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Motivational Capital and Incentives in Health Care Organisations

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Abstract

This paper explores optimal incentive schemes in public health institutions when agents (doctors) are intrinsically motivated. We develop a principal-agent dynamic model with moral hazard in which agents' intrinsic motivation could be promoted (crowding-in) by combining monetary and non-monetary rewards. Intrinsic motivation could also be discouraged (crowding-out) when the health manager uses only monetary incentives.

We discuss the conditions under which investing in doctors' motivational capital by the use of well designed nonmonetary rewards is optimal for the health organizations manager. Our results show that such investments will be more efficient than pure monetary incentives in the long run. We will also prove that when doctors are risk-averse, it is profitable for the health manager to invest in motivational capital.

Keywords: contracts, moral hazard, intrinsic motivation, crowding effects, motivational capital.

1 Introduction

The purpose of this work is to investigate the roles played by the intrinsic motivation of doctors working in public health systems and by crowding effects, which can either undermine or enhance these inner motivations. Should health care organisations invest in motivating doctors? How should organisations' managers design incentive schemes so that they can benefit from what Akerlof and Kranton [1] call *motivational capital*? Could intrinsic motivation be the key to avoiding opportunistic behaviour?

People who work in the provision of collective goods are usually intrinsically motivated agents who get satisfaction from the very act of doing their work. There are motives such as altruism, reciprocity, intrinsic pleasure in helping others and ethical commitments, that induce people to help others more than would an own-material-maximizing individual [7]. Teachers, doctors, firefighters, policemen and social workers are good examples of such intrinsically motivated workers [2, 4, 20]. We use the term "intrinsic motivation" to refer to doing something because it is inherently interesting or enjoyable [10, 11]. In health care, intrinsic motivation refers to doctors' willingness to exert effort performing in medical activities that are of non-material interest like research, teaching, further education, health prevention activities or clinical management.

A new branch of contract theory investigates optimal contracts and incentives when agents are intrinsically motivated and when incentives beyond the money work [13, 14, 24, 28]. Dewatripont, Jewitt and Tirole [14] explore the effects of implicit incentives in the form of career concerns. Murdock [24] shows that in presence of implicit contracts, the firm can commit to implement some financially non-profitable projects with positive intrinsic value for the agent because doing that, agents will respond putting high effort to generate more projects and increasing the expected returns of the firm.

Another body of the literature analyzes the effects of having motivated agents in public organisations or in private organisations that serve collective goods [4, 16, 17, 27]. Wilson [29] explains how in the collective goods provision agencies, incentives are supplemented with a sense of mission based on a shared organizational culture. In Ghatak and Mueller [20] organisations can reduce incentive payments when they contract intrinsically motivated agents. Thus, an organisation that adopts the *non-for-profit* status will attract motivated workers and will benefit from paying agents lower efficiency wages. Dewatripont, Jewitt and Tirole [15] show that specialization and profesionalization of organisations raises the incentives of agents and create a sense of mission. They point out that *"this paradigm can be fruitfully expanded, for example to a dynamic perspective where effort choices are repeated and where the evolution of mission design can be analysed (p. 216)"*.

The above literature incorporates intrinsic motivation and the importance of the non-monetary incentives in principal-agent models. However, all these works have neglected the well established fact that incentives affect intrinsic motivation. Psychologists [8, 9, 10, 12], and behavioural economists [2, 5, 18, 19] argue that under some specific conditions incentives crowd-out intrinsic motivation of agents. The *crowding-out* effect is one of the most important anomalies in economics, and it acts in a manner opposite to the fundamental economic 'law' that raising monetary incentives increases supply [2, 3, 5, 7, 19, 22]. Bowles and Polanía-Reyes [7] classify the mechanisms accounting for crowding out. Our framework deals with three of these mechanisms: the informative value of incentives about principal's intentions or type, the compromise of agents' self determination or control aversion, and the agents' preferences updating process.

However *crowding-in* also can occur [7, 11]. In sixteen out of the fifty experiments surveyed in Bowles and Polanía-Reyes [7] they found evidence of crowding-in showing that well designed fines, subsidies, and the like, make incentives and intrinsic motivation complements rather than substitutes.

This work investigates the principal-agent relationship between managers and doctors [23], where the divergence in objectives between the principal's performance measures and the physicians' mission is a source of conflict. It is assumed that principals in health care are primarily focused on health benefits. They focus heavily upon improving certain health performance measures that are easily observable by the electorate: for instance reducing the amount of time spent on waiting lists, increasing the number of operations conducted for common pathologies, increasing the infrastructure, buying new technology assets, reducing costs and saving resources, and enlarging the range of services supplied. In contrast, physicians' goals are focused toward patients, a subset of all tax-payers, and also they have other interests in clinical and medical research, teaching and further education that taken together form what is called the doctors' "mission". One key fact of our approach is that incentives may make the action of providing health a less convincing signal of a doctors' intrinsic motivation resulting in observers interpreting some generous acts as merely self-interested. This may crowd out doctors intrinsic motivation and they could shift from an ethical to a payoff maximizing frame [3, 7].

The contribution of our approach is threefold: first, following Dewatripont, Jewitt and Tirole [14] research program, we present a dynamical principal-agent model with intrinsically motivated agents and repeated effort and incentives choices to analyze the evolution of optimal contracts; second, we incorporate crowding effects in this dynamic model; and third, the proposed dynamical setting allows us to endogeneize changes in doctors' preferences in response to the principal actions and therefore to evaluate how optimal contracts evolve and affect the outcomes of the game.

In the model, health managers have two options to motivate doctors: motivational investments and monetary incentives. We use the term *motivational investments* to refer to the resources devoted to well designed mechanisms, beyond the monetary incentives, oriented towards maintaining, recovering or enhancing doctors' intrinsic motivation through a crowding-in effect. However, the use of pure monetary incentives may discourage doctors through a crowding-out effect, leading them to behave as payoff maximisers.

We discuss the conditions under which spending resources on motivational capital is optimal for the health organisation's manager. Our results show that investing in motivational capital will be more efficient than monetary incentives in the long run. We will also prove that when doctors are risk-averse, it is more profitable for the health manager to invest in motivational capital.

The paper is organised as follows: section 2 presents the model, section 3 shows the results and section 4 summarizes the work with some concluding remarks.

2 The Model

There are two players in the game: a doctor $\mathcal{A}$ (agent) and a health manager $\mathcal{P}$ (principal)[1]. We assume that $\mathcal{A}$ is intrinsically motivated. We also restrict the analysis to linear contracts.

The game is played for a finite number of periods $t = 0, 1, ..., T, ...$ There is a health performance measure $q_t \in \mathbb{R}$ −the number of QALYs for instance− that $\mathcal{P}$ wants to maximise. For all t let $R_t(q_t)$ be a function $R_t : \mathbb{R} \longrightarrow \mathbb{R}_+$ which assigns a monetary value to every q_t[2].

Performance q_t is a function of doctor's effort $e_t \in \{\underline{e}, \overline{e}\}$. Assume that $q_t \in \{\overline{q}, \underline{q}\}$ in which $\overline{q} > \underline{q}$. Take $\overline{q}$ as $\mathcal{P}$'s target for performance level and $\underline{q}$ as a failure to reach this target performance level. Let $p(q_t = \overline{q}|e_t) = \theta_i$ be the conditional probability of high performance given $\mathcal{A}$'s effort choice $i = 0, 1$ in which 0 indicates low effort $\underline{e}$ and 1 indicates high effort $\overline{e}$. The probability distribution of q_t conditioned to e_t is given by: $p(q_t = \overline{q}|e_t = \overline{e}) = \theta_1$; $p(q_t = \underline{q}|e_t = \overline{e}) = 1 - \theta_1$ and, $p(q_t = \overline{q}|e_t = \underline{e}) = \theta_0$; $p(q_t = \underline{q}|e_t = \underline{e}) = 1 - \theta_0$. We assume that $\theta_1 > \theta_0$, which indicates that q_t is an informative signal of e_t.

We denote the health expected revenue conditional to q_t with $E[R_t(q_t)|\theta_i]$; $\overline{R}$ and $\underline{R}$ will stand for $R_t(\overline{q})$ and $R_t(\underline{q})$, respectively.

Let $w_t(q_t)$ be the contingent monetary reward offered by $\mathcal{P}$. $E[w_t(q_t)|\theta_i]$ will then be the expected monetary cost for the health organisation, or $\mathcal{P}$. Let $s_0 \in \{0, S\}$ be the total initial investment in motivational capital. This investment generates a cost stream $C_t(s_0)$ that takes the value $C_0(S) = S$ or $C_0(0) = 0$ in $t = 0$

[1] We use she and he to refer to the agent and the principal respectively, is conventional whithin the principal agent literature.
[2] QALY stands for Quality Adjusted Live Years. For an estimation of the monetary value of a QALY see Pinto-Prades, Loomes and Brey (2009).

and gives the depreciation cost $C_t(S) = \gamma S$ for every $t \geqslant 1$ at a constant depreciation rate of $\gamma \in [0, 1)$. We assume, as in Murdock [24], that by having motivated doctors, $\mathcal{P}$ should expect discounted future profits higher than the current cost of motivational incentives. $\mathcal{P}$'s problem is to maximise the expected profit function.

$$E[\pi_t|\theta_i] = E[R_t(q_t) - w_t(q_t) - C_t(s_0)|\theta_i]$$

We represent $\mathcal{A}$'s preferences with the following overall expected utility function.

$$E[U_t|\theta_i] = E[u_t(w_t) - \psi_t(e_t) + \phi_t(w_t, s_0)|\theta_i]$$

The first term on the right hand side of the above expression $u_t(w_t)$, represents $\mathcal{A}$'s utility from monetary incentives which *"...complement the remuneration provided by the employer of the physician (p. 1)"*, as in De Pouvourville [26]. We assume that $\mathcal{A}$ is risk-averse and that this utility function from monetary rewards satisfies the Inada conditions[3].

The middle term $\psi_t(e_t)$ is the cost from effort in utility terms that depends positively upon effort: $\psi_t(\underline{e}) = 0$ and $\psi_t(\overline{e}) = \Psi$. Thus, $\psi_t(e_t) \in \{0, \Psi\}$.

The last term is $\phi_t(w_t, s_0) \in [0, \Phi]$, in which $\phi_t : \mathbb{R}^2_+ \longrightarrow \mathbb{R}_+$ captures $\mathcal{A}$'s intrinsic motivation. Intrinsic motivation depends negatively upon incentives w_t and positively on $\mathcal{P}$'s investment in motivational capital s_0.

The incentives offered by $\mathcal{P}$ may affect the intrinsic motivation of $\mathcal{A}$ through crowding effects. The properties of this intrinsic motivation function and of crowding effects are summed up in the following assumptions:

A1: For any fixed value of w_t, $w^* \in [0, \infty)$ we have $\phi_t(w^*, S) - \phi_t(w^*, 0) > 0$.

A2: Intrinsic motivation depends negatively upon incentives:

$$\partial \phi_t(w_t, s_0)/\partial w_t < 0.$$

A3: Crowding in: in the case that $\mathcal{P}$ chooses $s_0 = S$, ϕ_t increases over time:

$$\mathrm{d}\phi_t\left(w_t, S\right)/\mathrm{d}t > 0$$

[3]Inada conditions: $\mathrm{d}u_t(w_t)/\mathrm{d}w_t > 0$, $\mathrm{d}^2u_t(w_t)/\mathrm{d}w_t^2 < 0$, $u_t(0) = 0$, $\lim\limits_{t\to\infty}\left[\mathrm{d}u_t(w_t)/\mathrm{d}w_t\right] = 0$ and $\lim\limits_{t\to 0}\left[\mathrm{d}u_t(w_t)/\mathrm{d}w_t\right] = \infty$.

A4: Crowding out: in case of $\mathcal{P}$ chooses $s_0 = 0$, ϕ_t decreases over time;

$$\mathrm{d}\phi_t\,(w_t, 0)\,/\mathrm{d}t < 0$$

Assumption A1 shows a fixed crowding effect. Assumption A2 tells that intrinsic motivation is negatively correlated with incentives (crowding out). Assumption A3 captures a crowding-in effect: when $\mathcal{P}$ chooses the $s_0 = S$, $\mathcal{A}$'s intrinsic motivation will increase period after period. Assumption A4 captures a crowding-out effect: when $\mathcal{P}$ chooses a $s_0 = 0$, $\mathcal{A}$'s intrinsic motivation will diminish period after period.

Physicians may have different degrees of intrinsic motivation at $t = 0$. The model captures this heterogeneity with a probability distribution function, $F_0(\phi_0)$ that is defined over the value of the intrinsic motivation at $t = 0$. For any $\phi^* \in [0, \Phi]$ the distribution function calculates the probability $F_0(\phi^*) = Prob(\phi_0 \leqslant \phi^*)$. In the game, $\mathcal{P}$ knows $F_0(\phi_0)$. His offer at $t = 0$ affects $\mathcal{A}$'s intrinsic motivation through crowding effects. We model crowding effects as time displacements of the distribution function conditional to $s_0 \in \{0, S\}$ and w_t (for example, $F_t(\phi_t|w_t, s_0)$). Thus, for any $\phi_t = \phi^* \in [0, \Phi]$, the conditional distribution calculates the probability $F_t(\phi_t|w_t, s_0) = Prob(\phi_t \leqslant \phi^*)$.

Figure 1 shows how crowding effects affect the intrinsic motivation probability distribution function. At $t = 0$, $\mathcal{P}$ knows a given distribution function $F_0(\phi_0)$. His choice of incentives in $t = 0$ affects agents intrinsic motivation switching the distribution function at $t = 1, 2, \ldots, T, \ldots$.

Fig. 1: **Stochastic Dominance.** The figure shows how crowding effects affect the intrinsic motivation probability distribution function in response to principal's choice of incentive policy: motivational investments $s_0 = S$, or pure monetary incentives $s_0 = 0$. Motivational investments $s_0 = S$ cause crowding-in switching the distribution function to the right period after period: $F_t(\phi|w_t, S) > F_{t+1}(\phi|w_{t+1}, S)$. Pure monetary incentives $s_0 = 0$ cause crowding-out switching the distribution function to the left period after period: $F_t(\phi|w_t, 0) < F_{t+1}(\phi|w_{t+1}, 0)$. Stochastic dominance ensures that no curve cross each together

As shown in the figure, if $\mathcal{P}$ chooses $s_0 = 0$, then the distribution function will shift to the left period after period. In other words, if incentives are only monetary, then doctors will concentrate around lower values of intrinsic motivation $\phi_t = 0$. In contrast, if incentives are motivational $s_0 = S$, then doctors will concentrate around higher values of intrinsic motivation $\phi_t = \Phi$. In this latter case, the distribution function shifts period after period to the right in figure 1.

We assume stochastic dominance in distribution function time shifts. This property assumes, as shown in figure 1, that $\mathcal{P}$'s choices of incentives affect every $\mathcal{A}$ intrinsic motivation in the same way. As a result, stochastic dominance assumes that probability distributions do not intersect on another[4].

[4]For a more formal description of this property, see the mathematical appendix.

The game is a repeated dynamic recontracting game. In each period of the game both players have to make new choices: $\mathcal{P}$ must offer a new contract after updating his beliefs about $\mathcal{A}$, and $\mathcal{A}$ has to choose a new effort level. The choices made by $\mathcal{P}$ affect $\mathcal{A}$'s intrinsic motivation, and changes in $\mathcal{A}$'s motivation affect the contract and equilibrium payments offered by $\mathcal{P}$ in the next period.

Each period of the game consists of three stages: stage 0, stage 1, and stage 2. The timing of the within-period in each $t = 0, 1 \ldots, T, \ldots$ is:

(0) The principal $\mathcal{P}$ knows the distribution of doctors' intrinsic motivation $F_0(\phi_0)$ at $t = 0$ or updates $F_t(\phi_t|s_0, w_t)$ given w_t and s_0 at $t = 1, 2, \ldots, T, \ldots$. He then offers a contract to $\mathcal{A}$. This contract consists of a pair of stochastic contingent payments $w_0(q_0) = \{\underline{w}, \overline{w}\}$ and the choice to invest or not invest in motivational capital s_0: $\{w_0(q_0), s_0\}$ at $t = 0$ and $\{w_t(q_t), s_0\}$ at $t = 1, 2, \ldots, T, \ldots$.

(1) $\mathcal{A}$ accepts or refuses the contract. If she accepts, then she chooses an action $e_t \in \{\underline{e}, \overline{e}\}$ at each $t = 0, 1, 2, \ldots, T, \ldots$. If she refuses then she gets her reservation utility $\overline{U}$.

(2) Finally, output is realised $q_t \in \{\underline{q}, \overline{q}\}$, payment is realised $w_t(q_t) = \{\underline{w}, \overline{w}\}$ and payoffs π_t and U_t are realised in each $t = 0, 1, 2, \ldots, T, \ldots$.

Figure 2 shows the sequence of these stages in $t = 0, 1, 2, \ldots, T, \ldots$.

Fig. 2: **Timing.** The figure describes the stages of the game within each period, differentiating the starting period of the game $t = 0$, where no crowding effect has had place, from subsequent periods $t = 1, 2, \ldots$ where $\mathcal{P}$'s actions affects $\mathcal{A}$s' intrinsic motivation through crowding effects

Before solving the game, let us assume that $\mathcal{P}$ and $\mathcal{A}$ can not sign long term contracts at $t = 0$. As a result, they have to agree upon the rewards at every period t. Once $\mathcal{P}$ has chosen $s_0 = S$ in $t = 0$ he bears the depreciation cost $C_t(s_0) = \gamma S$. We also assume that there is no contract renegotiation in the short term. In this game, the only way to agree upon a contract is to play the repeated game at every period $t = 0, 1, ..., T, ...$ as a new game.

We can therefore write $\mathcal{P}$'s problem as follows,

$$Max_{\{w_t(q_t), s_0\}} E[R_t(q_t) - w_t(q_t) - C_t(s_0)|\theta_1] \tag{1}$$

Subject to

$$E[u_t(w_t) - \psi_t(\overline{e}) + \phi_t\Big(w_t, s_0\Big)|\theta_1)] \geqslant E[u_t(w_t) - \psi_t(\underline{e}) + \phi_t\Big(w_t, s_0\Big)|\theta_0)] \text{ (ICC)} \tag{2}$$

$$E[u_t(w_t) - \psi_t(\overline{e}) + \phi_t\Big(w_t, s_0\Big)|\theta_1)] \geqslant \overline{U} \quad \text{(PC)} \tag{3}$$

$$u_t(\underline{w}) \geqslant 0 \quad \text{(LLC)} \tag{4}$$

(2) is $\mathcal{A}$'s *incentive compatibility constraint* (ICC) and ensures that the agent will prefer to exert high effort. (3) is the $\mathcal{A}$'s *participation constraint* (PC) and ensures that the agent will prefer to participate and accept the contract. Finally, (4) is a *limited liability constraint* (LLC) and ensures that the low utility payment will never fall below zero.

The solution to the above problem for each t is a pair of contingent payments $\{\overline{w}, \underline{w}\}$ associated with $\overline{q}$ and $\underline{q}$, respectively. Let us show how we calculate the equilibrium of the game.

For notational simplicity we will write $u_t(\overline{w}) = \overline{u}$ and $u_t(\underline{w}) = \underline{u}$. Let $h : u(w) \longmapsto w$ be the inverse of the utility function $h(u(w)) = (u(w))^{-1} = w$; then $\overline{w} = h(\overline{u})$ and $\underline{w} = h(\underline{u})$. Finally $\Delta\theta = (\theta_1 - \theta_0)$; and reservation utility is denoted by $\overline{U}$.

We rewrite $\mathcal{P}$'s problem as follows:

$$Max_{\{w_t(q_t), s_0\}} \theta_1 \left(\overline{R} - h(\overline{u})\right) - (1 - \theta_1) \left(\underline{R} - h(\underline{u})\right) - C_t(s_0) \tag{5}$$

Subject to

$$\theta_1 \overline{u} + (1 - \theta_1)\underline{u} - \Psi + \phi_t \geqslant \theta_0 \overline{u} + (1 - \theta_0)\underline{u} + \phi_t \text{ (ICC)} \tag{6}$$

$$\theta_1 \overline{u} + (1 - \theta_1)\underline{u} - \Psi + \phi_t \geqslant \overline{U} \quad \text{(PC)} \tag{7}$$

$$\underline{u} \geqslant 0 \quad \text{(LLC)} \tag{8}$$

Letting λ and μ be the non-negative Khun-Tucker multipliers associated respectively to (ICC) and (PC) constraints. First-order conditions of this problem lead to:

$$\left(1/u'(\overline{w})\right) = \mu + \lambda \cdot \left(\Delta\theta/\theta_1\right) \tag{9}$$

$$\left(1/u'(\underline{w})\right) = \mu - \lambda \cdot \left(\Delta\theta/(1 - \theta_1)\right) \tag{10}$$

The equations (9) and (10) (jointly with (6) and (7)) form a system of four equations with four variables $(\overline{w}, \underline{w}, \mu, \lambda)$. Multiplying (9) by θ_1 and (10) by $(1-\theta_1)$ and adding those two modified equations, we obtain;

$$\mu = \Big(\theta_1/u'(\overline{w})\Big) + \Big(1-\theta_1)/u'(\underline{w})\Big) > 0 \tag{11}$$

Therefore, $\mu > 0$ and the participation constraint (9) is binding. Using (11) and (9), we also obtain,

$$\lambda = \Big((1-\theta_1)\cdot\theta_1/\Delta\theta\Big)\cdot\Big(\big(1/u'(\overline{w})\big) - \big(1/u'(\underline{w})\big)\Big) > 0 \tag{12}$$

Therefore, $\lambda > 0$ and the incentive compatibility constraint (6) is also binding. Thus, we can immediately obtain the values of $\overline{u}$ and $\underline{u}$ by solving a system with two equations and two unknowns. The result is shown below:

$$\begin{aligned}\overline{u}_t &= \overline{U} - \phi_t\left(w_t, s_0\right) + \Big((1-\theta_0)/\Delta\theta\Big)\Psi \\ \underline{u}_t &= \overline{U} - \phi_t\left(w_t, s_0\right) - \Big(\theta_0/\Delta\theta\Big)\Psi.\end{aligned}$$

Applying the variable change $w_t(q_t) = h(u_t(w_t)) = (u_t(w_t))^{-1}$, we have the following payments,

$$\begin{aligned}\overline{w}_t = h(\overline{u}_t) &= \Big(\overline{U} - \phi_t\left(w_t, s_0\right) + \Big((1-\theta_0)/\Delta\theta\Big)\Psi\Big)^{-1} \\ \underline{w}_t = h(\underline{u}_t) &= \Big(\overline{U} - \phi_t\left(w_t, s_0\right) - \Big(\theta_0/\Delta\theta\Big)\Psi\Big)^{-1}.\end{aligned}$$

Thus, at every period of the game, $\mathcal{P}$ must offer to $\mathcal{A}$ the following expected payments,

$$\overline{w}_t = \Big(\overline{U} - E[\phi_t|w_t, s_0] + \Big((1-\theta_0)/\Delta\theta\Big)\Psi\Big)^{-1} \tag{13}$$

$$\underline{w}_t = \Big(\overline{U} - E[\phi_t|w_t, s_0] - \Big(\theta_0/\Delta\theta\Big)\Psi\Big)^{-1}. \tag{14}$$

We write the Expected Cost function for the health manager at each t as follows,

$$EC_t = (\theta_1\overline{w}_t + (1-\theta_1)\underline{w}_t) + C_t(s_0)$$

Let us use the superscript $s_0 \in \{0, S\}$ in $EC_t^{s_0}$ and $w_t^{s_0}$ to differentiate the expected cost function and expected payments when $\mathcal{P}$ invests in motivational capital $s_0 = S$ from the no investment case $s_0 = 0$. We then have EC_t^S and EC_t^0.

$$EC_t^0 = \left(\theta_1 \overline{w}_t^0 + (1-\theta_1)\underline{w}_t^0\right)$$

$$EC_t^S = \left(\theta_1 \overline{w}_t^S + (1-\theta_1)\underline{w}_t^S\right) + c_t(S)$$

As we have said in Section II, doctors' intrinsic motivation can be considered another productive asset or capital of the health organization called *Motivational Capital*. The current net value (CNV^{mk}) of the return of an investment in motivational capital is:

$$CNV^{mk} = \sum_{t=0}^{T} \delta^t \left[EC_t^0 - EC_t^S\right] \tag{15}$$

in which, $\delta^t = \left(1/(1+r)\right)^t$ is the discount factor, and r is the discount rate. We say that the principal has incentives to invest in motivational capital when $CNV^{mk} \geqslant 0$ and we say that, there is no incentive to invest in motivational capital when $CNV^{mk} < 0$.

3 Results

We solve the principal's problem under two alternative scenarios: when $\mathcal{P}$ chooses $s_0 = S$ and when he chooses $s_0 = 0$. We calculate the solution for each case to show necessary and sufficient conditions for investing in motivational capital.

3.1 Motivational Incentives: Crowding In

First, we solve the model for the case in which the health manager chooses $s_0 = S$. In this case, $\mathcal{A}$'s spot utilities and spot payments in each t are:

$$\overline{u}_t^S = \overline{U} - \phi_t\left(w_t, S\right) + \left((1-\theta_0)/\Delta\theta\right)\Psi; \qquad \underline{u}_t^S = \overline{U} - \phi_t\left(w_t, S\right) - \left(\theta_0/\Delta\theta\right)\Psi \qquad \text{and}$$
$$\overline{w}_t^S = \left(\overline{U} - E_t[\phi_t|w_t, S] + \left((1-\theta_0)/\Delta\theta\right)\Psi\right)^{-1}; \qquad \underline{w}_t^S = \left(\overline{U} - E_t[\phi_t|w_t, S] - \left(\theta_0/\Delta\theta\right)\Psi\right)^{-1}.$$

We write the expected cost function as

$$EC_t^S = \theta_1 \overline{w}_t^S + (1-\theta_1)\underline{w}_t^S + C_t(S).$$

We can now calculate the spot expected profit $E_t[\pi_t^S|\theta_1]$ for $\mathcal{P}$ and the spot expected utility $E_t[\mathcal{U}_t^S|\theta_1]$

for $\mathcal{A}$.

$$E_t[\pi_t^S|\theta_1] = E_t[R_t(q_t)|\theta_1] - [EC_t^S] \tag{16}$$

$$E_t[\mathcal{U}_t^S|\theta_1] = \left(\theta_1 \overline{u}_t^S + (1-\theta_1)\underline{u}_t^S\right) - \Psi + \phi_t(w_t, S) \tag{17}$$

Finally, we will compute the current value of the sum of spot expected profits (Π^S), the sum of the spot expected utilities ($\mathcal{U}^S$) and the current value of the total surplus (TS^S) when the action of $\mathcal{P}$ is $s_0 = S$.

$$\Pi^S = \sum_{t=0}^{T} \delta^t E_t[\pi_t^S|\theta_1] = \sum_{t=0}^{T} \delta^t \left(E_t[R_t(q_t)|\theta_1] - [EC_t^S]\right)$$

$$\mathcal{U}^S = \sum_{t=0}^{T} \delta^t E_t[\mathcal{U}_t^S|\theta_1] = \sum_{t=0}^{T} \delta^t \Big(\theta_1 \overline{u}_t^S + (1-\theta_1)\underline{u}_t^S - \Psi + \phi_t\big(w_t, S\big)\Big)$$

$$TS^S = \mathcal{U}^S + \Pi^S \tag{18}$$

3.2 Motivational Incentives: Crowding Out

The second case is $s_0 = 0$, when $\mathcal{P}$ uses pure monetary rewards and causes the crowding out of intrinsic motivation. In this case, $\mathcal{A}$'s spot utilities and spot payments in each t are:

$$\overline{u}_t^0 = \overline{U} - \phi_t\left(w_t, 0\right) + \Big((1-\theta_0)/\Delta\theta\Big)\Psi; \qquad \underline{u}_t^0 = \overline{U} - \phi_t\left(w_t, 0\right) - \Big(\theta_0/\Delta\theta\Big)\Psi \qquad \text{and}$$
$$\overline{w}_t^0 = h\left(\overline{U} - E_t[\phi_t|w_t, 0] + \Big((1-\theta_0)/\Delta\theta\Big)\Psi\right); \qquad \underline{w}_t^0 = h\left(\overline{U} - E_t[\phi_t|w_t, 0] - \Big(\theta_0/\Delta\theta\Big)\Psi\right).$$

We write the expected cost function as

$$ECF_t^0 = \theta_1 \overline{w}_t^0 + (1-\theta_1)\underline{w}_t^0$$

We can now calculate the spot expected profit $E_t[\pi_t^0|\theta_1]$ for $\mathcal{P}$ and the spot expected utility $E_t[\mathcal{U}_t^0|\theta_1]$ for $\mathcal{A}$.

$$E_t[\pi_t^0|\theta_1] = E_t[R_t(q_t)|\theta_1] - EC_t^0 \tag{19}$$

$$E_t[\mathcal{U}_t^0|\theta_1] = \left(\theta_1 \overline{u}_t^0 + (1-\theta_1)\underline{u}_t^0\right) - \Psi + \phi_t(w_t, 0) \tag{20}$$

For this case, we also complete the results showing the current value of the sum of spot expected profits (Π^0), the sum of the spot expected utilities ($\mathcal{U}^0$), and the current value of the total surplus (TS^0) when the action of $\mathcal{P}$ is $s_0 = 0$.

$$\Pi^0 = \sum_{t=0}^{T} \delta^t E_t[\pi_t^0|\theta_1] = \sum_{t=0}^{T} \delta^t \left(E_t[R_t(q_t)|\theta_1] - [EC_t^0]\right)$$

$$\mathcal{U}^0 = \sum_{t=0}^{T} \delta^t \Big[\overline{u}_t^0 + (1-\theta_1)\underline{u}_t^0 + \phi_t\Big(w_t, 0\Big) - \Psi\Big]$$

$$TS^0 = \mathcal{U}^0 + \Pi^0 \tag{21}$$

3.3 Comparative Statics

Motivational Capital and Optimal Contracts

Our model shows that an intrinsically motivated doctor is willing to work for lower overall pay. When these savings in rewarding motivated agents are high enough, it can be worthwhile for $\mathcal{P}$ to undertake a costly program to promote doctors' intrinsic motivation.

This work shows that when monetary and non-monetary incentives are correctly set, health organisations could benefit from investing in doctors' intrinsic motivation. Changes in each parameter of the model will affect the profitability of such an investment on *Motivational Capital* which will be a key question in $\mathcal{P}$'s behaviour.

We want to establish a decision rule for $\mathcal{P}$. He will take an action over $s_0 = \{0, S\}$ depending upon the total present profit that he can extract from each. Our analysis of $\mathcal{P}$'s behaviour then begins with a comparison of the different values of the contracts that he gets in with each decision. Let T be the number of periods that the game is going to be played. We then have:

$$\Pi^S - \Pi^0 = \sum_{t=0}^{T} \delta^t \left[E_t[\pi_t^S|\theta_1] - E_t[\pi_t^0|\theta_1]\right] = \sum_{t=0}^{T} \delta^t \left[E_t[\pi_t^S - \pi_t^0|\theta_1]\right]$$

Looking at the above expression, the decision rule for $\mathcal{P}$ will be to choose $s_0 = 0$ (pure monetary reward incentives) when $\Pi^S - \Pi^0 < 0$ and to choose $s_0 = S$ when $\Pi^S - \Pi^0 > 0$. After substituting (16) and (19), and rearranging we get,

$$\Pi^S - \Pi^0 = \sum_{t=0}^{T} \delta^t \left[\theta_1(\overline{w}_t^0 - \overline{w}_t^S) + (1-\theta_1)(\underline{w}_t^0 - \underline{w}_t^S)\right] - \sum_{t=0}^{T} \delta^t C_t(S) = \sum_{t=0}^{T} \delta^t \left[EC_t^0 - EC_t^S\right]$$

As we can see, the above expression equals the expression (15), which reflects the current net value of an investment made by $\mathcal{P}$ to generate motivation CNV^{mk}. $\mathcal{P}$ will then choose $s_0 = S$ in the case that $CNV^{mk} > 0$ and will choose $s_0 = 0$ in the case that $CNV^{mk} < 0$.

We then establish the following result:

Proposition 1. *Let T be the number of periods that the game will be played. There always exists a threshold t^* such that:*

$$\sum_{t=0}^{t^*} \delta^t \left[\theta_1(\overline{w}_t^0 - \overline{w}_t^S) + (1-\theta_1)(\underline{w}_t^0 - \underline{w}_t^S)\right] = \sum_{t=0}^{t^*} \delta^t C_t(S)$$

and for which

i. If $t^* \leqslant T$ then $CNV^{mk} \geqslant 0$ and $\mathcal{P}$ finds it profitable to invest in motivational capital and choose the $s_0 = S$ strategy.

ii. If $t^* > T$ then $CNV^{mk} < 0$ and $\mathcal{P}$ finds it profitable to not invest in motivational capital and chooses the $s_0 = 0$ strategy.

Figure 3 illustrates the result. The left side shows $\mathcal{P}$'s expected cost functionf for $s_0 = 0$ and $s_0 = S$. The right side shows the value of the CNV^{mk} as a function of time t. The t^* threshold determines the critical point below which the best strategy for $\mathcal{P}$ will be to not invest.

Fig. 3: **Current Net Value of Motivational Capital.** The graph shows together the expected cost functions EC_t^S and EC_t^0, joint with the net current value of motivational capital CNV^{mk}. The motivational investments profitability threshold t^* fix the point at which the CNV^{mk} becomes positive and therefore investing in motivational capital $s_0 = S$ is the best choice for $\mathcal{P}$

CNV^{mk} depends on $\mathcal{P}$'s time preference, which is captured in the model by the parameter δ. Lower values indicate that the health manager puts more weight on the present. Impatience therefore makes $s_0 = S$ less attractive.

Remark. *A lower value of δ means that the health manager is more focused on the short term. This implies that t^* will be larger, consequently making any investment of resources in motivational capital (i.e., implementing the $s_0 = S$ strategy) less attractive to him.*

This simple observation leads to an important discussion: the need for politically independent managerial positions in health. The political cycle forces politicians and consequently managers in health, to set short-term goals. They have a low δ because they put a lot of weight in the profits earned during the legislature. In contrast, doctors are career professionals who have long- term goals in health provision. As a result, politicians usually prefer to implement control and command policies and monetary incentives rather than implementing motivational incentives or investing in motivational capital (both of which are initially costly).

Now let us compare the total surplus of each strategy $s_0 \in \{0, S\}$ of $\mathcal{P}$, to determine which cases are the members of the health organisation, taken as a whole, better off. What we summarise in the following proposition is that the social optimum coincides with the optimal choice of $\mathcal{P}$. This is the case despite the crowding effects of incentive policies, because incentive compatibility constraint (2) and participation constraint (3) assume that for every choice $s_0 \in \{0, S\}$ of $\mathcal{P}$, and for every $t = 0, 1, \ldots, T$ the expected utility required by $\mathcal{A}$ to exert high effort is the same.

Therefore, in line with the first result established in *Proposition 1*, we have the following:

Proposition 2. *Let* $CNV^{mk} = TS^S - TS^0 = \sum_{t=0}^{T} \delta^t \left[EC_t^0 - EC_t^S\right]$. *Let* (s_0, e_t) *be the strategy profile that solves the game.*

i. If $CNV^{mk} \geqslant 0$*, then* $(S, \overline{e})$ *is a Pareto-Efficient strategy profile and Pareto-Dominates* $(0, \overline{e})$*. Therefore investing in Motivational Capital,* $s_0 = S$*, is the optimal social choice.*

ii. If $CNV^{mk} < 0$*, then* $(0, \overline{e})$ *is a Pareto Efficient strategy profile and Pareto Dominates* $(S, \overline{e})$*. Therefore not investing in Motivational Capital,* $s_0 = 0$ *is the optimal social choice.*

Risk Aversion and Motivational Capital

In the model, agents are risk-averse and thereby receive contingent rewards linked to performance q_t. Because $\mathcal{A}$ is more intrinsically motivated, fewer incentives and less variation in terms of rewards are required in order to encourage him to exert high effort. Less variation in payments indicates that $\mathcal{A}$ can be compensated with a lower risk premium, and this constitutes another cost-saving source for the health organisation.

Proposition 3 formally states that investing in motivational capital is more profitable in the presence of risk-averse $\mathcal{A}$:

Proposition 3. *Let* $\mathcal{A}^1$ *and* $\mathcal{A}^2$ *be a pair of agents with* ϕ^1 *and* ϕ^2 *intrinsic motivation respectively. If the agents are risk-averse and* $\phi^1 < \phi^2$*, then the risk premium will be lower in the case of* $\mathcal{A}^2$ *than in the case of* $\mathcal{A}^1$*. This additional advantage in costs shortens* t^**.*

The intuition behind this result is that incentives must be greater in ordert to encourage high effort from agents without much intrinsic motivation. However, these higher incentives raise the range between the low $\underline{w}$ and the high $\overline{w}$ payments. Given that $\mathcal{A}$ is risk averse, the risk premium that $\mathcal{P}$ should offer to make the incentive contract attractive for $\mathcal{A}$ will be higher. Analogously, intrinsically motivated agents rerquired fewer incentives to exert high effort. Consequently, she has to bear a lower variance over payments and has to be compensated with a lower risk premium.

4 Conclusion

The following conclusions summarize the results of this work.

First, when the principal is able to encourage doctors' intrinsic motivation, the length of the game plays a key role. *Proposition 1* shows that investing in motivational capital, although costly at inception, will be more efficient than the use of monetary incentives in the long run. However, if health care managers are focused on the short run (legislative period), then they will have a tendency to choose purely monetary rewards.

Second, the optimal choice of incentives for the principal always coincide with a Pareto-Efficient and Pareto-Dominant outcome.

Third, when doctors are risk-averse, they accept lower expected payments as their intrinsic motivation increases. Thus, risk aversion makes it more profitable for the health manager to invest in motivational capital.

Finally, other parameters of the model such as time preference or managers' ability to affect doctors intrinsic motivation are also relevant in determining when a motivational incentive scheme is the optimal choice.

A Mathematical Appendix

Stochastic Dominance

Crowding effects move the distribution of doctors intrinsic motivation with a stochastic dominance.

$$\begin{aligned} F_t(\phi_t = \phi^*|w_t, 0) \geqslant F_{t-1}(\phi_{t-1} = \phi^*|w_{t-1}, 0) \geqslant \cdots \geqslant F_0(\phi_0) \\ \geqslant \cdots \geqslant F_{t-1}(\phi_{t-1} = \phi^*|w_{t-1}, S) \geqslant F_t(\phi_t = \phi^*|w_t, S) \end{aligned}$$

Assume that $F_t(\phi_1|w_t, S)$ converges to the upper bound of intrinsic motivation $\phi_t = \Phi$ and that $F_t(\phi_1|w_t, 0)$ converges to the lower bound of intrinsic motivation $\phi_t = 0$.

$$\lim_{t\to\infty} F_t(\phi_t|w_t, S) = \rho \qquad \text{in which} \qquad \rho = \begin{cases} 1 & \text{if } \phi_t = \Phi \\ 0 & \text{otherwise} \end{cases}$$

and

$$\lim_{t\to\infty} F_t(\phi_t|w_t,0) = 1, \text{ for every } \phi_t \in [0,\Phi].$$

Let $E_t[\phi|s_0, w_t]$ be the mathematical expectation in t of the value of ϕ_t given the incentive policy s_0 and incentives w_t. Consequently, stochastic dominance on $E_t[\phi_t|\cdot]$ assumes:

$$\forall t = 0,1,...,T,... \qquad E_{t+1}[\phi_{t+1}|w_{t+1},0] < E_t[\phi_t|w_t,0]$$

$$\forall t = 0,1,...,T,... \qquad E_{t+1}[\phi_{t+1}|w_{t+1},S] > E_t[\phi_t|w_t,S]$$

$$\forall t = 0,1,...,T,... \qquad E_t[\phi_t|w_t,0] < E_t[\phi_t|w_t,S]$$

In which:

$$E_t[\phi_t|s_0] = \int_0^\Phi \phi_t f(\phi_t|w_t,s_0)d\phi_t$$

Proof of Proposition 1

We have to study the sign of the following expression:

$$\Pi^S - \Pi^0 = \sum_{t=0}^{T} \delta^t \left[\theta_1(\overline{w}_t^0 - \overline{w}_t^S) + (1-\theta_1)(\underline{w}_t^0 - \underline{w}_t^S)\right] - \sum_{t=0}^{T} \delta^t C_t(S) = \sum_{t=0}^{T} \delta^t \left[ECF_t^0 - ECF_t^S\right]$$

We have to show that there is a given threshold $t^* \in t = 0,1,2,\ldots,T,\ldots$ such that,

$$\sum_{t=0}^{T} \delta^t \left[\theta_1(\overline{w}_t^0 - \overline{w}_t^S) + (1-\theta_1)(\underline{w}_t^0 - \underline{w}_t^S)\right] = \sum_{t=0}^{T} \delta^t C_t(S)$$

By crowding effects we have that $\forall t \in \{0,1,2,\ldots,T,\ldots\}$

$$E_t[\phi_t|w_t,S] < E_{t+1}[\phi_{t+1}|w_{t+1},S] \tag{22}$$

$$E_t[\phi_t|w_t,0] > E_{t+1}[\phi_{t+1}|w_{t+1},0] \tag{23}$$

Taking the expected payments (13) and (14), it can be shown immediately that for any incentive policy of $\mathcal{P}$ $s_0 \in \{0,S\}$, both payments (the low $\underline{w}^{s_0}$ and the high $\overline{w}^{s_0}$) depend negatively upon the amount of intrinsic motivation (ϕ).

$$\partial\overline{w}(E_t[\phi_t|s_0, w_t])/\partial\phi < 0 \tag{24}$$

$$\partial\underline{w}(E_t[\phi_t|s_0, w_t])/\partial\phi < 0. \tag{25}$$

It immediately follows that the expected cost function, independently of $\mathcal{P}$'s choice over $s_0 \in \{0, S\}$, also depends negatively upon intrinsic motivation:

$$\partial EC_t/\partial\phi < 0.$$

(22) and (23) together with (24) and (25), establish that:

$$\begin{aligned}
\overline{w}_t^S(E_t[\phi_t|w_t, S]) &> \overline{w}_{t+1}^S(E_{t+1}[\phi_{t+1}|w_{t+1}, S]) \\
\underline{w}_t^S(E_t[\phi_t|w_t, S]) &> \underline{w}_{t+1}^S(E_{t+1}[\phi_{t+1}|w_{t+1}, S]) \\
\overline{w}_t^0(E_t[\phi_t|w_t, 0]) &< \overline{w}_{t+1}^0(E_{t+1}[\phi_{t+1}|w_{t+1}, 0]) \\
\underline{w}_t^0(E_t[\phi_t|w_t, 0]) &< \underline{w}_{t+1}^0(E_{t+1}[\phi_{t+1}|w_{t+1}, 0])
\end{aligned}$$

Therefore, looking at the expected costs of incentivising effort in each case $s_0 \in \{0, S\}$:

$$\begin{aligned}
EC_t^S &= \theta_1\overline{w}_t^S(E_t[\phi_t|w_t, S]) + (1-\theta_1)\underline{w}_t^S(E_t[\phi_t|w_t, S]) \\
EC_t^0 &= \theta_1\overline{w}_t^0(E_t[\phi_t|w_t, 0]) + (1-\theta_1)\underline{w}_t^0(E_t[\phi_t|w_t, 0])
\end{aligned}$$

It is immediately shown that the expected cost of incentivising effort is decreasing with time whenever the choice of $\mathcal{P}$ is $s_0 = S$ and that the expected cost of incentivising effort is increasing with time whenever the choice of $\mathcal{P}$ is $s_0 = 0$. Formally,

$$\Delta EC^S = EC_{t+1}^S - EC_t^S < 0 \text{ and } \Delta EC^0 = EC_{t+1}^0 - EC_t^0 > 0 \tag{26}$$

$$\text{for any } t \in \{1, 2, \ldots, T, \ldots\}.$$

Now if we calculate φ_t, the period-by-period saved cost for $\mathcal{P}$ as a result of his choice of the $s_0 = S$ incentive scheme, we see that these savings are positive and increase over time: Let $\varphi_t = EC_t^0 - EC_t^S$ the cost that is saved in $t \in \{0, 1, 2, \dots T, \dots\}$ by $\mathcal{P}$ as a result of his choice of $s_0 = S$. φ_t together with (26) give:

$$\Delta\varphi = \varphi_{t+1} - \varphi_t = \Delta EC^0 - \Delta EC^S = \underbrace{[EC^0_{t+1} - EC^0_t]}_{>0} - \underbrace{\overbrace{[EC^S_{t+1} - EC^S_t]}^{<0}}_{>0} > 0$$

These time increasing positive savings of choosing $s_0 = S$ ensures that for some $\hat{t} \in t = 1, 2, \dots, T, \dots$ savings will be such that:

$$\varphi_{\hat{t}} = EC^0_{\hat{t}} - EC^S_{\hat{t}} = \gamma S = C_{\hat{t}}(S)$$

This result indicates that there is a given time period $\hat{t} \in t = 1, 2, \dots, T, \dots$ in which the amount of resources saved by $\mathcal{P}$ in incentivising $\mathcal{A}$'s effort is greater than the depreciation cost of the initial investment in intrinsic motivation undertaken by $\mathcal{P}$. Equation (26) also ensures that once the game goes beyond $\hat{t}$ periods, for every $t \geqslant \hat{t}$ we will have that:

$$\varphi_{\hat{t}} = EC^0_{\hat{t}} - EC^S_{\hat{t}} > \gamma S = C_{\hat{t}}(S)$$

Therefore, beyond the $\hat{t}$ period, $\mathcal{P}$ will get a positive return from making the decision to invest in motivational capital $s_0 = S$ at $t = 0$. Thus, we have limited losses from $t = 0$ to $t = \hat{t}$, and unlimited positive returns from $t = \hat{t}$ to $t = \infty$. Let us denote the total limited loss of a $s_0 = S$ strategy as L. The following expression then allows us to calculate the present value of this loss:

$$L = \sum_{t=0}^{\hat{t}} \delta^t \left[\theta_1(\overline{w}^0_t - \overline{w}^S_t) + (1 - \theta_1)(\underline{w}^0_t - \underline{w}^S_t)\right] - \sum_{t=0}^{\hat{t}} \delta^t C_t(S) < 0 \tag{27}$$

Now let us note the total positive returns of a $s_0 = S$ strategy as B. The following expression then allows us to calculate the current value of this return, depending upon the number of times that the game will be played,

$$B = \sum_{t=\hat{t}}^{\infty} \delta^t \left[\theta_1(\overline{w}^0_t - \overline{w}^S_t) + (1 - \theta_1)(\underline{w}^0_t - \underline{w}^S_t)\right] - \sum_{t=\hat{t}}^{\infty} \delta^t C_t(S) > 0 \tag{28}$$

With a time horizon of infinite number of periods, (40) and (41) jointly assume that there is a threshold $t^* \in \{\hat{t}, \dots, T, \dots\}$ such that $L = B$ holds and this result proves Proposition 1.

Proof of Proposition 2

Immediate by comparing (28) and (34), and using *Proposition 1.* Proof available from the authors upon request.

Proof of Proposition 3

Immediate by concavity on A's utility from rewards and the lower variation in incentive payments when intrinsic motivation is higher. Proof available from the authors upon request.

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Figure 1.

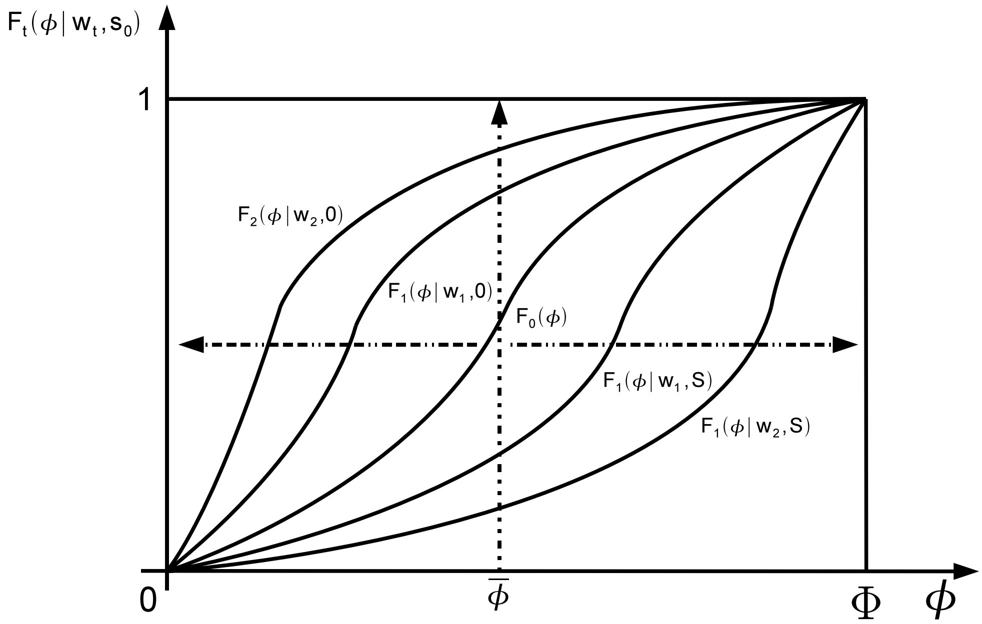
$F_t(\phi | w_t, s_0)$
1
$F_2(\phi | w_2, 0)$
$F_1(\phi | w_1, 0)$
$F_0(\phi)$
$F_1(\phi | w_1, S)$
$F_1(\phi | w_2, S)$
0
$\overline{\phi}$
Φ
ϕ

Figure 2.

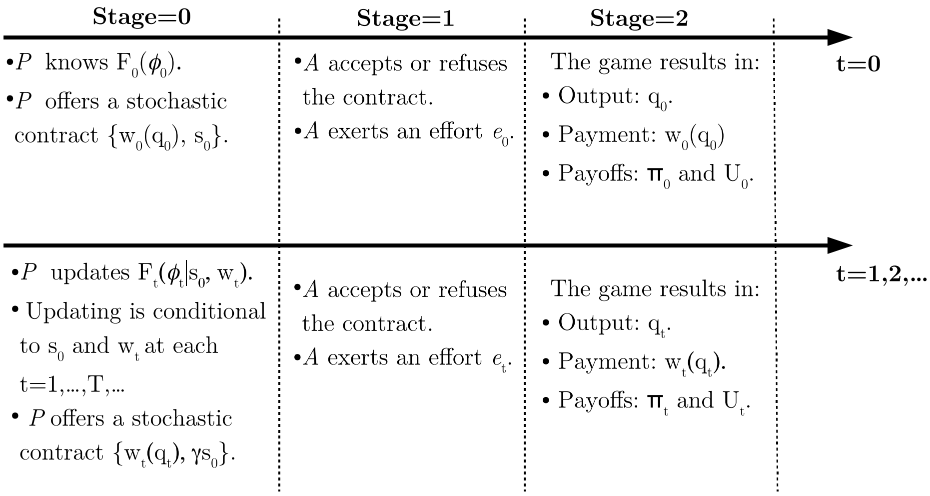
Stage=0
Stage=1
Stage=2
•P knows $F_0(\phi_0)$.
•P offers a stochastic contract $\{w_0(q_0), s_0\}$.
•A accepts or refuses the contract.
•A exerts an effort e_0.
The game results in:
• Output: q_0.
• Payment: $w_0(q_0)$
• Payoffs: π_0 and U_0.
t=0
•P updates $F_t(\phi_t|s_0, w_t)$.
• Updating is conditional to s_0 and w_t at each t=1,...,T,...
• P offers a stochastic contract $\{w_t(q_t), \gamma s_0\}$.
•A accepts or refuses the contract.
•A exerts an effort e_t.
The game results in:
• Output: q_t.
• Payment: $w_t(q_t)$.
• Payoffs: π_t and U_t.
t=1,2,...

Figure 3.