MECS 570-1: Organizational Economics I

Michael Powell

Incentives in Organizations, Part III: Career Concerns

# No Contracts (Updated: Jan 14 2017)

In many environments, contractible measures of performance may be so bad as to render them useless. Yet, aspects of performance that are relevant for the firm's objectives may be observable, but for whatever reason, they cannot be written into a formal contract that the firm can commit to. These aspects of performance may then form the basis for informal reward schemes. We will discuss two classes of models that build off this insight.

### Career Concerns (Updated: Jan 14 2017)

An Agent's performance within a firm may be observable to outside market participants—for example, fund managers' returns are published in prospectuses, academics post their papers online publicly, a CEO's performance is partly announced in quarterly earnings reports. Holmstrom (1982/1999) developed a model to show that in such an environment, even when formal performance-contingent contracts are impossible to write, workers may be motivated to work hard out of a desire to convince "the market" that they are intrinsically productive in the hopes that doing so will attract favorable outside offers in the future—that is, they are motivated by their own career concerns.

**Description** There are two risk-neutral Principals, whom we will denote by $P_1$ and $P_2$, and a risk-neutral Agent $(A)$ who interact in periods $t = 1, 2$. The Agent has ability $\theta$, which is drawn from a normal distribution, $\theta \sim N\left(m_0, h_0^{-1}\right)$. $\theta$ is unobservable by all players, but all players know the distribution from which it is drawn. In each period, the Agent chooses an effort level $e_t \in E$ at cost $c\left(e_t\right)$ (with $c\left(0\right) = c'\left(0\right) = 0 < c', c''$) that, together with his ability and luck (denoted by $\varepsilon_t$), determine his output $y_t \in Y$ as follows:

$$y_t = \theta + e_t + \varepsilon_t.$$

Luck is also normally distributed, $\varepsilon_t \sim N\left(0, h_\varepsilon^{-1}\right)$ and is independent across periods and independent from $\theta$. This output accrues to whichever Principal employs the Agent in period $t$. At the beginning of each period, each Principal $i$ offers the Agent a short-term contract $w_i \in W \subset \{w_i : M \to \mathbb{R}\}$, where $M$ is the set of outcomes of a performance measure. The Agent has to accept one of the contracts, and if he accepts Principal $i$'s contract in period $t$, then Principal $j \neq i$ receives 0 in period $t$. For now, we will assume that there are no available performance measures, so short-term contracts can only take the form of a constant wage.

**Comment on Assumption.** Do you think the assumption that the Agent does not know more about his own productivity than the Principals do is sensible?

If Principal $P_i$ employs the Agent in period $t$, the agent chooses effort $e_t$, and output $y_t$ is realized, payoffs are given by

$$\begin{aligned} \pi_i\left(w_{it}, e_t, y_t\right) &= py_t - w_{it} \\ \pi_j\left(w_{it}, e_t, y_t\right) &= 0 \\ u_i\left(w_{it}, e_t, y_t\right) &= w_{it} - c\left(e_t\right). \end{aligned}$$

Players share a common discount factor of $\delta < 1$.

**Timing** There are two periods $t = 1, 2$. In each period, the following stage game is played:

1. $P_1$ and $P_2$ propose contracts $w_{1t}$ and $w_{2t}$. These contracts are commonly observed.

2. $A$ chooses one of the two contracts. The Agent's choice is commonly observed. If $A$ chooses contract offered by $P_i$, denote his choice by $d_t = i$. The set of choices is

denoted by $D = \{1, 2\}$.

3. $A$ receives transfer $w_{it}$. This transfer is commonly observed.

4. $A$ chooses effort $e_t$ and incurs cost $c(e_t)$. $e_t$ is only observed by $A$.

5. Output $y_t$ is realized and accrues to $P_i$. $y_t$ is commonly observed.

**Equilibrium** The solution concept is Perfect-Bayesian Equilibrium. A **Perfect-Bayesian Equilibrium** of this game consists of a strategy profile $\sigma^* = \left(\sigma^*_{P_1}, \sigma^*_{P_2}, \sigma^*_A\right)$ and a belief profile $\mu^*$ (defining beliefs of each player about the distribution of $\theta$ at each information set) such that $\sigma^*$ is sequentially rational for each player given his beliefs (i.e., each player plays the best response at each information set given his beliefs) and $\mu^*$ is derived from $\sigma^*$ using Bayes's rule whenever possible.

It is worth spelling out in more detail what the strategy space is. By doing so, we can get an appreciation for how complicated this seemingly simple environment is, and how different assumptions of the model contribute to simplifying the solution. Further, by understanding the role of the different assumptions, we will be able to get a sense for what directions the model could be extended without introducing great complexity.

Each Principal $i$ chooses a pair of contract-offer strategies $w^*_{i1} : \Delta(\Theta) \to \mathbb{R}$ and $w^*_{i2} : W \times D \times Y \times \Delta(\Theta) \to \mathbb{R}$. The first-period offers depend only on each Principal's beliefs about the Agent's type (as well as their equilibrium conjectures about what the Agent will do). The second-period offer can also be conditioned on the first-period contract offerings, the Agent's first-period contract choice, and the Agent's first-period output. In equilibrium, it will be the case that these variables determine the second-period contract offers only inasmuch as they determine each Principal's beliefs about the Agent's type.

The Agent chooses a set of acceptance strategies in each period, $d_1 : W^2 \times \Delta(\Theta) \to \{1, 2\}$ and $d_2 : W^4 \times D \times E \times Y \times \Delta(\Theta) \to \{1, 2\}$ and a set of effort strategies $e_1 : W^2 \times D \times \Delta(\Theta) \to \mathbb{R}_+$ and $e_2 : W^4 \times D \times E \times Y \times \Delta(\Theta) \to \mathbb{R}_+$. In the first period, the agent chooses which contract to accept based on which ones are offered as well as his beliefs about his own type. In the present model, the contract space is not very rich (since it is only the set of scalars), so it will turn out that the Agent does not want to condition his acceptance decision on his beliefs about his own ability. This is not necessarily the case in richer models in which Principals are allowed to offer contracts involving performance-contingent payments. The Agent then chooses effort on the basis of which contracts were available, which one he chose, and his beliefs about his type. In the second period, his acceptance decision and effort choice can also be conditioned on events that occurred in the first period.

It will in fact be the case that this game has a unique Perfect-Bayesian Equilibrium, and in this Perfect-Bayesian equilibrium, both the Principals and the Agent will use **public** strategies in which $w_{i1}^* : \Delta(\Theta) \to \mathbb{R}$, $w_{i2}^* : \Delta(\Theta) \to \mathbb{R}$, $d_1 : W^2 \to \{1, 2\}$, $d_2 : W^2 \to \{1, 2\}$, $e_1 \in \mathbb{R}_+$ and $e_2 \in \mathbb{R}_+$.

**The Program** Sequential rationality implies that the Agent will choose $e_2^* = 0$ in the second period, no matter what happened in previous periods. This is because no further actions or payments that the Agent will receive are affected by the Agent's effort choice in the second period. Given that the agent knows his effort choice will be the same no matter which contract he chooses, he will choose whichever contract offers him a higher payment.

In turn, the Principals will each offer a contract in which they earn zero expected profits. This is because they have the same beliefs about the Agent's ability. This is the case since they have the same prior and have seen the same public history, and in equilibrium, they have the same conjectures about the Agent's strategy and therefore infer the same information about the Agent's ability. As a result, if one Principal offers a contract that will yield him positive expected profits, the other Principal will offer a contract that pays the Agent slightly more, and the Agent will accept the latter contract. The second-period contracts offered will therefore be

$$w_{12}^* \left( \hat{\theta}(y_1) \right) = w_{22}^* \left( \hat{\theta}(y_1) \right) = w_2^* \left( \hat{\theta}(y_1) \right) = pE\left[ y_2 \mid y_1, \sigma^* \right] = pE\left[ \theta \mid y_1, \sigma^* \right],$$

where $\hat{\theta}(y_1)$ is the equilibrium conditional distribution of $\theta$ given realized output $y_1$.

If the agent chooses $e_1$ in period 1, first-period output will be $y_1 = \theta + e_1 + \varepsilon_1$. Given conjectured effort $e_1^*$, the Principals' beliefs about the Agent's ability will be based on two signals: their prior, and the signal $y_1 - e_1^* = \theta + \varepsilon_1$, which is also normally distributed with mean $m_0$ and variance $h_0^{-1} + h_\varepsilon^{-1}$. The joint distribution is therefore

$$\begin{bmatrix} \theta \\ \theta + \varepsilon_1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} \theta \\ \varepsilon_1 \end{bmatrix} \sim N\left( \begin{bmatrix} m_0 \\ m_0 \end{bmatrix}, \begin{bmatrix} h_0^{-1} & h_0^{-1} \\ h_0^{-1} & h_0^{-1} + h_\varepsilon^{-1} \end{bmatrix} \right)$$

Their beliefs about $\theta$ conditional on these signals will therefore be normally distributed:

$$\theta | \, y_1 \sim N\left( \varphi y_1 + (1 - \varphi) m_0, \frac{1}{h_\varepsilon + h_0} \right),$$

where $\varphi = \frac{h_\varepsilon}{h_0 + h_\varepsilon}$ is the signal-to-noise ratio. Here, we used the normal updating formula, which just to jog your memory is stated as follows. If $X$ is a $K \times 1$ random vector and $Y$ is an $N - K$ random vector, then if

$$\begin{bmatrix} X \\ Y \end{bmatrix} \sim N\left( \begin{bmatrix} \mu_X \\ \mu_Y \end{bmatrix}, \begin{bmatrix} \Sigma_{XX} & \Sigma_{XY} \\ \Sigma'_{XY} & \Sigma_{YY} \end{bmatrix} \right),$$

then

$$X | \, Y = y \sim N\left( \mu_X + \Sigma_{XY} \Sigma_{YY}^{-1} (y - \mu_Y), \Sigma_{XX} - \Sigma_{XY} \Sigma_{YY}^{-1} \Sigma'_{XY} \right).$$

Therefore, given output $y_1$, the Agent's second-period wage will be

$$w_2^* \left( \hat{\theta}(y_1) \right) = p \left[ \varphi (y_1 - e_1^*) + (1 - \varphi) m_0 \right] = p \left[ \varphi (\theta + e_1 + \varepsilon_1 - e_1^*) + (1 - \varphi) m_0 \right].$$

In the first period, the Agent chooses a non-zero effort level, even though his first-period contract does not provide him with performance-based compensation. He chooses a non-zero effort level, because doing so affects the distribution of output, which the Principals use in the second period to infer his ability. In equilibrium, of course, they are not fooled by his effort choice.

Given an arbitrary belief about his effort choice, $\hat{e}_1$, the signal the Principals use to update their beliefs about the Agent's type is $y_1 - \hat{e}_1 = \theta + \varepsilon_1 + e_1 - \hat{e}_1$. The agent's incentives to exert effort in the first period to shift the distribution of output are therefore the same no matter what the Principals conjecture his effort choice to be. He will therefore choose effort $e_1^*$ in the first period to solve

$$\max_{e_1} -c(e_1) + \delta E_{y_1}\left[ w_2^*\left(\hat{\theta}(y_1)\right) \middle| e_1 \right] = \max_{e_1} -c(e_1) + \delta p\left(\varphi\left(\theta + e_1 - e_1^*\right) + (1-\varphi) m_0\right),$$

so that he will choose

$$c'(e_1^*) = p\delta \frac{h_\varepsilon}{h_0 + h_\varepsilon},$$

and if $c(e) = \frac{c}{2}e^2$,

$$e_1^* = \frac{p}{c}\delta \frac{h_\varepsilon}{h_0 + h_\varepsilon}.$$

This second-period effort choice is, of course, less than first-best, since first-best effort satisfies $c'\left(e_1^{FB}\right) = 1$ or $e_1^{FB} = p/c$. He will choose a higher effort level in the first period the less he discounts the future ($\delta$ larger), the more prior uncertainty there is about his type ($h_0$ small), and the more informative output is about his ability ($h_\varepsilon$ large). Finally, given that the Agent will choose $e_1^*$, the first-period wages will be

$$w_{11}^* = w_{21}^* = pE[y_1] = p(m_0 + e_1^*).$$

This model has a number of nice features. First, despite the fact that the Agent receives no formal incentives, he still chooses a positive effort level, at least in the first period. Second, he does not choose first-best effort (indeed, in versions of the model with three or more periods, he may initially choose excessively high effort), even though there is perfect competition in the labor market for his services. When he accepts an offer, he cannot commit to choose a particular effort level, so competition does not necessarily generate efficiency when there are contracting frictions.

The model is remarkably tractable, despite being quite complicated. This is largely due to the fact that this is a symmetric-information game, so players neither infer nor communicate information about the agent's type when making choices. The functional-form choices are also aimed at ensuring that it not only starts out as a symmetric information game, but it also remains one as it progresses. At the end of the first period, if one of the Principals (say the one that the Agent worked for in the first period) learned more about the Agent's type than the other Principal did, then there would be asymmetric information at the wage-offering stage in the second period.

This model extends nicely to three or more periods. In such an extension, however, if the Agent's effort affected the variance of output, he would have more information about his type at the beginning of the second period than the Principals would. This is because he would have more information about the conditional variance of his own ability, because he knows what effort he chose. In turn, his choice of contract in the second period would be informative about what effort level he would be likely to choose in the second period, which would in turn influence the contract offerings. If ability and effort interact, and their interaction cannot be separated out from the noise with a simple transformation (e.g., if $y_t = \theta e_t + \varepsilon_t$), then the Agent would acquire private information about his marginal returns to effort, which would have a similar effect. For these reasons, the model has seen very little application to environments with more than two periods, except in a couple special cases (see Bonatti and Horner (2016) for a recent example with public all-or-nothing learning).

Finally, if the Agent's effort choice affects the informativeness of the public signal (e.g., $\varepsilon_t \sim N\left(0, h_\varepsilon\left(e_t\right)^{-1}\right)$), then the model may generate multiple equilibria. In particular, the equilibrium condition for effort in the first period will be

$$c'\left(e_1^*\right) = p\delta \frac{h_\varepsilon\left(e_1^*\right)}{h_0 + h_\varepsilon\left(e_1^*\right)},$$

which may have multiple solutions if $h'_\varepsilon(e_t) > 0$. Intuitively, if the Principals believe that the Agent will not put in effort in $t = 1$, then they think the signal is not very informative, which means that they will not put much weight on it in their belief formation. As a result, the Agent indeed has little incentive to put in effort in period 1. In contrast, if the Principals believe the Agent will put in lots of effort in $t = 1$, then they think the signal will be informative, so they will put a lot of weight on it, and the Agent will therefore have strong incentives to exert effort.

**Exercise.** *Can the above model be extended in a straightforward way to environments with more than* 3 *periods if the Agent has imperfect recall regarding the effort level he chose in past periods?*

An important source of conflicting objectives within firms is often the tension between the firm's desire to maximize profits and its workers' concerns for their careers. And importantly, as this model shows, these incentives are not chosen by the firm but rather, they are determined by the market and institutional context in which the firm operates. That is, career concerns provide *incidental*, rather than *designed*, incentives.

In this model, these incidental incentives motivate productive effort. Of course, these incentives may be excessively strong for young workers (see Landers, Rebitzer, and Taylor (1996) for evidence of this effect in law firms), and they may be especially weak for older workers (see Gibbons and Murphy (1992) for evidence of this effect among executives). More generally, however, career concerns incentives may motivate employees to make decisions that are counterproductive for the firm. If an employee is risk-averse, and he can choose between a safe project with outcomes that are independent of his ability and a risky project with outcomes that are more favorable if he is high-ability, he may opt for the safe project, even if the safe project is bad for the firm. In particular, if his expected future wage is linear in his expected ability, then since the market's beliefs about his ability are a martingale, he prefers the market's beliefs to remain constant. If a professional adviser cares about her reputation for appearing well-informed, then she may withhold valuable information when giving advice (Ottaviani and Sorensen, 2006).

If an employee cares about his reputation for being a quick learner, then an "Impetuous Youngsters and Jaded Old-Timers" dynamic can arise (Prendergast and Stole, 1996). In particular, if an employee observes private signals about payoffs of different projects, and smarter employees have more precise information, then smarter employees will put more weight on these private signals. Smarter employees' outcomes will therefore be more variable, and the market understands this, so there is an incentive for employees to "go out on a limb" by putting excessive weight on their private signals to convince the market they are smart (i.e., "youngsters may be impetuous"). Moreover, reversing a previous decision in the future signals, in part, that a worker's initial information was wrong, so older workers might inefficiently stick to prior decisions (i.e., "old-timers may be jaded").

**Further Reading** Dewatripont, Jewitt, and Tirole (1999b) shows that when there are complementarities between effort and the informativeness of the agent's output, there may be multiple equilibria. Dewatripont, Jewitt, and Tirole (1999a) explore a more-general two-period model and examine the relationship between the information structure and the incentives the agent faces. They also highlight the difficulties in extending the model beyond two periods with general distributions, since, in general, asymmetric information arises on the equilibrium path. Bonatti and Horner (2016) explore an alternative setting in which effort and the agent's ability are non-separable, but nevertheless, asymmetric information does not arise on the equilibrium path, in particular because their information structure features all-or-nothing learning. Cisternas (2016) sets up a tractable environment in which asymmetric information in fact arises on the equilibrium path.

The contracting space in the analysis above was very limited—principals could only offer short-term contracts specifying a fixed wage. Gibbons and Murphy (1992) allow for principals to offer (imperfect) short-term performance-based contracts. Such contracts are substitutes for career-concerns incentives and become more important later in a worker's career, as the market becomes less impressionable. In principle, we can think of the model above as characterizing the agent's incentives for a particular long-term contract—the contract implicitly provided by market competition when output is publicly observed. He, Wei, Yu, and Gao (2014) characterize the agent's incentives for general long-term contracts in a continuous-time version of this setting and derives optimal long-term contracts. Finally, the firm may have other instruments available for helping shape employees' career concerns. For example, team design in a setting where individual outputs cannot be individually observed (Bar-Isaac, 2007), and information design in a setting where the agent's current principal controls the information the market observes about his output (Prat, 2005; Wolitzky, 2012; Horner and Lambert, 2016; Rodina, 2016).