Proposition 3

1. Unless spot markets are optimal for all levels of reservation variance, a DPC regime is optimal for very low variance.

2. At any reservation variance above some threshold level, spot markets are optimal.

3. At any reservation variance beyond some threshold level, if profit sharing is optimal, then it will be in the form of an SPC equilibrium.

Proof. Part 1: Assume $s_h - s_l = \varepsilon$, where $\varepsilon$ is very small. Consider a candidate SPC equilibrium. Then the bull constraint will hold with equality but the bear constraint will not bind. Combining these constraints with (10), it must be the case that $s_h - s_l > \frac{(p_h - p)(2p_h - 1)}{2p_h(1 - p_h)}$. But that cannot hold for small enough $\varepsilon$, so a DPC will prevail.

Part 2: The left sides of both (14) and (15) are unaffected by reservation variance, but the right sides of both equations are strictly decreasing in reservation variance. So, for high enough reservation variance, (14) and (15) must both hold and spot markets will be strictly preferred to retaining workers.

Part 3: The proof of part 3 follows directly from (13). Q.E.D.

The proposition establishes that profit sharing becomes a bad strategy if the variance in reservation utilities is extreme. This is because high variance in outcomes leads, ultimately, to higher rents paid to the agent in slow times. It is rents, rather than a risk premium, that lead to spot markets, because the firm always has the option of just paying the high reservation utility in all states and, thus, can eliminate the risk premium. It is never in the firm’s best interests to do this, however, since some level of risk premium always pays for itself in lower rents.

 Increases in reservation variance refer to increases in $s_h - s_l$ that preserve the mean reservation utility. Given (6), a change in variance occurs through equal but opposite changes in $s_h$ and $s_l$. If the $p_h + p_l = 1$ assumption were relaxed, then any change in $s_h$ would be coupled with an opposite change of $\frac{1}{1 - q}$ in $s_l$. 

The proposition also shows that, to the extent that profit sharing dominates spot markets, a DPC will be in place for low enough reservation variance because the agent can be held to her indifference point in all states without much of a risk premium. But beyond some threshold reservation variance, it is worth paying the rents in an SPC regime rather than impose the risk costs needed to make the agent’s participation constraint bind in all states. Taken together, these clauses of the proposition suggest that, as the reservation variance increases from zero to extreme, the firm is likely to transition from a DPC regime to an SPC regime to spot markets. I now explore the profit and profit sharing implications of this evolution.

**Proposition 4**

1. *The optimal bonus (b) weakly increases in the reservation variance.*

2. *Firm profits monotonically decrease in the reservation variance in any profit sharing equilibrium. Profits are convex in the reservation variance in a DPC regime and are linear in the reservation variance in an SPC regime.*

Again, the proof follows from simple differentiation and is omitted. The profit result is intuitively simple – increased variance in the agent’s outside options leads to either an increase in the risk premium (in a DPC regime) or in the agent’s rent (in an SPC regime). Either one of these effects increases the payments to the worker and lowers the firm’s profits. The quadratic risk premium drives the effect on profits in a DPC regime, leading labor costs (profits) to increase (decrease) at an increasing rate. But once the regime shifts to SPC, increases in reservation variance cause the firm to pay a constant half unit of rents in bad states for every unit increase in reservation variance. This increase in rents as reservation variance increases is very similar to Harris and Holmstrom’s (1982) finding that “insurance” increases with variance in worker ability. In both cases, the firm finds it optimal to protect risk averse agents from bad realizations of their market wage.

Profit sharing increases with reservation variance in a DPC regime because more variance in pay is required to keep the worker on both participation constraints as the difference in reservation utility widens. Once the firm lets the lower participation constraint go slack, the optimal trade-off between risk and rents is unrelated to the spread between the reservation utilities. As a result, profit sharing increases with initial increases in reservation variance, reaches a plateau, and then is abandoned altogether when the rents overwhelm the adjustment costs associated with spot markets. Figures 4 and 5 graph the effect of reservation variance on profit sharing and profits.

### 4.3 Risk Aversion

The level of agent risk aversion is critical to the model. If the agent is risk neutral (that is, $r = 0$), then the firm can insure participation in all states while paying no rents. At the other
Figure 4: Reservation Variance Effect on Bonus

Figure 5: Reservation Variance Effect on Profit
extreme, an agent whose aversion to risk grows arbitrarily large cannot be efficiently paid through a profit sharing scheme and the firm will either have to pay substantial rents in some states or face adjustment costs. This section explores how the level of profits and profit sharing evolve for levels of risk aversion between these extremes. I first show that, as the agent’s level of risk aversion increases from zero to an arbitrarily high level, the transitions are similar to those when the reservation variance increases – that is, from a DPC regime to an SPC regime to a spot market regime. I then show the intuitive results that profit sharing and firm profits decrease in the agent’s level of risk aversion.

**Proposition 5**  
1. Unless spot markets are optimal for risk neutral agents, a DPC regime is optimal for the least risk averse agents.
2. Unless paying a guaranteed wage of $s_h$ in all states always yields higher profits than using the spot labor market, spot markets are optimal for very high agent risk aversion levels.
3. At any risk aversion beyond some threshold level, if profit sharing is optimal, then an SPC regime is optimal.

The proof follows the same logic as the proof of Proposition 3 and is not drawn out in detail here. The results on risk aversion parallel those for reservation utility because increasing uncertainty has the same effect as an increasing distaste for uncertainty. At low enough levels of risk aversion, the risk premium necessary to keep a worker bound by both participation constraints is not too great and the firm can sustain a DPC equilibrium. As the agent gets more risk averse, the risk premium grows relative to the rents that the firm would have to pay the worker if it let the lower participation constraint go slack. Eventually, the firm prefers an SPC equilibrium. Further increases in risk aversion make the risk premium so high that profit sharing may eventually give way to spot markets.

While the transitions among regime type are similar for risk aversion and reservation variance, the effects on profit sharing and profits are somewhat different, as shown in the following proposition.

**Proposition 6**  
1. The optimal bonus ($b$) weakly decreases in the level of agent risk aversion.
2. The firm’s profits monotonically decrease in the level of risk aversion in any profit sharing equilibrium. Profits are linear in the level of risk aversion in a DPC regime and concave in the level of risk aversion in an SPC regime.
This proof also follows from differentiation. The level of profit sharing is not affected by risk aversion in a DPC regime because the risk in both the high and low states is the same.\footnote{This is the only result that I have found to rely on the assumption that $p_h + p_l = 1$. When this assumption is relaxed, the level of risk (and the sensitivity of the bonus to risk) depends on the signal. The optimal $b$ increases (decreases) with $r$ if $p_h$ ($p_l$) is nearer to 0.5 than $p_l$ ($p_h$.)} However, as $r$ continues to increase, the risk premium in a DPC regime eventually becomes sufficiently high that the firm prefers the rents of an SPC to the risk premium needed to keep the agent bound by both participation constraints. Once the SPC regime is in place, further increases in $r$ require further reductions in the bonus as the firm trades even more rents to keep the risk premium in line. Eventually, if the rents are too great, then the firm may move to a spot market.

Profits fall monotonically as the agent’s risk aversion increases, but they fall faster in the DPC regime because the risk premium comes straight out of profits. In contrast, once the SPC is in place, the firm can substitute towards rents (and away from risk premium) as $r$ grows further. Figures 6 and 7 graph the effect of risk aversion on profits and profit sharing.
Figure 7: Risk Aversion Effect on Profit

5 Applications

5.1 Employee Stock Options

High tech companies often give stock options to ALL employees. At a fledgling “dot com” company with fewer than fifty employees, options can clearly have very powerful incentive effects. However, it is hard to imagine that most new workers at Microsoft and Cisco Systems, both of which have over 20,000 workers and offer stock options to all of them, believe that their actions affect the value of their stock options. So why do these and other firms offer options as part of their standard compensation plan? One standard justification for offering stock options is that they vest over a period of time. However, many other pay instruments (such as subjective cash bonuses) can be made contingent on continued service without forcing as much risk onto agents. Other common explanations for offering stock options are that the market systematically undervalues the dilution effect of outstanding options, that workers are not as risk averse as commonly believed, and that group-based incentive plans can have a powerful effect on morale. Lazear (1999), after arguing that

\[12\] In fact, from 1989-1992, I worked for two different Silicon Valley companies, each of which had approximately 2000 employees. Like everyone else at both companies, I received stock options and, like almost everyone else at both companies, there was virtually no chance that I would have any measurable effect on the price of the companies’ stock. One of these companies still offers stock options and profit sharing to all employees, despite its staff having grown to 13,000.
stock options and other firm-wide incentive plans are not consistent with incentive effects, suggests that stock options can help firms select on workers with the highest skill. But he concludes that his model “does not explain why some firms give stock options even to very low-level workers.”

The model presented above, however, can justify stock options (or other compensation tied to the success of the firm as a whole) for any worker whose outside opportunities are correlated with the success of the firm. That is, if the health of the firm is related to the health of the overall market, and if the state of the overall market is related to initial wage offers, then stock options can be a relatively inexpensive retention device.

The model may also help explain the fact that stock options are a relatively common and large part of compensation among growing technology firms. As noted in Section 4.1, a key distinguishing feature of the model is that, at least in a DPC equilibrium, higher idiosyncratic risk (that is, lower signal quality) leads to more contingent pay. Where previous agency models would expect relatively little contingent pay in high-tech companies, the model in this paper can be consistent with observed patterns.

The technology industry, as measured by stock volatility, has traditionally had relatively high variance in the overall fortunes of the industry, which could lead to high reservation variation as firms’ demand for labor comes and goes with their markets. This is largely consistent with the discussion in Section 4.2, where I showed that profit sharing increases in the reservation variance (though profit sharing becomes non-optimal at extreme levels of reservation variance.)

The costs of turnover and lack of labor market frictions also make the model consistent with technology firms’ use of stock options. One might expect that, because there is relatively little firm-specific skill in Silicon Valley and a clustering of similar firms in a small geographic area, the costs to the worker of switching jobs are relatively small. Also, brisk demand for technology workers makes workers mobile while making it difficult for firms to fill openings (that is, high $k$). The conditions under which profit sharing yields higher profit than spot markets ((14) and (15)) suggest that high $k$ make profit sharing (in this case in the form of stock options) profitable relative to spot markets.

A recent example from the technology industry shows how the model in this paper may affect the financial instruments a firm chooses and offers to its employees. According to the Economist magazine (March 25, 2000, page 76), “DLJ direct, an online brokerage, boasts that selling its tracking stock has reduced turnover among technical staff from 30% to 5%, even though its share price is now below its issue price.” While the firm could offer its technical workers options in the parent company (Donaldson, Lufkin, & Jenrette) stock, this would have exposed them to the ups and downs of the brokerage and financial services markets. But the technical staff is more likely to
be courted by other internet businesses, so the correlation between their outside opportunities and
the parent company’s stock price ($p_h$) is likely to be low. This low correlation makes stock options
expensive. However, by issuing a tracking stock that more accurately reflects the internet economy
and, by extension, the technical workers’ other market opportunities, the firm was able to improve
signal quality and more cost effectively retain employees.

Several Wall Street firms, in conjunction with large technology firms such as Cisco Systems and
Intel, are currently exploring the possibility of starting venture capital pools that invest in the types
of startups that often lure away key personnel from these large technology companies.13 These firms
would then offer shares in these funds to the people they are most afraid of losing, conditional on
continued employment. This fits the model perfectly in that the firms are attempting to increase
$p_h$ rather than pay the costs to renegotiate or replace workers. One impediment to these funds
has been allotting shares in the funds, which is another type of negotiation or transaction cost. In
the framework of the model, these financial instruments involve the firm paying some amount of
negotiation/transaction fees (that is, some $k$, but less than losing the person) to increase $p_h$. Since
profits are increasing in $p_h$, if the cost in terms of $k$ is not too extreme, then the firms stand to
gain from these venture funds.

Can the model explain the economy-wide increase in stock based pay over the last few years?14
If the tight job market of the last few years truly is indicative of high $k$, then this could help explain
why stock options have become a more widely-used pay instrument. I know of no other systematic
changes in the model’s parameters ($r, s_h - s_l, p_h$) that can tie the stock option trend to the
model, however.

5.2 Executive Compensation

Are executive compensation contracts consistent with agency theory? That is an often studied and
widely argued question. Models of efficient risk sharing typically imply that, wherever possible,
executives should be measured on relative, rather than absolute, performance. That is, to the
extent that some underlying shock affects performance across multiple firms in a way that indi-

13 Economist magazine, May 27, 2000, page 71. Also see an example in The Industry Standard, May 15, 2000, page
77.

14 The January 18, 2000 Wall Street Journal cites a study by the consulting firm of Watson Wyatt Worldwide that
found an increase in the number of employees eligible for stock options, even at lower levels of organizations, between
measures of executive performance.\textsuperscript{15} Most executive stock options and other executive incentives do not compensate for market-wide or industry-wide shocks, and empirical studies have found little evidence of relative performance evaluation in executive pay.\textsuperscript{16} Reasons given for the lack of indexing in executive pay include tax considerations, simplicity, and the costs and difficulties of identifying an appropriate comparison group. But perhaps one reason relative performance evaluation is not more common is that the models that show it to be optimal typically assume a constant participation constraint.\textsuperscript{17} The variable participation constraint presented here may lead firms to reward executives for absolute performance so that compensation varies with the executives' outside opportunities.

Bertrand and Mullainathan (2000) analyze the efficiency of CEO incentive contracts, starting with the hypothesis that an efficient contract will reward (punish) high (low) relative performance. They study the oil industry, where common shocks (especially commodity prices) can be easily identified and removed from measures of executive performance. They show that the pay of CEOs of oil companies is affected by oil prices, a factor that is surely beyond the executives’ control. They go on to establish evidence of CEOs being rewarded for factors beyond their control in a range of industries.

But the model presented here, with relabeling of some variables, suggests that it can be optimal to pay CEOs for industry-level performance if industry performance is correlated with the executives’ outside opportunities. Suppose that a high oil price (or a high oil futures price) leads to increased demand for oil executive talent, either because of entry or because incumbent firms launch new projects. This should raise the demand for, and price of, managerial talent in the oil industry. In the terms of the model, high oil prices cause the probability of success of new ventures to be \(p_h\) at the same time as they raise a manager’s reservation wage to \(s_h\). Paying the manager for the firm’s absolute performance \(\theta\), rather than its relative performance \((\theta - \theta_{market})\) could be an efficient way to provide incentives for the manager to work hard while minimizing the chances

\textsuperscript{15}Aggarwal and Samwick (1999) and Baker (2000), exploring the distortionary effects of relative performance evaluation noted by Gibbons and Murphy (1990), consider other reasons executive pay should not always be adjusted for peer performance.

\textsuperscript{16}Gibbons and Murphy (1990) provide the strongest evidence of relative performance evaluation in executive pay. Murphy (1999) discusses the strength of executive incentives and the lack of indexing.

\textsuperscript{17}Himmelberg and Hubbard (1999) develop a model that is similar in spirit to the model above. But rather than considering signal quality and reservation variance, they focus on how an executive’s outside opportunities are related to the size of the firm he manages. Using Chief Executive Officer compensation data, they then go on to find empirical evidence that supports their model, as well as the model in this paper.
that she will leave for another oil producer.\footnote{Bertrand and Mullainathan (2000) briefly discuss the issue of oil CEO reservation utility. They argue that such a model could explain part of their findings but is unlikely to completely explain their results. This is likely to be true when they show that CEOs with weaker corporate governance gain more from “luck” than CEOs with tight oversight. However, this result is also consistent with more talented CEOs endogenously weakening corporate governance (see Hermalin and Weisbach (1998).)}

Further evidence consistent with the model can be found in the bank CEO market analyzed by Barro and Barro (1990). They find that bank CEO pay is responsive to firm performance but is not adjusted for relative performance, which implies that bank CEO compensation is partially based on conditions in the overall banking market. Barro and Barro (1990) also find that bank CEO turnover does respond to relative performance. These facts are consistent with banks letting their compensation schemes fluctuate so as keep pace with market rates, while dismissing executives when firm performance lags peer performance.

\section*{5.3 Traditional Profit Sharing}

Profit sharing plans are common in a variety of industries.\footnote{Kruse (1993) survey the incidence of profit sharing and economic studies of profit sharing. The model above does not apply as well to “gain sharing” and other plans based on improvements of a specific project or initiative within a firm, because the success of such efforts is less likely to be correlated with agents’ outside opportunities. However, given that such plans are implemented endogenously and perhaps at least partially in response to competitive wage pressures, they may fit the general idea at some level.} Some firms and economists have justified profit sharing plans on the basis of their incentive effects. According to this argument, employees work harder if they can expect to reap some of the rewards of their efforts. Weitzman and Kruse (1990) argue that profit sharing has at least a mildly positive effect on productivity and profitability. However, Kruse (1993) and Card (1990) argue that the free-rider (or “1/N”) problem makes the productivity argument unlikely. Prendergast (1999) and Kruse (1993) suggest that the causality of this relationship is hard to establish. That is, high profits may induce firms to implement profit sharing rather than profit sharing leading to high profits. Also, Kruse (1993) points out that no empirical study has found a link between the likelihood of profit sharing and the number of employees. If profit sharing has incentive effects, then one would expect these to dissipate with increases in firm size.

If profit sharing does not have significant incentive effects, then why would a firm impose the risk of profit sharing on its employees? The model in this paper, as well as that of Weitzman (1984), justify profit sharing based on what Kruse (1993) calls the “stability theory.” When wages are rigid, profit sharing is a means of keeping workers at or near their participation constraints. Kruse
(1993) suggests that there is some empirical support for this idea, but that it is inconclusive in most studies. He points out that identification of stability effects is difficult given the endogeneity of profit sharing.

Kruse (1993) also found that the best predictor of the adoption of profit sharing is an increase in profitability of the firm. This is consistent with rent sharing between the firm and workers, but it may also be consistent with the model in this paper. If a firm’s prospects improve, then the value of retaining workers increases, which increases \( k \) in the model. As discussed above, increasing \( k \) increases the value of profit sharing relative to using the spot labor market. Also note that this contrasts with the empirical implications of Weitzman (1984). While the stability effect of profit sharing in the above model comes from minimizing voluntary turnover, stability in Weitzman (1984) derives from the firm’s not laying off workers in a downturn. The latter idea would make profit sharing relatively more valuable when the firm’s prospects dim.

In their study of Australian firms, Drago and Heywood (1995) find that profit sharing is relatively common at firms whose workers are highly skilled and who have invested in firm-specific human capital (as measured by proportion of managers, proportion of “casual” workers, use of productivity groups, and a propensity to promote from within.) If these workers are relatively expensive to replace, then these findings are consistent with profit sharing being more common at firm with relatively high \( k \). Drago and Heywood (1995) also find that turnover is negatively associated with profit sharing, which is consistent with profit sharing having a stabilizing effect.

Another factor that has been found to be correlated with profit sharing is union representation. This could also be due to rent sharing, but perhaps the incidence of unions and profit sharing both stem from other causes. Consider the automobile industry, which has historically been heavily unionized and where profit sharing arrangements are common. The automobile industry is subject to significant macroeconomic shocks that are common across firms and affect the marginal value of labor. As a result, a firm’s willingness to pay for labor (and, therefore, worker reservation wages) may have significant variation over time and these movements are probably highly correlated with the firm’s prospects. Thus, it may well be the case that signal quality \( (p_h) \) is quite high in the automobile industry. In addition, auto workers have significant industry and firm-specific knowledge, which makes turnover costs to the firm \( (k) \) relatively high. Though this argument is speculative and anecdotal, it provides a plausible explanation for how profit sharing in the automobile industry could be consistent with the model in this paper.
6 Conclusions and Further Research

I derived a model that provides a possible reconciliation of agency theory with the fact that agents are often rewarded or punished for things they cannot control. I showed that variability in an agent’s reservation utility may lead the firm to want to transfer risk to the worker as a means of insuring participation in various states of the economy. The model relies critically on the assumption that the terms of an agent’s compensation scheme are costly to adjust. I also determined that the firm may find it optimal to pay rents to workers during relatively slow periods and, under certain conditions, may prefer to forsake long-term retention of employees.

One important feature of the model is that it has some clear empirical predictions. However, predictions are made somewhat ambiguous both by the model’s non-monotonic relationships between the amount of profit sharing and certain parameters and by the fact that the model often has opposing implications for a given parameter’s effect on profit sharing adoption and the amount of profit sharing a firm will choose. Figures 8 and 9 graphically capture the difficulty of testing the model. They show the interaction of the effects of signal quality and reservation variance on optimal profit sharing. Figure 8 shows how the optimal bonus evolves with signal quality (just as in Figure 2), but contrasts this relationship for two different levels of reservation variance. Increasing reservation variance reduces the range of signal qualities for which profit sharing is profitable, has no effect on profit sharing for some signal qualities, and increases the optimal level of profit sharing at other signal qualities. Similarly, Figure 9 shows the effect of reservation variance on the optimal bonus at two levels of signal quality. Increasing signal quality increases the bonus for some levels of reservation variance, but decreases it for other reservation variances.

The model does, however, yield some specific testable hypotheses. These include:

1. The adoption of profit sharing increases in the firm’s costs of replacing workers.

2. As signal quality (that is, the correlation between the state of the economy and the prospects for the individual firm) increases, the adoption of profit sharing becomes more attractive. However, if profit sharing is implemented, then the effect of signal quality on the amount of profit sharing is ambiguous.

3. As the variation in workers’ reservation utility grows, the adoption of profit sharing becomes less attractive. However, if profit sharing is implemented, then greater variation in reservation utility leads to an increase in the amount of profit sharing.

4. Both the adoption and amount of profit sharing decrease in the level of the agent’s risk aversion.
Figure 8: Effect of Signal Quality and Reservation Variance on Bonus

Figure 9: Effect of Reservation Variance and Signal Quality on Bonus
I discussed how these predictions match anecdotal and empirical evidence of broad-based employee stock option plans, executive pay schemes, and traditional stock option plans. Though I argued that the evidence is largely consistent with the model’s predictions, it may be feasible to test the predictions more rigorously. For instance, one could examine the cross-sectional (and perhaps time-series) variation in profit sharing occurrence and levels using surveys of HR practices, details of bonus plans from consulting firms, and executive compensation contracts.

In addition, there are many ways to enrich the model. For example, the model assumes that separation costs are constant, but they are likely to be dependent on job tenure. Modeling this relationship could lead to interesting findings about the optimal vesting of profit sharing and stock options. Also, it would be interesting to see how the firm would behave if outside offers were drawn from a distribution related to the state of the economy, rather than being perfectly correlated with $s$. This would lead the firm to have to consider the optimal level of turnover, given that it would probably not want to match all outside offers.
References


