The impact of outsourcing on investments in firm-specific human capital under varying contract regimes

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Abstract

Investments in firm-specific human capital have come to play a central role in the value creation for most companies and organisations as job tasks have become ever more complex and demanding to carry out. Today successful performance of essential job tasks often necessitates highly specialised knowledge and skills, thus requiring continuous updating of employee competences. This paper develops a two-period agency model to show how the threat of layoff (outsourcing of job tasks to a third party supplier) can help a company trigger or ease employee investments in firm-specific human capital by creating explicit career concerns for the individual employee. Results are provided under long-term as well as short-term contracting regimes. In particular, the paper has relevance for companies operating under short-term contracting where investments in firm-specific human capital might be profitable yet very difficult or even impossible to induce.

1 Introduction

Resource-based theory suggests that a key element to ensure long-term company profitability is an ongoing focus on what resources to use and how to combine these most effectively to exploit their full potential (Wernerfelt 1984). In many companies the most important resources are human by nature, which naturally relates firm prosperity to the knowledge and skills held by the employees (Becker 1964; Spender and Grant 1996). Sometimes these capabilities can be combined and codified into intellectual assets like inventions and technologies that can be claimed as property by the company. At other times it is impossible, or very costly and difficult, to materialise human capabilities, for which reason their value-creating potential remains with the individual worker and can only be used at his discretion (Edvinsson and Sullivan 1996; Kogut and Zander 1993; Nonaka and Takeuchi 1994). Still, however, such non-codified knowledge and skills can generate value through reinforcement of essential processes within the company.

Whether knowledge and skills can be codified or not, learning is essential because it is a precondition for value creation that the employees acquire the necessary know-how to master and develop the company's intellectual assets or reinforce company processes. Some required capabilities are non-idiosyncratic and widely available in the labour market as they can be acquired by any worker prior to joining a particular firm (e.g. school training). Yet, if competition is fierce, competitiveness and thus profitability can best be ensured by focusing company activities around superior resources that are unique and difficult for competitors to imitate (Prahalad and Hamel 1990; Barney 1991). That is, only through such resources is it possible to obtain a low cost position in the market (Ricardian rents) or lower competition by differentiating company products from the rest of the market (monopoly rents) (Peteraf 1993). Consequently, firm-specific learning (on-the-job training) needs to take place inside the company after the worker has been hired. For example, the profit potential of

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a manufacturing firm producing a standard good following a low-cost strategy may depend on the employees' inclination to acquire specific know-how about the company's production processes that can help perfect critical manufacturing routines, thus improving productivity. Likewise, the monopoly rent of a high-tech company having differentiated its business thanks to a patent on one of its intellectual assets may partially depend on certain employees acquiring the knowledge necessary to master this technology, a knowledge acquisition which by definition is company specific due to the technology being patented.

More formally, the term human capital can be used to capture the idea that much skill and knowledge required to do a job can only be acquired if some "investment" is made in time and resources (Becker 1964). In this respect, there are generally two types of human capital; firm-specific and regular human capital. Regular (non-firm-specific) human capital is transferable between jobs, which implies that the inherent value is independent of a particular employment relationship. Contrary to this, firm-specific human capital is characterised by having a much higher value in a given employment relationship than it does in other potential relationships, and so, just like specialised physical investments, it may enhance productivity beyond what can be realised using regular human capital.

Hence, where profitability can be improved by employees investing time and effort in tailoring their capabilities to specific company operations, companies have a clear interest in such investments being undertaken. The difficulty, however, is that the inherent asset specificity complicates the employment relationship by introducing a fundamental hold-up problem. On the one side, if the firm has paid for the specific training of a worker who quits to take another job, its capital expenditure will be partly wasted for no further return to be collected (Becker 1964). However, even if the cost of education is negligible, as will be assumed in this paper, providing the facilities will not necessarily do the job since learning can only happen at the worker's own discretion. This represents the other side of the hold-up problem and will in this paper be described as a combination of two effects. First, the total effort that an employee can exert in a given period might be constrained, which can cause reluctance to invest in firm-specific human capital since learning is counterproductive in the short run and reduces effort available to spend on other short-term productive activities. Second, the firm specificity makes the investment risky as the acquired abilities only have limited value in alternative use, thereby making the worker vulnerable to layoff or salary cuts before fully recouping his investment.

Since learning cannot be enforced by the company, it can merely try to encourage learning implicitly through carefully designed incentive mechanisms that make it attractive for the employee to acquire firm-specific capabilities. One way to induce such long-term actions is by providing job security for the worker, which can be attained through long-term contracts where the company commits to a given compensation in future periods at the time of contract initiation (Milgrom and Roberts 1992, p. 363). By doing so, the employee no longer needs to worry about dismissal or forced salary cuts as a consequence of being locked in when undertaking investments in firm-specific human capital. In particular, if the salary in future periods partly depends on how productive the worker is, and productivity can be influenced positively by improving skills and knowledge, long-term engagements naturally motivate the employee to upgrade his competence level.

However, not all companies can operate under long-term contracts but instead have to rely on short-term engagements. For example, it is not difficult to imagine a company that for strategic reasons needs to keep the cost structure flexible and thus contracts with a part of the employees on a short-term basis in order to make periodical salary adjustments possible. Likewise, a company might be interested in minimising employee shirking through the disciplining effect of ongoing performance evaluation that, contrary to long-term engagements, is naturally embedded in short-term contracts (Anderhub et al. 2003). Still, even under such conditions it may be in the company's best interest that firm-specific learning takes place, since company performance may then be enhanced due to increased productivity ex post the competence investment. The problem is, however, that short-term contracting does not eliminate the risk related to the worker's investment in firm-specific human capital as it makes it non-credible for the company to commit to compensations in future periods. Thus, if em-

ployee competences can be observed, a rational company will try to exploit the worker's inflexibility ex post the investment and enforce a salary cut that leaves the employee with little or no expected value of his competence improvement. In total, this might eliminate the worker's incentive to invest in firm-specific capabilities when taking into consideration the negative effect that learning has on short-run productivity.

One way to incentivise the worker to take given actions even under short-term contracting can be found in the literature on labour economics where the disciplining effect of unemployment has been studied (Calvo 1979; Shapiro and Stiglitz 1984). The basic idea in Shapiro and Stiglitz (1984) is that if no unemployment exists and all workers receive the market wage, the worst that can happen to a worker not exhibiting the right behaviour (e.g. shirking) is getting fired. However, since he can immediately be rehired at the market wage, he pays no penalty for his misdemeanour and has no incentive to behave well. With unemployment the situation changes; even if all firms pay the same wages, a worker has an incentive to behave correctly because if he is laid off, no other job is immediately available. Therefore, the equilibrium unemployment rate must be large enough to make it worthwhile for workers to undertake actions that are in the company's best interest and avoid dismissal.

Another way to provide the worker with incentive to undertake certain actions, which is of particular interest to the present paper, can be found in the literature on career concerns, also known as implicit market-driven incentives (e.g. Gibbons and Murphy 1992; Dewatripont et al. 1999a, 1999b; Holmström 1999). Typically, career concerns arise when the (internal or external) labour market settles future compensation to reflect employee ability but neither the worker's skill level nor his productive effort is observable. Yet, output can be observed and so the market uses this to update its belief about the worker's ability in order to apply this revised expectation to determine future wages. As a result, the worker wants to take advantage of effort being unobservable, in an attempt to increase output and thus influence the market's belief about talent.[1]

Motivated by the importance of firm-specific human capital in many employment relationships and intrigued by the use of unemployment and career concerns as incentive mechanisms, I set out to formally study how outsourcing can be used as a possible device to overcome incentive problems of investing in competence improvement under varying contract regimes. Assuming that capabilities are observable and no immediate rent yielding job positions are available after layoff, the simple idea is that the mere threat of outsourcing makes the employee concerned with unemployment, which induces him to take firm-specific long-term actions. As such, this partly resembles the idea from Shapiro and Stiglitz (1984) of using unemployment as a disciplining device, although the concern of the present paper is not with analysing the dynamics or equilibrium effects in the labour market. Instead the centre of attention is kept on the employment relationship after a particular worker has been selected but before any investment in firm-specific human capital has been made or compensation contracts have been formally established. Put differently, my analysis concentrates on how outsourcing can trigger or ease the undertaking of competence improvement within the employment relationship by forcing the worker, when maximising his utility, to explicitly consider how attractive a certain investment in firm-specific human capital makes him in the eyes of the company. In this respect, the incentive to signal attractiveness bears certain similarities to the typical career concern model. However, while the underlying mechanism may be the same, my proposed setup differs from the standard modelling of career concerns in two important ways. First, the worker's ability is not a constant but can indeed be improved by the worker's own behaviour if he spends time on learning. Second, the worker's competence level will be fully revealed to the company, and so what drives future wages is not the observed output but in fact the observed ability, since this partially determines whether the worker will be laid off or allowed to continue production.

In particular, I initially concentrate on an employment relationship based on long-term contracts to provide a

[1] For models along these lines, see Holmström (1999), which is a re-publication of a paper from 1988, and Gibbons and Murphy (1992).

benchmark for my subsequent analysis of short-term contracting. I thus show how the company can regulate (strengthen or weaken) the worker's incentive to invest in firm-specific human capital through commitment to a given compensation structure ex post the investment. Following this, I demonstrate why outsourcing flexibility can be alluring for the company to bring about even under long-term contracting as it comprises two potentially value creating effects; a real option effect and a behavioural effect. The real option effect sets in as the external supplier alternative reduces the dependence on in-house learning if the company can choose the severance fee paid to the worker at dismissal without constraints. The behavioural effect is coined through the worker's incentive to stay attractive to the company and avoid layoff. Hence, if the rent from continued in-house production is lucrative to the worker, the mere introduction of an outsourcing alternative may incentivise him to invest in firm-specific human capital to signal attractiveness to the company and avoid layoff. In consequence, introducing outsourcing flexibility is not necessary to induce a certain investment in firm-specific human capital under long-term contracts, yet it holds the potential for the company to induce the investment at a lower cost than under no outsourcing.

The second part of this article studies short-term contracting. Initially, I show how this contracting regime leaves the employee with no incentive to invest in firm-specific human capital if competences can be observed. Specifically, since the company cannot credibly commit to any future contracts, it will always exploit the firm-specificity of the worker's investment and enforce a salary cut ex post the competence improvement that reduces the value of the firm-specific investment to zero. As such, this can be harmful to the company if learning is productive. I thus demonstrate how the company can benefit from introducing outsourcing flexibility into the setting to create explicit career concerns for the employee and make him undertake long-term actions to signal attractiveness and maintain production in-house. That is, although future compensation will be adjusted by the company to offset the effect of firm-specific investments under short-term contracting, there are still rents to be collected by the worker if not dismissed. Consequently, compared to full commitment the introduction of outsourcing flexibility is absolutely necessary to encourage a positive investment in firm-specific human capital under short-term contracting. I close this second part with some example-based reflections on the value of the outsourcing flexibility to both the company and the employee. My final section concludes the paper.

2 Full commitment

2.1 The basic model without outsourcing flexibility

In what follows I will consider a company setting lasting for two periods and consisting of a risk neutral principal (the manager or company) and a risk neutral agent with limited liability (the employee). For the purpose of illustration, I will let the agent be the company's sole productive resource and assume that he possesses two basic capabilities; a physical productive ability and an intellectual capacity to learn. As such, the physical productive ability makes the employee able to produce the company's output while the intellectual capacity provides the employee with an opportunity to acquire certain firm-specific skills regarding company processes and best practice that can complement and amplify the effect of using the physical productive ability.

Under full commitment the principal at $t = 0$ contracts with the agent for production of the stochastic output $\tilde{x}_1 \in \{x_L, x_H\}$ in period 1 and $\tilde{x}_2 \in \{x_L, x_H\}$ in period 2 where $\Delta x = x_H - x_L > 0$.[2]

The output in period 1 is affected by the level and composition of the agent's effort. As such, the agent's effort can take on two levels, $e_1 \in \{e_L, e_H\}$ with $e_H > e_L \geq 0$, which can be further divided into physical productive effort, $a \geq 0$, and skill improvement (investment in firm-specific human capital), $h \geq 0$. Mathematically, I assume that the probability of realising the high output (upstate), x_H, in period 1 is given by $\varphi_1(x_H | e_1, h) = (e_1 - h)^{1/2}$ while the probability of realising the low output (downstate) is $\varphi_1(x_L | e_1, h) = 1 - (e_1 - h)^{1/2}$. Intuitively, this implies that the more effort the agent exerts, the greater is the chance of realising the high outcome. However, should the agent choose to spend time on skill improvement, this will diminish the probability of realising

[2] Notice that all through this article, Δ represents *change* in the particular variable of interest.

the high outcome, since investing in firm-specific human capital is assumed non-productive during period 1. Moreover, I assume that putting forth effort does not come without cost, for which reason the agent suffers a personal cost of $\kappa_1 = 0$ or $\kappa_1 = \kappa_H > 0$ when exerting e_L or e_H, respectively. Finally, at the end of period 1 the output, x_1, is realised and since this output is the only contractable variable in period 1, this determines the agent's payment, c_1. As such, c_1 can never be negative due to the agent's limited liability.

All told, the agent's expected utility in period 1 conditional on e_1 and h takes the following form

$$\begin{aligned} E\left[U_1 \middle| e_1, h\right] &= \varphi_1\left(x_H \middle| e_1, h\right) c_{1H} + \left(1 - \varphi_1\left(x_L \middle| e_1, h\right)\right) c_{1L} - \kappa_1 \\ &= c_{1L} + \left(e_1 - h\right)^{1/2} \Delta c_1 - \kappa_1 \end{aligned} \tag{1}$$

Likewise, if the revenue from production is assumed to be net of production cost, the principal only explicitly incurs the compensation cost to the agent and faces the following expected profit conditional on e_1 and h.

$$\begin{aligned} E\left[\pi_1 \middle| e_1, h\right] &= \varphi_1\left(x_H \middle| e_1, h\right)\left(x_H - c_{1H}\right) + \varphi_1\left(x_L \middle| e_1, h\right)\left(x_L - c_{1L}\right) \\ &= \left(e_1 - h\right)^{1/2}\left(x_H - c_{1H}\right) + \left(1 - \left(e_1 - h\right)^{1/2}\right)\left(x_L - c_{1L}\right) \end{aligned} \tag{2}$$

To keep the model tractable in period 2, I continue the simplicity from period 1 and assume that the agent's effort can take on the same two levels, $e_2 \in \{e_L, e_H\}$. This time, however, further skill improvement is pointless for which reason the agent only directs his effort towards physical production. Additionally, the agent benefits from his investment in firm-specific human capital; the probability of receiving the high output in period 2 is $\varphi_2\left(x_H \middle| e_2, h\right) = e_2^{1/2}\left(1 + \alpha h\right)$ while the probability of receiving the low output is $\varphi_2\left(x_L \middle| e_2, h\right) = 1 - e_2^{1/2}\left(1 + \alpha h\right)$ for any given $h \geq 0$. With regard to the specific structure of the probability function, the parameter α determines how productive firm-specific human capital is in period 2 and thus how much investing in firm-specific human capital increases the likelihood of realising the upstate. Moreover, for $h = 0$ the probabilities in period 1 and 2 are identical; if no investment is made in firm-specific human capital and the same amount of effort is put forth in each period, the probability of realising the upstate is the same in both periods. In continuation of this, I make the special assumption that the principal can only establish a compensation programme in period 2 that is independent of the realised period 1 compensation. Again, I assume that the agent suffers a personal cost in period 2 of $\kappa_2 = 0$ or $\kappa_2 = \kappa_H > 0$ when exerting e_L or e_H, respectively.

In total, this provides the agent with the following expected utility, $E\left[U_2^{NO} \middle| e_2, h\right]$ in period 2 when no outsourcing flexibility exists (NO)

$$\begin{aligned} E\left[U_2^{NO} \middle| e_2, h\right] &= \varphi_2\left(x_H \middle| e_2, h\right) c_{2H} + \varphi_2\left(x_L \middle| e_2, h\right) c_{2L} - \kappa_2 \\ &= c_{2L} + e_2^{1/2}\left(1 + \alpha h\right) \Delta c_2 - \kappa_2 \end{aligned} \tag{3}$$

while the principal's profit under full contract commitment and no outsourcing in period 2 is given by

$$\begin{aligned} E\left[\pi_2^{NO} \middle| e_2, h\right] &= \varphi_2\left(x_H \middle| e_2, h\right)\left(x_H - c_{2H}\right) + \varphi_2\left(x_L \middle| e_2, h\right)\left(x_L - c_{2L}\right) \\ &= e_2^{1/2}\left(1 + \alpha h\right)\left(x_H - c_{2H}\right) + \left(1 - e_2^{1/2}\left(1 + \alpha h\right)\right)\left(x_L - c_{2L}\right) \end{aligned} \tag{4}$$

Figure 1 below outlines the sequence of events in the model.

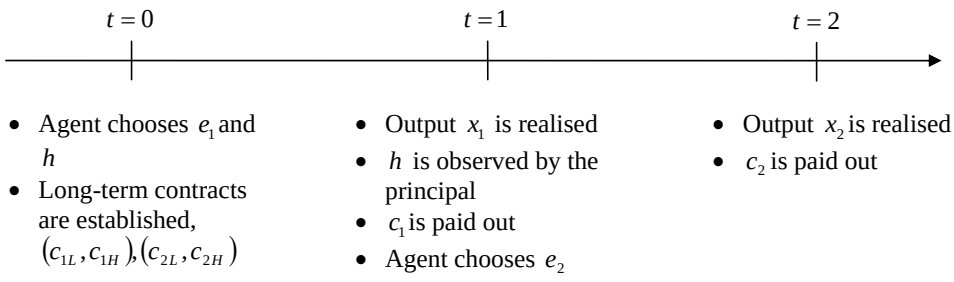

Figure 1: Sequence of events in the basic model

2.2 Analysis under full commitment and no outsourcing flexibility

Initially, I will consider what will be termed the *benchmark situation* where outsourcing is *not* possible and long-term contracts can be established. I assume that Δx is sufficiently large to provide the principal with incentive to induce the high effort level in each period, i.e. $(e_1, e_2) = (e_H, e_H)$. First I will concentrate on deriving the optimal level of firm-specific human capital in first-best. Subsequently, I will focus on second-best and determine how the principal will select the compensation structure in each period to maximise his profit.

2.2.1 First-best

In first-best (FB) no incentive problem exists for which reason the principal at $t = 0$ sets $c_{1L} = c_{1H} = c_{2L} = c_{2H} = \kappa_H$ to satisfy the agent's participation constraint, $E\left[U^{NO}\right] = E\left[U_1^{NO}\right] + E\left[U_2^{NO}\right] = 0$, and maximises his profit by choosing h_{FB}^{NO}. From (2) and (4) I get

$$\begin{aligned}\max_{h_{FB}^{NO}} E\left[\pi^{NO}\right] &= E\left[\pi_1 | e_H, h\right] + E\left[\pi_2^{NO} \middle| e_H, h\right] \\ &= (e_H - h)^{1/2} x_H + \left(1 - (e_H - h)^{1/2}\right) x_L \\ &\quad + e_H^{1/2}(1 + \alpha h) x_H + \left(1 - e_H^{1/2}(1 + \alpha h)\right) x_L\end{aligned}$$

The principal only wants the agent to take long-term action if it increases the expected profit and so I initially evaluate $\partial E\left[\pi^{NO}\right]/\partial h$ at $h = 0$ to determine what makes firm-specific human capital valuable.

$$\left.\frac{\partial E\left[\pi^{NO}\right]}{\partial h}\right|_{h=0} = e_H^{-1/2} \Delta x \left(e_H \alpha - \frac{1}{2}\right) > 0 \Leftrightarrow e_H \alpha > 1/2$$

That is, $e_H \alpha > 1/2$ represents the necessary condition to make learning favourable to the principal. Conversely, this also implies that investing in firm-specific human capital can be a bad to the principal when $e_H \alpha \leq 1/2$.

Since $\partial^2 E\left[\pi^{NO}\right]/\partial h^2 = -1/4\,(e_H - h)^{-3/2} < 0$, the first-best problem, $\max E\left[\pi^{NO}\right]$ wrt. h_{FB}^{NO}, is concave with the following solution[3]

$$\frac{\partial E\left[\pi^{NO}\right]}{\partial h} = -\frac{1}{2}(e_H - h)^{-1/2} \Delta x + e_H^{1/2} \alpha \Delta x = 0 \Rightarrow h_{FB}^{NO} = \max\left\{0, e_H - \left(\frac{1}{2\alpha}\right)^2 \frac{1}{e_H}\right\} \tag{5}$$

Thus, in first-best the principal induces the agent to improve his skill level, $h_{FB}^{NO} > 0$, if this increases the total likelihood of a good outcome ($e_H \alpha > 1/2$). On the other hand, if learning is unproductive ($e_H \alpha \leq 1/2$), the principal selects $h_{FB}^{NO} = 0$ and induces the agent to only focus on exerting short-term productive effort. In relation to this, I also notice that the more productive firm-specific human capital is (the higher α is), the more the principal wants the agent to invest in skill improvement.

[3] I use the $max\{*\}$ function to indicate that h can never be negative.

2.2.2 Second-best

Having determined the first-best investment in firm-specific human capital, I turn to the second-best situation (SB) where information asymmetry between the principal and the agent exists. In second-best the principal at $t = 0$ chooses the compensation plan in period 1 and 2 to ensure that the agent's participation contraint (PC) and incentive compatibility constraints (IC's) are all satisfied and lead the agent to pick the levels of effort and firm-specific human capital that maximise profit. To study this optimisation problem, I will initially establish how the compensation programme in period 1 and 2 can be set to always satisfy the PC and IC's. The reason is that this simplifies the notation in relation to the subsequent derivations. Following this, I will focus on the agent to show how he can be given incentive to invest in firm-specific human capital. Moreover, I will derive how he settles his investment in firm-specific human capital in second-best (reponse function). Finally, I will turn to the principal's actual maximisation problem.

Consider first $E\left[U_{HH}^{NO}\right]$ where the agent picks $(e_1, e_2) = (e_H, e_H)$ and $E\left[U_{e_1e_2}^{NO}\right]$ that in this case represents the expected utility for all other combinations of e_1 and e_2[4]

$$\begin{aligned} E\left[U_{HH}^{NO}\right] &= E\left[U_1 \middle| e_H, h_{HH}^{NO}\right] + E\left[U_2^{NO} \middle| e_H, h_{HH}^{NO}\right] \quad (6) \\ &= \left(e_H - h_{HH}^{NO}\right)^{1/2} \Delta c_1 + c_{1L} + e_H^{1/2}\left(1 + \alpha h_{HH}^{NO}\right)\Delta c_2 + c_{2L} - 2\kappa_H \\ E\left[U_{e_1e_2}^{NO}\right] &= E\left[U_1 \middle| e_1, h_{e_1e_2}^{NO}\right] + E\left[U_2^{NO} \middle| e_2, h_{e_1e_2}^{NO}\right] \quad (7) \\ &= \left(e_1 - h_{e_1e_2}^{NO}\right)^{1/2} \Delta c_1 + c_{1L} + e_2^{1/2}\left(1 + \alpha h_{e_1e_2}^{NO}\right)\Delta c_2 + c_{2L} - \kappa_2 \end{aligned}$$

From (6) and (7), it is evident that the principal can always select $c_{1L} = c_{2L} = 0$ and pick c_{1H} and c_{2H} to satisfy $E\left[U_{HH}^{NO}\right] \geq E\left[U_{e_1e_2}^{NO}\right]$ and thus the IC's, since the agent cares only about the difference in compensation in each period (the bonus). Moreover, by doing so, the PC is automatically satisfied as $E\left[U_{HH}^{NO}\right] \geq E\left[U_{LL}^{NO}\right] = \left(e_1 - h_{LL}^{NO}\right)^{1/2} c_{1H} + e_2^{1/2}\left(1 + \alpha h_{LL}^{NO}\right) c_{2H} > 0$.

With this in mind, I will turn to investigate how the agent's investment in firm-specific human capital changes for given levels of effort and compensation, since this affects the principal's actual choice of compensation and allows for comparison with the first-best level of firm-specific human capital. Hence, I will derive the agent's response function for h as a function of e_1, e_2, c_{1H} and c_{2H}. My results are summarised in proposition 1 below.

Proposition 1 *(Worker) (I) If the company can commit to the second-period contract, the worker can be given incentives to invest in firm-specific human capital. (II) Increasing (Decreasing) the bonus paid while skill-improvement takes place, c_{1H}, weakens (strengthens) the incentive to invest in firm-specific human capital. Increasing (decreasing) the bonus paid after productive skills have been acquired, c_{2H}, strengthens (weakens) the incentive to invest in firm-specific human capital.*

Proof. *(I):* Knowing the compensation in both periods, the agent maximises his expected utility by choosing $h_{e_1e_2}^{NO}$ at $t = 0$ for any combination of efforts (e_1, e_2) and compensations (c_{1H}, c_{2H}).

$$\max_{h_{e_1e_2}^{NO}} E\left[U^{NO}\right] = E\left[U_1 \middle| e_1, h\right] + E\left[U_2 \middle| e_2, h\right]$$

Evaluating the derivative at $h = 0$ provides insight into the agent's incentive to invest in h

$$\left.\frac{\partial E\left[U^{NO}\right]}{\partial h}\right|_{h=0} = -\frac{1}{2}e_1^{-1/2}c_{1H} + e_2^{1/2}\alpha c_{2H} > 0 \Rightarrow c_{2H} > \frac{1}{2\alpha}e_1^{-1/2}e_2^{-1/2}c_{1H}$$

[4]Notice that the notation h_{HH}^{NO} represents the level of firm-specific human capital under no outsourcing (NO) when the agent picks the high effort level, e_H, in both periods (HH). Moreover, if the levels of effort in either period, (e_1, e_2), are left unspecified, this will be denoted $h_{e_1e_2}^{NO}$.

That is, if the principal at $t = 0$ can commit to a compensation structure where $c_{2H} > 1/(2\alpha)\, e_1^{-1/2} e_2^{-1/2} c_{1H}$, the agent can be given incentive to invest in firm-specific human capital. This completes the argument for (I).

(II): Since $\partial^2 E\left[U^{NO}\right]/\partial h^2 = -1/4\,(e_1 - h)^{-3/2} < 0$, $\max E\left[U^{NO}\right]$ wrt. $h^{NO}_{e_1 e_2}$ represents a concave problem with the following solution

$$\frac{\partial E\left[U^{NO}\right]}{\partial h} = -\frac{1}{2}(e_1 - h)^{-1/2} c_{1H} + e_2^{1/2}\alpha c_{2H} = 0 \Rightarrow h^{NO}_{e_1 e_2} = \max\left\{0, e_1 - \left(\frac{c_{1H}}{2\alpha c_{2H}}\right)^2 \frac{1}{e_2}\right\} \tag{8}$$

Intuitively, $h^{NO}_{e_1 e_2}$ characterises the agent's investment in firm-specific human capital for given combinations of efforts and compensations in each period. The higher the compensation in period 1 is, the lower will be the agent's investment in learning. This is due to the fact that increasing the salary in period 1 makes it less lucrative to invest in h, since skill improvement is counterproductive in period 1 and reduces the probability of realising the high outcome. Increasing the compensation in period 2, however, has the opposite effect as h is productive in period 2 and makes it more likely to achieve the high outcome. This concludes the argument for (II). ■

Given these results for the agent, I am ready to state the principal's overall constrained maximisation problem in second-best to analyse how the compensation in each period will be settled.

$$\begin{aligned}\max_{h^{NO}_{HH}, c_{1H}, c_{2H}} E\left[\pi^{NO}\right] &= (e_H - h)^{1/2}(x_H - c_{1H}) + \left(1 - (e_H - h)^{1/2}\right) x_L \\ &\quad + e_H^{1/2}(1 + \alpha h)(x_H - c_{2H}) + \left(1 - e_H^{1/2}(1 + \alpha h)\right) x_L \end{aligned} \tag{9}$$

s.t.

$$\left(e_H - h^{NO}_{HH}\right)^{1/2} c_{1H} + e_H^{1/2}\left(1 + \alpha h^{NO}_{HH}\right) c_{2H} - 2\kappa_H \geq 0 \quad \text{(PC)}$$

$$\left(e_H - h^{NO}_{HH}\right)^{1/2} c_{1H} + e_H^{1/2}\left(1 + \alpha h^{NO}_{HH}\right) c_{2H} - 2\kappa_H \geq \left(e_L - h^{NO}_{LH}\right)^{1/2} c_{1H} + e_H^{1/2}\left(1 + \alpha h^{NO}_{LH}\right) c_{2H} - \kappa_H \quad \text{(IC1)}$$

$$\left(e_H - h^{NO}_{HH}\right)^{1/2} c_{1H} + e_H^{1/2}\left(1 + \alpha h^{NO}_{HH}\right) c_{2H} - 2\kappa_H \geq \left(e_H - h^{NO}_{HL}\right)^{1/2} c_{1H} + e_L^{1/2}\left(1 + \alpha h^{NO}_{HL}\right) c_{2H} - \kappa_H \quad \text{(IC2)}$$

$$\left(e_H - h^{NO}_{HH}\right)^{1/2} c_{1H} + e_H^{1/2}\left(1 + \alpha h^{NO}_{HH}\right) c_{2H} - 2\kappa_H \geq \left(e_L - h^{NO}_{LL}\right)^{1/2} c_{1H} + e_L^{1/2}\left(1 + \alpha h^{NO}_{LL}\right) c_{2H} \quad \text{(IC3)}$$

where h^{NO}_{HH}, h^{NO}_{LH}, h^{NO}_{HL} and h^{NO}_{LL} can all be calculated on the basis of equation (8) for respective combinations of effort levels e_1, e_2 and compensation levels c_{1H}, c_{2H}. On the basis of (9), I will prove proposition 2 below.

Proposition 2 *(Company) (I) If firm-specific human capital is counterproductive to the company, this equates the first period bonus, c_{1H}, with the second period bonus, c_{2H}, and realises no investment in skill improvement (first-best), $h^{NO}_{HH} = 0$. (II) If firm-specific human capital is productive to the company, the first period bonus, c_{1H}, will be set lower than the second period bonus, c_{2H}, and an investment in firm-specific human capital that is larger than first-best will be realised, $h^{NO}_{HH} > h_{FB}$.*

Proof. *(I):* If long-term actions are *unproductive* ($e_H\alpha \leq 1/2$), the principal wants to induce $h^{NO}_{HH} = 0$ all things being equal. From (8) this can be ensured if the principal selects identical compensations in both periods, $c^*_{1H} = c^*_{2H}$. The question then becomes whether this compensation policy maximises the principal's profit and induces the agent to exert the high effort level in both periods. To establish that this in fact is the case, I check to see if the IC's are all satisfied. As such, it can be noticed that $h^{NO}_{HH} = 0$ implies $h^{NO}_{HL} = h^{NO}_{LH} = h^{NO}_{LL} = 0$ since it follows from (8) that $h^{NO}_{LL}, h^{NO}_{LH}, h^{NO}_{HL} \leq h^{NO}_{HH}$. Assuming that IC1 is binding (and thus satisfied), I find for $c^*_{1H} = c^*_{2H}$

$$e_H^{1/2} c^*_{1H} + e_H^{1/2} c^*_{1H} - 2\kappa_H = e_L^{1/2} c^*_{1H} + e_H^{1/2} c^*_{1H} - \kappa_H \Rightarrow c^*_{1H} = \frac{\kappa_H}{e_H^{1/2} - e_L^{1/2}}$$

Rearranging IC2 for $c_{1H}^* = c_{2H}^*$ gives

$$e_H^{1/2} c_{1H}^* + e_H^{1/2} c_{1H}^* - 2\kappa_H \geq e_H^{1/2} c_{1H}^* + e_L^{1/2} c_{1H}^* - \kappa_H \Rightarrow c_{1H}^* \geq \frac{\kappa_H}{e_H^{1/2} - e_L^{1/2}}$$

which is satisfied for $c_{1H}^* = \kappa_H / \left(e_H^{1/2} - e_L^{1/2}\right)$ in particular. Finally, rearranging IC3 and inserting $c_{1H}^* = c_{2H}^* = \kappa_H / \left(e_H^{1/2} - e_L^{1/2}\right)$ show that IC3 is satisfied

$$\begin{array}{l} e_H^{1/2} c_{1H}^* + e_H^{1/2} c_{2H}^* - 2\kappa_H \geq e_L^{1/2} c_{1H}^* + e_L^{1/2} c_{2H}^* \Rightarrow \\ \left(e_H^{1/2} - e_L^{1/2}\right) c_{1H} + \left(e_H^{1/2} - e_L^{1/2}\right) c_{2H} - 2\kappa_H \geq 0 \Rightarrow \\ \left(e_H^{1/2} - e_L^{1/2}\right) \frac{\kappa_H}{e_H^{1/2} - e_L^{1/2}} + \left(e_H^{1/2} - e_L^{1/2}\right) \frac{\kappa_H}{e_H^{1/2} - e_L^{1/2}} - 2\kappa_H = 0 \end{array}$$

To see that $c_{1H}^* = c_{2H}^*$ also maximises the principal's profit, I only need to observe that choosing $c_{2H}^* > c_{1H}^*$ in (8) potentially induces the agent to pick $h_{HH}^{NO} > 0$, which can never be optimal given that firm-specific human capital is assumed counterproductive. Similarly, selecting $c_{1H}^* > c_{2H}^*$ only reduces the agent's incentive to undertake learning even further, which can never be optimal since $c_{1H}^* = c_{2H}^*$ already ensures $h_{HH}^{NO} = 0$. Consequently, when long-term actions are unfavourable to the principal, he selects $c_{1H}^* = c_{2H}^* = \kappa_H / \left(e_H^{1/2} - e_L^{1/2}\right)$ and arrives at the first-best investment in firm-specific human capital, $h_{HH}^{NO} = h_{FB}^{NO} = 0$. This concludes the proof for (I).

(II): If long-term actions are *productive* ($e_H \alpha > 1/2$) to the principal, no closed formed solution to the maximisation problem in (9) can be derived. Yet, the following argument can be made: assume that $c_{1H}^* \geq c_{2H}^*$ and look at the compensation variation $c_{1H}^{var} \equiv c_{1H}^* - \varepsilon, c_{2H}^*$. Inserting this variation into (8) provides us with the following level of firm-specific human capital

$$h_{e_1 e_2}^{NO} = e_1 - \left(\frac{c_{1H}^* - \varepsilon}{2\alpha c_{2H}^*}\right)^2 \frac{1}{e_2} \tag{10}$$

Inserting (10) into the principal's profit (9) and rearranging the terms give

$$\begin{array}{rcl} E\left[\pi^{NO}\right] & = & \left(\left(\frac{c_{1H}^* - \varepsilon}{2\alpha c_{2H}^*}\right) \frac{1}{e_2^{1/2}}\right) (\Delta x - c_{1H}^* + \varepsilon) \\ & & + e_2^{1/2} \left(1 + \alpha \left(e_1 - \left(\frac{c_{1H}^* - \varepsilon}{2\alpha c_{2H}^*}\right)^2 \frac{1}{e_2}\right)\right) (\Delta x - c_{2H}^*) + 2x_L \end{array}$$

Taking the first order derivative of $E\left[\pi^{NO}\right]$ wrt. ε and evaluating this at $\varepsilon = 0$ give (note that the positive sign follows from $c_{1H}^* \geq c_{2H}^*$)

$$\left.\frac{\partial E\left[\pi^{NO}\right]}{\partial \varepsilon}\right|_{\varepsilon=0} = \left(\frac{c_{1H}^*}{c_{2H}^*} - 1\right) \left(\frac{1}{2\alpha c_{2H}^*}\right) \frac{1}{e_2^{1/2}} \Delta x + \left(\frac{c_{1H}^*}{2\alpha c_{2H}^*}\right) \frac{1}{e_2^{1/2}} \geq 0$$

Intuitively, if ε increases and hence the period 1 compensation, c_{1H}^{var}, decreases, the principal's profit, $E\left[\pi^{NO}\right]$, will increase.

Next, consider the agent's utility, $E\left[U_{e_1 e_2}^{NO}\right]$ and insert (10)

$$\begin{array}{rcl} E\left[U_{e_1 e_2}^{NO}\right] & = & \left(\frac{1}{2\alpha}\right) \frac{\left(c_{1H}^* - \varepsilon\right)^2}{c_{2H}^*} \frac{1}{e_2^{1/2}} + e_2^{1/2} \left(1 + \alpha \left(e_1 - \left(\frac{1}{2\alpha}\right)^2 \left(\frac{c_{1H}^* - \varepsilon}{c_{2H}^*}\right)^2 \frac{1}{e_2}\right)\right) c_{2H}^* \\ & & -\kappa_1 - \kappa_2 \end{array}$$

Taking the first order derivative $E\left[U_{e_1e_2}^{NO}\right]$ wrt ε

$$\begin{aligned}\frac{\partial E\left[U_{e_1e_2}^{NO}\right]}{\partial\varepsilon} &= -\left(\frac{1}{\alpha}\right)\left(\frac{(c_{1H}^{*}-\varepsilon)}{c_{2H}^{*}}\right)\frac{1}{e_2^{1/2}}+\frac{1}{2\alpha}\left(\frac{c_{1H}^{*}-\varepsilon}{c_{2H}^{*}}\right)\frac{1}{e_2^{1/2}} \\ &= -\frac{1}{2\alpha e_2^{1/2}}\frac{(c_{1H}^{*}-\varepsilon)}{c_{2H}^{*}} \\ &< 0\end{aligned} \tag{11}$$

Rewriting (11) for each combination of effort (e_1, e_2) and evaluating this at $\varepsilon = 0$ give

$$\begin{aligned}\left.\frac{\partial E\left[U_{e_L,e_H}\right]}{\partial\varepsilon}\right|_{\varepsilon=0} &= -\frac{1}{2\alpha e_H^{1/2}}\frac{c_{1H}^{*}}{c_{2H}^{*}} \\ \left.\frac{\partial E\left[U_{e_H,e_L}\right]}{\partial\varepsilon}\right|_{\varepsilon=0} &= -\frac{1}{2\alpha e_L^{1/2}}\frac{c_{1H}^{*}}{c_{2H}^{*}} \\ \left.\frac{\partial E\left[U_{e_L,e_L}\right]}{\partial\varepsilon}\right|_{\varepsilon=0} &= -\frac{1}{2\alpha e_L^{1/2}}\frac{c_{1H}^{*}}{c_{2H}^{*}} \\ \left.\frac{\partial E\left[U_{e_H,e_H}\right]}{\partial\varepsilon}\right|_{\varepsilon=0} &= -\frac{1}{2\alpha e_H^{1/2}}\frac{c_{1H}^{*}}{c_{2H}^{*}}\end{aligned}$$

Hence, I have

$$\left.\frac{\partial E\left[U_{e_L,e_L}\right]}{\partial\varepsilon}\right|_{\varepsilon=0} = \left.\frac{\partial E\left[U_{e_H,e_L}\right]}{\partial\varepsilon}\right|_{\varepsilon=0} \leq \left.\frac{\partial E\left[U_{e_L,e_H}\right]}{\partial\varepsilon}\right|_{\varepsilon=0} = \left.\frac{\partial E\left[U_{e_H,e_H}\right]}{\partial\varepsilon}\right|_{\varepsilon=0} < 0$$

Consequently, when ε increases and thus the period 1 compensation, c_{1H}^{var}, decreases, the decrease in $E\left[U_{e_H,e_H}\right]$ will always be smaller than or equal to the decrease in $E\left[U_{e_L,e_L}\right]$, $E\left[U_{e_L,e_H}\right]$, $E\left[U_{e_H,e_L}\right]$. That is, if the IC's are satisfied for $c_{1H}^{*} \geq c_{2H}^{*}$, this will also be the case for $c_{1H}^{var} < c_{2H}^{*}$.

Since the principal's profit increases when c_{1H}^{var} decreases and the IC's are still satisfied, the principal will select $c_{1H}^{var} < c_{2H}^{*}$. As a result of this, the level of firm-specific human capital will increase above first-best.

$$h_{FB} = e_1 - \left(\frac{1}{2\alpha}\right)^2\frac{1}{e_2} < e_1 - \left(\frac{1}{2\alpha}\right)^2\left(\frac{c_{1H}^{var}}{c_{2H}^{*}}\right)^2\frac{1}{e_2} = h_{c_{1H}^{var}c_{2H}}$$

This concludes the proof for (II). ■

In conclusion, I have shown that under full commitment the agent can be given incentive to invest in firm-specific human capital by adjusting the compensation in period 1 and 2 (c_{1H} and c_{2H}) properly (proposition 1). Additionally, I have proved that the principal can always arrive at the first-best level of firm-specific human capital by equating c_{1H} and c_{2H}. However, he will only do so in second-best if firm-specific human capital is counterproductive, since this is the cheapest way of ensuring $h_{HH}^{NO} = 0$. If firm-specific human capital is productive, it will always be optimal for the principal to choose $c_{1H} < c_{2H}$ and realise a higher investment in firm-specific human capital in second-best than in first-best, $h_{HH}^{NO} > h_{FB}$ (proposition 2). The intuition is that the principal expectedly saves more from lowering the period 1 compensation than is lost from inducing a firm-specific investment that is above first-best when taking into consideration the agent's reaction pattern.

2.3 Extended model: Introducing outsourcing flexibility

Having characterised the benchmark situation, I extend the basic setup and introduce an external third party supplier with whom the company can contract at $t = 1$ for production in period 2 if it sees fit to do so. The reason for the company establishing an alternative to internal production can be grounded in two distinct potentially value-creating effects. First, outsourcing flexibility naturally represents a *real option* to the company

as it enables the company to avoid situations where expected in-house production in period 2 is bad; the more lucrative the outsourcing alternative is the higher the value of the real option is. Second, the outsourcing flexibility may make it easier and thereby *cheaper to incentivise* the worker to undertake long-term actions and invest in firm-specific human capital. These two effects will thus be the centre of analysis in the following where special attention will be given to the employee's problem since the complexity of the company's constrained maximisation problem leaves no room for meaningful comparative statics.

Formally, I will suppose that the principal at $t = 1$ is given the flexibility to dismiss the worker in return for a proper severance fee, γ, settled at $t = 0$, if the expected profitability can be improved by contracting with the third party supplier in period 2. For this reason, I assume that the external contractor offers a price $\tilde{p} \sim U(0,1)$ so that the distribution hereof is known to both the principal and the agent at $t = 0$ while the actual value is not realised and observed before $t = 1$.[5] Additionally, the principal conducts an interview with the agent at $t = 1$ to learn his type (i.e. his current skill level), h, since this provides the principal with insight about the expected profitability of maintaining production in-house.

To make the model tractable, I continue the simplicity from the basic setup and extend the notation with an outsourcing scenario only. As such, the probability of realising the high output if production is contracted out is not affected by any factors inside the model but simply given by the constant η. Altogether, this implies that the agent's expected utility in period 2 from outsourcing (O) is

$$E\left[U_2^O\right] = \gamma \tag{12}$$

while the expected profit to the principal can be expressed as

$$E\left[\pi_2^O\right] = \eta x_H + (1-\eta)\, x_L - p - \gamma \tag{13}$$

Figure 2 below outlines the sequence of events in the model when outsourcing is introduced.

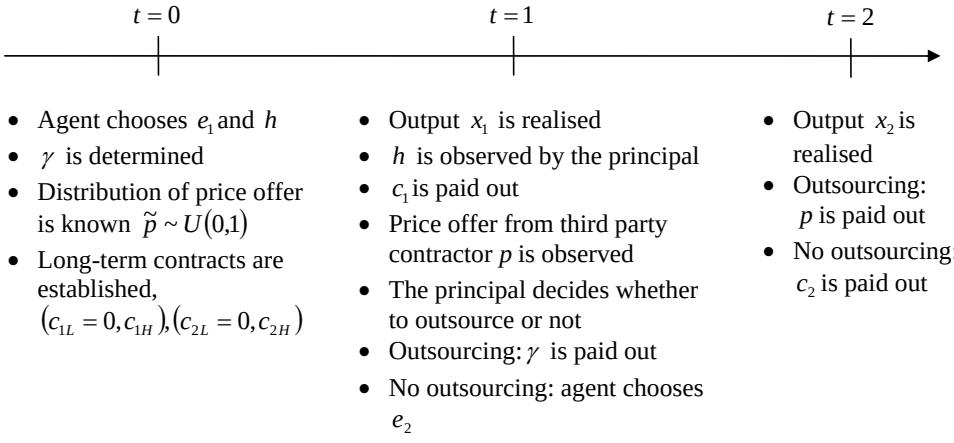

Figure 2: Sequence of events under full commitment when an outsourcing alternative exists

2.4 The probability of outsourcing: The principal's decision rule

To determine what triggers the principal to contract out production at $t = 1$, it is important to understand how $E\left[\pi_2^{NO} \middle| e_H, h\right]$ and $E\left[\pi_2^O\right]$ behave as a function of h and p, respectively. For this reason, I start out by

[5] Notice that it can be problematic to assume that $p \sim U(0,1)$ if the output levels in period 2, x_{2L} and x_{2H}, are very high, since this might create a situation where outsourcing is always the preferred alternative. A solution to this could be to model $p \sim U(0, \bar{p})$. However, to maintain simplicity this has been abandoned. Instead I will assume that the output levels in period 2 are never so high as to always render the outsourcing alternative favourable.

rewriting (4) using $c_{2L} = 0$ from (6)

$$\begin{aligned} E\left[\pi_2^{NO}\middle| e_H, h\right] &= e_H^{1/2}(1+\alpha h)(x_H - c_{2H}) + \left(1 - e_H^{1/2}(1+\alpha h)\right) x_L \\ &= e_H^{1/2}\alpha(\Delta x - c_{2H})\, h + x_L + e_H^{1/2}(\Delta x - c_{2H}) \end{aligned} \tag{14}$$

Equation (14) depicts a straight line in h with interception $x_L + e_H^{1/2}(\Delta x - c_{2H})$ and a positive slope of $e_H^{1/2}\alpha(\Delta x - c_{2H})$. Similarly, from (13) it can be seen that $E\left[\pi_2^O\right]$ depicts a straight line in p with interception $\eta x_H + (1-\eta)\, x_L - \gamma$ and slope -1.

On the basis of observing h and p, the *decision rule* for the principal is to select the third party supplier if the expected payoff from outsourcing the activities exceeds the expected payoff from internalising period 2 production, i.e. $E\left[\pi_2^O\middle| p\right] > E\left[\pi_2^{NO}\middle| e_H, h\right]$. Moreover, for every observed h there must exist a p_0 such that $E\left[\pi_2^O\middle| p_0\right] = E\left[\pi_2^{NO}\middle| e_H, h\right]$. This implies

$$\begin{aligned} p_0 &= \eta x_H + (1-\eta)\, x_L - \gamma - E\left[\pi_2^{NO}\middle| e_H, h\right] \\ &= \eta\Delta x - \gamma - e_2^{1/2}(1+\alpha h)(\Delta x - c_{2H}) \end{aligned} \tag{15}$$

Hence, the probability at $t = 0$ of the principal selecting outsourcing at $t = 1$ can now be expressed as the probability at $t = 0$ of the observed price offer p from the third party supplier at $t = 1$ being less than p_0, i.e. $P\left(E\left[\pi_2^{NO}\middle| e_H, h\right] < E\left[\pi_2^O\middle| p\right]\right) = P(p < p_0)$.

$$\begin{aligned} P(p < p_0) &= \int_0^{p_0} \frac{1}{1-0} dp \\ &= p_0 \end{aligned} \tag{16}$$

Figure 3 below illustrates these arguments.

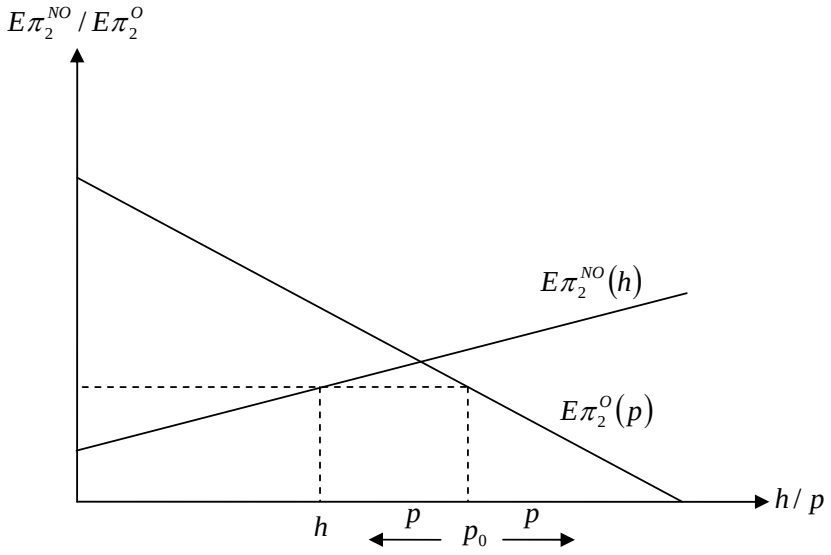

Figure 3: Illustration of how the probability of outsourcing, p_0, is decided on the basis of $E\pi_2^{NO}$ and $E\pi_2^O$. For a given h a p_0 exists so $E\pi_2^{NO} = E\pi_2^O$. Hence, for $p < p_0$ observed, the principal will choose outsourcing since $E\pi_2^O(p) > E\pi_2^{NO}(h)$. Contrarily, for $p \geq p_0$ observed, the principal will choose in-house production since $E\pi_2^O(p) \leq E\pi_2^{NO}(h)$.

2.5 Analysis under full commitment and outsourcing flexibility

Having analysed what makes the principal choose outsourcing at $t = 1$, I am ready to study what characterises the optimal investment in firm-specific human capital when outsourcing is possible. Again I will thus divide the analysis into two parts, first-best and second-best, and compare my findings to the case of no outsourcing. In relation to second-best, I will additionally show how the period 2 compensation and the severance fee can be combined to provide the agent with incentive to invest in firm-specific human capital.

2.5.1 First-best

In order to examine the characteristics of the optimal investment in firm-specific human capital under outsourcing, I initially derive the principal's objective function

$$\begin{aligned}
E\left[\pi^O\right] &= E\left[\pi_1 \middle| h, e_H\right] + \int_0^1 E\left[\pi_2 \middle| h, e_H\right] dp \\
&= E\left[\pi_1 \middle| h, e_H\right] + \int_0^{p_0} E\left[\pi_2^O \middle| e_H\right] dp + \int_{p_0}^1 E\left[\pi_2^{NO} \middle| h, e_H\right] dp \\
&= E\left[\pi_1 \middle| h, e_H\right] + \int_0^{p_0} \left(\eta x_{2H} + (1-\eta) x_{2L} - p - \gamma\right) dp + (1-p_0) E\left[\pi_2^{NO} \middle| h, e_H\right] \\
&= E\left[\pi_1 \middle| h, e_H\right] + \int_0^{p_0} \left(\eta x_{2H} + (1-\eta) x_{2L} - \gamma\right) dp - \int_0^{p_0} p dp + (1-p_0) E\left[\pi_2^{NO} \middle| h, e_H\right] \\
&= E\left[\pi_1 \middle| h, e_H\right] + p_0 \left(\eta x_{2H} + (1-\eta) x_{2L} - \gamma\right) - \frac{1}{2} p_0^2 + (1-p_0) E\left[\pi_2^{NO} \middle| h, e_H\right] \\
&= E\left[\pi_1 \middle| h, e_H\right] + p_0 \left(\eta x_{2H} + (1-\eta) x_{2L} - \gamma - E\left[\pi_2^{NO} \middle| h, e_H\right]\right) - \frac{1}{2} p_0^2 + E\left[\pi_2^{NO} \middle| h, e_H\right] \\
&= E\left[\pi_1 \middle| h, e_H\right] + \frac{1}{2} p_0^2 + E\left[\pi_2^{NO} \middle| h, e_H\right] \qquad (17)
\end{aligned}$$

Intuitively, $1/2p_0^2$ in (17) represents the real option value of the outsourcing flexibility compared to the case of no outsourcing; if the principal can choose the severance fee, γ, unreservedly he can always arrive at the scenario without the flexibility by choosing γ so large that $p_0 = 0$. This is summed up in (I) in proposition 3 below.

In first-best the principal selects $c_{1L} = c_{1H} = c_{2L} = c_{2H} = \kappa_H$ and $\gamma = 0$ and maximises (17) by choosing h_{FB}^O[6]

$$\max_{h_{FB}^O} E\left[\pi^O\right] = (e_H - h)^{1/2} \Delta x + \frac{1}{2}\left(p_0^{FB}\right)^2 + e_H^{1/2}(1 + \alpha h)\Delta x + 2x_L$$

The first-order condition wrt. h is

$$\frac{\partial E\left[\pi^O\right]}{\partial h} = \underbrace{-\frac{1}{2}(e_H - h)^{-1/2}\Delta x}_{\text{Expected decrease in period 1 profit}} + \underbrace{p_0^{FB}\frac{\partial p_0^{FB}}{\partial h} + e_H^{1/2}\alpha\Delta x}_{\text{Expected increase in period 2 profit}} = 0 \qquad (18)$$

where $\partial p_0^{FB}/\partial h = -e_H^{1/2}\alpha\Delta x < 0$. The explicit solution to h_{FB}^O is complicated and does not bring much insight. Instead, the intuition is clear from (18); it is optimal for the principal to increase the agent's investment in firm-specific human capital as long as the expected decrease in period 1 rent is more than countered by an increase in the period 2 rent. Furthermore, comparing (18) to first-best under no outsourcing in (5), $\partial E\left[\pi^{NO}\right]/\partial h = -\frac{1}{2}(e_H - h)^{-1/2}\Delta x + e_H^{1/2}\alpha\Delta x$, reveals how the real option value of the outsourcing flexibility affects the level of firm-specific human capital. That is, $p_0^{FB}\left(\partial p_0^{FB}/\partial h\right) < 0$ represents the reduction in the real option value as h increases and in-house production becomes more attractive, which in turn makes the principal reduce the first-best investment, $h_{FB}^O < h_{FB}^{NO}$, for h productive ($e_H\alpha > 1/2$). The intuition is that the outsourcing flexibility reduces the downside of operating under a low level of firm-specific human capital in period 2. In consequence this makes it optimal to induce the agent to exert short-term productive effort

[6] Notice that p_0^{FB} represents the probability of outsourcing when first-best conditions exist, $c_{2H} = 0$ and $\gamma = 0$; i.e. $p_0^{FB} \equiv p_0(h)$.

in period 1 since this increases the expected profit in period 1 (i.e. the probability of profiting from learning in period 2 is reduced). Finally, if long-term actions are unproductive ($e_H\alpha \leq 1/2$) to the principal, he will continue to select $h^O_{FB} = h^{NO}_{FB} = 0$. This completes the argument for (II) in proposition 3 below.

Proposition 3 *(I) If no moral hazard problem exists under full commitment, the outsourcing flexibility represents a real option to the company. (II) Furthermore, if firm-specific human capital is counterproductive to the company ($e_H\alpha \leq 1/2$), it continues to induce no investment in skill improvement, $h^O_{FB} = 0$. In contrast, if firm-specific human capital is productive to the company ($e_H\alpha > 1/2$), it reduces the investment in skill improvement compared to the case of no outsourcing, $h^O_{FB} < h^{NO}_{FB}$.*

2.5.2 Second-best

When leaving first-best, the incentives are no longer necessarily aligned, which requires the agent's incentive compatibility constraints and participation constraint to be satisfied. Thus, at $t = 0$ the agent has to decide how much effort to exert in each period and how much effort should be concentrated on skill improvement in period 1 when taking into consideration that production might be outsourced at $t = 1$. As such, the worker faces the following maximisation problem for given effort choices (e_1, e_2) and compensations (c_{1H}, c_{2H}).

$$\max_{h^O_{e_1e_2}} E\left[U^O\right] = (e_1 - h)^{1/2} c_{1H} - \kappa_1 + p_0\gamma + (1 - p_0)\left(e_2^{1/2}(1 + \alpha h) c_{2H} - \kappa_2\right)$$

Noting that $\partial p_0/\partial h = -e_2^{1/2}\alpha(\Delta x - c_{2H}) < 0$ gives the following first order condition wrt. h

$$\frac{\partial E\left[U^O\right]}{\partial h} = -\frac{1}{2}(e_1 - h)^{-1/2} c_{1H} + \frac{\partial p_0}{\partial h}\left(\gamma - \left(e_2^{1/2}(1 + \alpha h) c_{2H} - \kappa_2\right)\right) + (1 - p_0) e_2^{1/2}\alpha c_{2H} = 0 \qquad (19)$$

The first term in (19) reflects that investing in h in period 1 reduces time available for short-term productive effort, which in turn decreases the probability of realising the high outcome and hence the expected rent in period 1. At the same time, however, investing in h reduces the probability of outsourcing and thus increases the agent's chance to stay on and earn a rent during period 2. This is captured by the last two terms in (19). Therefore, (19) partly reflects the same dynamic as under no outsourcing, yet complicated by factors related to the risk of outsourcing. The intuition behind (19) is therefore best understood when compared to the case of no outsourcing from (8), $\partial E\left[U^{NO}\right]/\partial h = -\frac{1}{2}(e_1 - h)^{-1/2} c_{1H} + e_2^{1/2}\alpha c_{2H} = 0$, for which reason I will assume, as a point of reference, that the current choice of investment in firm-specific human capital under outsourcing is equal to that of no outsourcing, i.e. $h^O_{e_1e_2} = h^{NO}_{e_1e_2}$. Rewriting the derivative from (19) gives

$$\begin{aligned}
\left.\frac{\partial E\left[U^O\right]}{\partial h}\right|_{h=h^{NO}_{e_1e_2}} &= -\frac{1}{2}\left(e_1 - h^{NO}_{e_1e_2}\right)^{-1/2} c_{1H} + e_2^{1/2}\alpha c_{2H} - p_0\left(h^{NO}_{e_1e_2}\right) e_2^{1/2}\alpha c_{2H} \\
&\quad + \frac{\partial p_0}{\partial h}\left(\gamma - \left(e_2^{1/2}\left(1 + \alpha h^{NO}_{e_1e_2}\right) c_{2H} - \kappa_2\right)\right) \\
&= \left.\frac{\partial E\left[U^{NO}\right]}{\partial h}\right|_{h=h^{NO}_{e_1e_2}} - p_0\left(h^{NO}_{e_1e_2}\right) e_2^{1/2}\alpha c_{2H} + \frac{\partial p_0}{\partial h}\left(\gamma - \left(e_2^{1/2}\left(1 + \alpha h^{NO}_{e_1e_2}\right) c_{2H} - \kappa_2\right)\right) \\
&= \underbrace{-p_0\left(h^{NO}_{e_1e_2}\right) e_2^{1/2}\alpha c_{2H}}_{\text{Term 1: Cost of layoff}} + \underbrace{\frac{\partial p_0}{\partial h}\left(\gamma - \left(e_2^{1/2}\left(1 + \alpha h^{NO}_{e_1e_2}\right) c_{2H} - \kappa_2\right)\right)}_{\text{Term 2: Attractiveness}} \qquad (20)
\end{aligned}$$

Equation (20) isolates the effects related to the risk of outsourcing; term 1 can be interpreted as measuring the *cost of layoff* to the agent as it represents the probability of outsourcing, evaluated at a current level of firm-specific human capital $h^{NO}_{e_1e_2}$ multiplied by the derivative of the rent lost if h is increased and outsourcing is chosen. This term will thus always be negative. Similarly, term 2 can be interpreted as the agent's incentive to stay *attractive* to the principal by furthering his investment in firm-specific human capital, since it measures

how much the probability of outsourcing is reduced for h increased, multiplied by the agent's gain/loss realised if outsourcing is chosen. Depending on the situation at hand, this term can thus be either positive or negative.

On the basis of (20), the following two lemmas can be formulated as supplements to proposition 3.

Lemma 3.1 *(Cost of layoff dominates attractiveness): If the cost of layoff is high and the severance fee exceeds the expected compensation from continued in-house production evaluated at a level of firm-specific human capital analogous to that of no outsourcing, $h^{NO}_{e_1e_2}$, the worker decreases his investment in firm-specific human capital under outsourcing compared to no outsourcing, $h^{O}_{e_1e_2} < h^{NO}_{e_1e_2}$.*

Lemma 3.2 *(Attractiveness dominates cost of layoff): If the cost of layoff is low and the severance fee falls below the expected compensation from continued in-house production evaluated at a level of firm-specific human capital analogous to that of no outsourcing, $h^{NO}_{e_1e_2}$, the worker increases his investment in firm-specific human capital under outsourcing compared to no outsourcing, $h^{O}_{e_1e_2} > h^{NO}_{e_1e_2}$.*

If the risk of layoff evaluated at $h^{NO}_{e_1e_2}$, $p_0\left(h^{NO}_{e_1e_2}\right)$, is relatively high as a result of a large η, and the difference between the severance fee and the expected rent in period 2 is positive for $h^{NO}_{e_1e_2}$, $\gamma - \left(e_2^{1/2}\left(1+\alpha h^{NO}_{e_1e_2}\right)c_{2H} - \kappa_2\right) > 0$, then (20) will in total be negative. This in turn leads the agent to reduce his investment in firm-specific human capital compared to what would have been the case had the outsourcing flexibility not existed, i.e. $h^{O}_{e_1e_2} < h^{NO}_{e_1e_2}$. The reason is that the outsourcing conditions are vastly favourable to the principal, which makes the risk of layoff imminent to the agent (high cost of layoff). Thus, combined with the fairly lucrative severance fee paid out at dismissal (low attractiveness), this in total reduces the agent's incentive to invest in h. Lemma 3.1 captures this reasoning.

However, if the probability of outsourcing, $p_0\left(h^{NO}_{e_1e_2}\right)$, is relatively low as a result of a small η, and the difference between the severance fee and the expected rent in period 2 is negative for $h^{NO}_{e_1e_2}$, $\gamma - \left(e_2^{1/2}\left(1+\alpha h^{NO}_{e_1e_2}\right)c_{2H} - \kappa_2\right) < 0$, then a situation may arise where the agent will increase his investment in h compared to what would have been the case had the outsourcing flexibility not existed, i.e. $h^{O}_{e_1e_2} > h^{NO}_{e_1e_2}$. The reason is that the agent has incentive to realise the rent in period 2, $e_2^{1/2}\left(1+\alpha h\right)c_{2H} - \kappa_2$, instead of the severance fee, γ, which can be done by investing more in h to increase *attractiveness* to the principal and reduce the probability of outsourcing. This concludes the argument for lemma 3.2.

Fundamentally, the cost of layoff and the attractiveness depend on γ and c_{2H} as seen from term 1 and 2 in (20). Now, imagine a situation where the introduction of outsourcing implies that the cost of layoff dominates attractiveness for existing contracts established under no outsourcing. From lemma 3.1 I know that this leads the agent to reduce his investment in firm-specific human capital compared to no outsourcing, $h^{O}_{e_1e_2} < h^{NO}_{e_1e_2}$, which is applicable to the principal only if h is unproductive ($e_H\alpha \leq 1/2$). If, however, h is productive ($e_H\alpha > 1/2$) it may be in the principal's best interest to limit this reduction by properly combining γ and c_{2H}.

I will thus examine how these two variables affect the agent's incentive to invest in h, although the analysis has to be conducted indirectly on the basis of (19) since the explicit solution to $h^{O}_{e_1e_2}$ is too complex and provides no meaningful insights. Consequently, given that $\partial p_0/\partial c_{2H} = e_2^{1/2}\left(1+\alpha h\right) > 0$ and $\partial\left(\partial p_0/\partial h\right)/\partial c_{2H} = e_2^{1/2}\alpha > 0$, I find the following first order derivatives of (19) wrt. c_{2H} and γ

$$\frac{\partial\left(\partial E\left[U^O\right]/\partial h\right)}{\partial c_{2H}} = e_2^{1/2}\alpha\left(2\left(\gamma - 2e_2^{1/2}\left(1+\alpha h\right)c_{2H}\right) + \left(2e_2^{1/2}\left(1+\alpha h\right) - \eta\right)\Delta x + 1 + \kappa_2\right) \quad (21)$$

$$\frac{\partial\left(\partial E\left[U^O\right]/\partial h\right)}{\partial \gamma} = \frac{\partial p_0}{\partial h} + e_2^{1/2}\alpha c_{2H} = e_2^{1/2}\alpha\left(2c_{2H} - \Delta x\right) \quad (22)$$

Intuitively, $\partial\left(\partial E\left[U^O\right]/\partial h\right)/\partial c_{2H}$ measures the effect on the expected utility of increasing h when c_{2H} is increased. Likewise, $\partial\left(\partial E\left[U^O\right]/\partial h\right)/\partial \gamma$ reflects the effect on the expected utility of increasing h when γ is

increased. Therefore, both comparative statics indirectly provide information about the agent's incentive to decrease or increase his investment in firm-specific human capital. My findings are captured in proposition 4 below.

Proposition 4 *The combined use of long-term contracts and a severance fee can regulate the worker's incentive to invest in firm-specific human capital. (I) Promising a higher bonus in period 2, c_{2H}, has two opposite directed effects; it incentivises the worker to further his investment in firm-specific human capital, h, but it also increases the risk of layoff, p_0, which naturally reduces the incentive to undertake the investment. (II) Fortunately, if increasing the level of firm-specific human capital is productive to the company, the increased risk of layoff can be mitigated by raising the severance fee, γ.*

Proof. *(I):* Assume $\gamma = 0$ and consider (21).

For $c_{2H} \to 0$ (21) reduces to

$$\frac{\partial\left(\partial E\left[U^O\right]/\partial h\right)}{\partial c_{2H}} = e_2^{1/2}\alpha\left(\left(e_2^{1/2}\left(1+\alpha h\right)-\eta\right)\Delta x + 1 + \kappa_2\right)$$

Thus, if $\eta \to 1$ the external supplier is relatively productive, which might create a situation where the outsourcing offer will always be the preferred alternative and the agent is left with no incentive to invest in h, if c_{2H} is increased above 0, $\partial\left(\partial\left(\partial E\left[U^O\right]/\partial h\right)\right)/\partial c_{2H} < 0$.

Moreover, if $\eta \to 0$ the external supplier is relatively unproductive, which might incentivise the agent to invest in h, if c_{2H} is increased, $\partial\left(\partial\left(\partial E\left[U^O\right]/\partial h\right)\right)/\partial c_{2H} \geq 0$. Consequently, c_{2H} can be used to incentivise the agent if the current level of c_{2H} is relatively low ($\to 0$).

For $c_{2H} \to \infty$ (21) will grow negative. That is,

$$\frac{\partial\left(\partial E\left[U^O\right]/\partial h\right)}{\partial c_{2H}} < 0$$

Hence, if c_{2H} is increased from a current level that is relatively high ($\to \infty$), the agent's incentive to invest in h is reduced as the probability of outsourcing, p_0, is increased.

This concludes the argument for (I).

(II): Assume $\gamma = 0$ and consider (22).

If $c_{2H} < 1/2\Delta x$ then $\partial\left(\partial E\left[U^O\right]/\partial h\right)/\partial\gamma < 0$. Hence, when c_{2H} is set too low ($< 1/2\Delta x$), increasing γ will only make the agent more reluctant to invest in firm-specific human capital, h, to avoid layoff.

If $c_{2H} \geq 1/2\Delta x$ then $\partial\left(\partial E\left[U^O\right]/\partial h\right)/\partial\gamma \geq 0$. Hence, when c_{2H} is set sufficiently high ($\geq 1/2\Delta x$), increasing γ will have a positive effect on the agent's incentive to invest in h as this reduces the probability of outsourcing. Under such circumstances γ can function as a *moderator*.

This completes the argument for (II). ■

Thus, proposition 4 reveals how the combined use of c_{2H} and γ can incentivise the agent to invest in firm-specific human capital. The basic idea for the principal is to provide "pure" incentive to invest in h through c_{2H}. Yet, c_{2H} can only be used single-handedly to a certain extent, since increasing c_{2H} also increases the probability

of outsourcing, p_0. However, if $c_{2H} \geq 1/2\Delta x$, γ can function as a *moderator* that reduces the probability of outsourcing and provides further scope for strengthening the agent's incentive to invest in h through c_{2H}.

To finish the analysis under full commitment, I will make a remark on the principal's cost of initiating learning. Bringing lemma 3.2 and proposition 4 together implies that when firm-specific human capital is productive to the principal ($e_H\alpha > 1/2$), the combined use of c_{2H} and γ under outsourcing may ensure that the agent's incentive from attractiveness dominates the cost of layoff. Consequently, the flexibility to outsource holds the potential to make the agent undertake learning at a lower cost, since lemma 3.2 asserts that the behavioural effect automatically leads the agent to invest more in firm-specific human capital under outsourcing than under no outsourcing for a given c_{2H}. Thus, establishing the same investment under outsourcing as under no outsourcing, $h^{NO}_{e_1e_2} = h^{O}_{e_1e_2}$, can be weakly cheaper for the principal as it may require a *lower* c_{2H}, possibly in combination with a properly chosen γ. However, this will only be true if the agent does not deviate from $e_1 = e_2 = e_H$ when c_{2H} is changed and γ is introduced.

3 Short-term contracting

Having analysed how incentives to undertake learning can be provided under full contract commitment, I will now assume that the principal can no longer commit to long-term contracts but is instead forced to make use of short-term engagements. In this respect, it is important to understand that under short-term contracting the principal cannot commit to the second period contract at $t = 0$, meaning that this contract is effectively established and negotiated for the first time at $t = 1$. In what follows the setup and notation from the previous section are kept the same. The only modification is that the second period contract will not be initialised before $t = 1$.

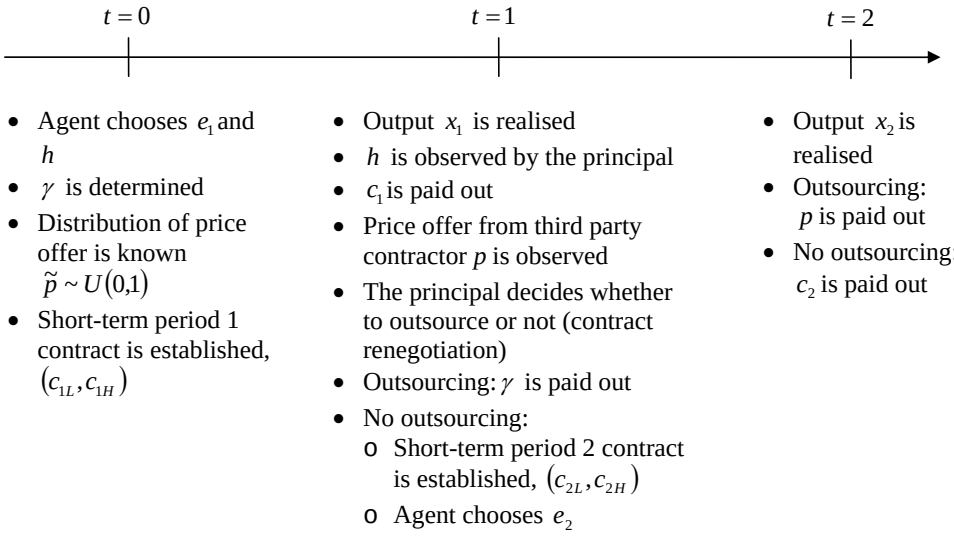

Figure 4: Sequence of events under short-term contracting

3.1 No outsourcing flexibility

In keeping with the structure from section 2, I will return to a situation where no outsourcing flexibility is provided to the principal. Still, however, the principal wants to induce e_H in both periods, and so he needs to provide the agent with a compensation scheme that encourages such behaviour. Focusing first on period 2 and working my way backwards, this implies that the principal's only interest under no contract commitment after observing h at $t = 1$ is to offer a sufficiently high compensation to ensure that the agent takes on the high effort level in period 2. The reason is that effort will automatically be channeled towards physical productive effort which is the agent's only alternative in period 2. Formally, using (3) this requires the following inequality to be

satisfied for any given h observed

$$E\left[U_2^{NO}\middle|\, e_H, h\right] \geq E\left[U_2^{NO}\middle|\, e_L, h\right] \Rightarrow \Delta c_2 \geq \frac{\kappa_H}{\left(e_H^{1/2} - e_L^{1/2}\right)(1+\alpha h)}$$

Hence, only the difference in compensation affects the agent's choice of effort level, leading the principal to select the minimum compensation programme in period 2, (c_{2L}^*, c_{2H}^*), as follows

$$c_{2L}^* = 0 \qquad \text{and} \qquad c_{2H}^* = \frac{\kappa_H}{\left(e_H^{1/2} - e_L^{1/2}\right)(1+\alpha h)} \tag{23}$$

With this in mind, I can now analyse the agent's incentive to invest in firm-specific human capital. Initially, I notice that the first-best level of firm-specific human capital under short-term contracting has not changed and is still given by (5). That is, the principal, ceteris paribus, wants to induce a positive level, $h_{FB}^{NO} > 0$. However, since it is always optimal for the principal, after observing h at $t = 1$, to offer the agent the minimum compensation programme from (23) , the expected utility in period 2 can be expressed as follows

$$\begin{aligned} E\left[U_2^{NO}\middle|\, e_H, h\right] &= e_H^{1/2}(1+\alpha h)\frac{\kappa_H}{\left(e_H^{1/2} - e_L^{1/2}\right)(1+\alpha h)} - \kappa_H \\ &= e_H^{1/2}\frac{\kappa_H}{e_H^{1/2} - e_L^{1/2}} - \kappa_H \\ &\equiv E\left[U_2^{NO}\right] \end{aligned} \tag{24}$$

Equation (24) reveals that the expected utility (expected compensation component) does not depend on the investment in skill improvement in period 1 and implies that the minimum compensation programme in period 2 can never be used to provide incentives to invest in h at $t = 0$. Put differently, it will never be credible for the principal to promise a higher salary in period 2 at $t = 0$ than the minimum compensation programme due to contracts being short-term and renegotiated at $t = 1$. This has implications for the agent's incentive to invest in h as the following proposition 5 reveals.

Proposition 5 *In the absence of outsourcing possibilities, the agent will never invest in firm-specific human capital if contracts are renegotiated after each period,* $h_{e_1H}^{NO} = 0$.

Proof. The absence of outsourcing possibilities leaves the agent with the following maximisation problem at $t = 0$[7]

$$\max_{h_{e_1H}^{NO}} E\left[U^{NO}\right] = (e_1 - h)^{1/2} c_{1H} - \kappa_H + \underbrace{E\left[U_2^{NO}\right]}_{\text{Independent of } h}$$

The first order condition with respect to h is

$$\frac{\partial E\left[U^{NO}\right]}{\partial h} = -(e_1 - h)^{-1/2} c_{1H} < 0 \tag{25}$$

Intuitively, this means that marginally increasing the investment in firm-specific human capital decreases the expected utility, thereby leading the agent to always choose $h_{e_1H}^{NO} = 0$ and only exert physical productive effort a. ■

From proposition 5 it immediately follows that the miminum compensation programme in period 2 from (23) reduces to

$$c_{2H}^* = \frac{\kappa_H}{e_H^{1/2} - e_L^{1/2}}$$

[7] Notice that h_{e_1H} denotes an unspecified effort level, e_1, in period 1 and the high effort level (H) in period 2 has been chosen.

Furthermore, the lack of investments in skill improvement entails that the condition ensuring that the agent picks e_H in period 1 is given by

$$E\left[U_1|\, e_H, h_{HH}^{NO}=0\right] \geq E\left[U_1|\, e_L, h_{LH}^{NO}=0\right] \Rightarrow \Delta c_1 \geq \frac{\kappa_H}{e_H^{1/2}-e_L^{1/2}}$$

Hence, only the difference in compensation affects the agent's choice of effort, e_1, and so the principal can induce e_H by arranging the minimum compensation programme, (c_{1L}^*, c_{1H}^*), in period 1 as follows

$$c_{1L}^* = 0 \qquad \text{and} \qquad c_{1H}^* = \frac{\kappa_H}{e_H^{1/2}-e_L^{1/2}}$$

Consequently, the minimum compensation structures ensuring e_H in each period, (c_{1L}^*, c_{1H}^*) and (c_{2L}^*, c_{2H}^*), reduce to identical expressions. In total, this implies that the principal's profit can be calculated as

$$\begin{aligned} E\left[\pi^{NO}\right] &= e_H^{1/2}\left(x_H - c_{1H}^*\right) + e_H^{1/2}\left(x_H - c_{2H}^*\right) \\ &= 2e_H^{1/2}\left(x_H - \frac{\kappa_H}{e_H^{1/2}-e_L^{1/2}}\right) \end{aligned}$$

3.2 Introducing outsourcing flexibility

Given that the agent underinvests in firm-specific human capital compared to first-best, I will once again introduce outsourcing flexibility to study how this affects the situation. With the possibility of outsourcing, the agent's maximisation problem at $t=0$ takes the following form

$$\max_{h_{HH}^O} E\left[U^O\right] = \left(e_H - h\right)^{1/2} c_{1H} - \kappa_H + p_0\gamma + \left(1-p_0\right) E\left[U_2^{NO}\right]$$

and results in the following first order condition wrt. h

$$\frac{\partial E\left[U^O\right]}{\partial h} = -\underbrace{\frac{1}{2}\left(e_H-h\right)^{-1/2} c_{1H}}_{\text{Term 1: Lost rent in period 1}} + \underbrace{\frac{\partial p_0}{\partial h}\left(\gamma - E\left[U_2^{NO}\right]\right)}_{\text{Term 2: Attractiveness}} = 0 \tag{26}$$

where $\partial p_0/\partial h = -e_H^{1/2}\alpha\Delta x < 0$. Similarly to full commitment, the last term in (26) can be interpreted as the agent's incentive to stay attractive to the principal by investing more in h; $\partial p_0/\partial h < 0$ represents the reduction in the risk of layoff when h increases while $\gamma - E\left[U_2^{NO}\right]$ denotes the gain/loss realised in period 2 when the probability of outsourcing decreases.

Using (26) I can derive proposition 6 below.

Proposition 6 *(Incentive to stay attractive): Given short-term contracting, (I) If continued in-house production in period 2 is not lucrative, $\gamma \geq E\left[U_2^{NO}\right]$, the agent will continue to invest nothing in firm-specific human capital, $h_{HH}^O = 0$, even if outsourcing flexibility is introduced. (II) If the expected gain from continued in-house production in period 2 is lucrative, $\gamma << E\left[U_2^{NO}\right]$, the risk of layoff is responsive to skill improvement, $\partial p_0/\partial h << 0$, and the loss in period 1 rent from skill improvement is small, $1/2e_H^{-1/2}c_{1H} \approx 0$, the worker can have an incentive to invest in firm-specific human capital, $h_{HH}^O > 0$, to stay attractive to the company.*

Proof. *(I):* Assume $\gamma \geq E\left[U_2^{NO}\right]$. It then follows from (26) that (notice $\partial p_0/\partial h = -e_H^{1/2}\alpha\Delta x < 0$)

$$\left.\frac{\partial E\left[U^O\right]}{\partial h}\right|_{h=0} = -\frac{1}{2}e_H^{-1/2}c_{1H} + \frac{\partial p_0}{\partial h}\left(\gamma - E\left[U_2^{NO}\right]\right) < 0$$

Hence, under such circumstances the agent will continue to invest nothing in firm-speficific human capital, $h_{HH}^{O} = 0$, as he receives more from dismissal than from continued in-house production in period 2. That is, $\gamma < E\left[U_2^{NO}\right]$ is a necessary but not sufficient condition for the outsourcing flexibility to incentivise the agent to invest in $h_{HH}^{O} > 0$. This completes the argument for (I).

(II): Assume next $\gamma < E\left[U_2^{NO}\right]$ and consider

$$\left.\frac{\partial E\left[U^{O}\right]}{\partial h}\right|_{h=0} = -\frac{1}{2}e_H^{-1/2}c_{1H} + \frac{\partial p_0}{\partial h}\left(\gamma - E\left[U_2^{NO}\right]\right) \tag{27}$$

If $\gamma \approx E\left[U_2^{NO}\right]$ (in-house production is *not* lucrative) and/or $\partial p_0/\partial h = -e_H^{1/2}\alpha\Delta x \approx 0$ (risk of layoff is *not* responsive to skill improvement) and/or $1/2e_H^{-1/2}c_{1H} >> 0$ (big loss in period 1 rent from skill improvement), a situation can happen where $\partial p_0/\partial h\left(\gamma - E\left[U_2^{NO}\right]\right) < \frac{1}{2}e_H^{-1/2}c_{1H}$, thus making (27) negative. In this case the agent's incentive to signal attractiveness is dominated by the loss in period 1 rent and so he invests nothing in firm-specific human capital, $h_{HH}^{O} = 0$.

If $\gamma << E\left[U_2^{NO}\right]$ (in-house production is lucrative) and/or $\partial p_0/\partial h = -e_H^{1/2}\alpha\Delta x << 0$ (risk of layoff is responsive to skill improvement) and/or $1/2e_H^{-1/2}c_{1H} \approx 0$ (small loss in period 1 rent from skill improvement), a situation can happen where $\partial p_0/\partial h\left(\gamma - E\left[U_2^{NO}\right]\right) > \frac{1}{2}e_H^{-1/2}c_{1H}$, thus making (27) positive. In this case the agent has incentive to invest in firm-specific human capital, $h_{HH}^{O} > 0$. That is, in-house production is so lucrative to the agent that even though the expected rent in period 2 does not explicitly depend on h, the outsourcing flexibility induces the agent to invest in h for the very reason that it makes him more attractive to the principal and reduces the risk of layoff. This concludes the argument for (II). ■

As a curiosum of proposition 6, it is perhaps surprising that (26) does not depend on the risk of layoff, p_0, explicitly but only on the partial derivative, $\partial p_0/\partial h$, since this implies that the ability of the third party supplier, modelled through η, has no influence on the agent's decision to invest in h. That is, two separate cases where the external supplier is either highly skilled (η high) or poorly skilled (η low) can lead the agent to undertake the same level of skill improvement. This is due to the already mentioned fact that the expected in-house compensation in period 2 is not affected by the agent's investment, and so, as explained above, the agent's decision to take long-term actions boils down to how much this reduces expected rent in period 1 compared to the proportional gain in period 2. This sums up (I) in lemma 6.1 below.

Clearly, this stands in contrast to the full commitment case in (19) where $\partial E\left[U^{O}\right]/\partial h$ depends explicitly on p_0 and thus η for the very reason that the expected compensation in period 2 is influenced by h. Therefore, under such circumstances the two separate scenarios where the external supplier is either highly skilled (η high) or poorly skilled (η low) can *never* lead the agent to undertake the same level of skill improvement, all else equal. This completes the argument for (II) in lemma 6.1 below.

Lemma 6.1 *(I) Under short-term contracting the skills of the third party supplier does not influence the worker's incentive to invest in firm-specific human capital. (II) This is the case under full commitment.*

Having clarified that the agent can be incentivised to invest in firm-specific human capital under short-term contracting by the introduction of an outsourcing alternative, I will, in keeping with my treatment of the full commitment case in section 2.5.2, study how c_{2H} and γ affect the incentive. My findings are captured in the following proposition.

Proposition 7 *A combination of short-term contracts and a severance fee cannot be used to incentivise the worker to invest in firm-specific human capital. (I) Due to contract commitment not being credible, the bonus*

offered after long-term actions have been taken, c_{2H}, will always be reduced by the company to eliminate the benefit to the worker of undertaking the investment. (II) Additionally, the severance fee, γ, reduces the risk of layoff and hence the size of the investment in firm-specific human capital required to stay attractive to the company.

Proof. *(I):* Consider the period 2 upstate compensation set at $t = 1$ from (23)

$$c_{2H}^{*} = \frac{\kappa_H}{\left(e_H^{1/2} - e_L^{1/2}\right)(1 + \alpha h)}$$

For $h \to \infty$, $c_{2H}^{*} \to 0$. Hence, the principal takes advantage of the agent's firm-specific investment and reduces the bonus in period 2 ($c_{2H}^{*} \to 0$) according to the level of investment that he observes ($h \to \infty$). In consequence, this eliminates the benefit to the worker of undertaking the investment to increase productivity in period 2. This concludes the argument for (I).

(II): Consider next the first derivative of (15) wrt. γ

$$\frac{\partial p_0}{\partial \gamma} = -1$$

Hence, increasing γ decreases the risk of layoff p_0, which automatically leads the agent to reduce his investment in h. This can explicitly be seen from (26) by taking the first derivative wrt. γ

$$\frac{\partial(\partial E\left[U^O\right]/\partial h)}{\partial \gamma} = \frac{\partial p_0}{\partial h} = -e_H^{1/2}\alpha\Delta x < 0$$

That is, a lower skill level is needed for the agent to stay attractive to the principal and keep period 2 production in-house. This completes the argument for (II). ■

Thus, comparing proposition 4 concerning full commitment to proposition 7 reveals that c_{2H} and γ play a very different role under full commitment than is the case under short-term contracting. Under short-term contracting c_{2H} cannot be used to incentivise the agent to invest in firm-specific human capital, since he cannot credibly commit to the period 2 contract at $t = 0$ and hence will always exploit the firm-specificity of the agent's investment ex post the investment has been undertaken. In relation to this, γ cannot play the role of a moderator that reduces the probability of outsourcing as it increases when c_{2H} is raised. Consequently, neither c_{2H} nor γ can be used to strengthen the agent's incentive to invest in h under short-term contracting, which stands in clear contrast to the case of full commitment.

3.3 Does outsourcing flexibility bring value to the company under short-term contracting?

Given the analysis above, the natural question is under what circumstances introducing an outsourcing alternative adds or destroys value to the principal. To discuss this, I will initially establish the principal's constrained maximisation problem under outsourcing. Subsequently, I will illustrate my findings with carefully chosen examples as no closed form solutions can be derived for the problem.

Since $\partial^2 E\left[U^O\right]/\partial h^2 = -\frac{1}{4}(e_1 - h)^{-3/2} c_{1H} < 0$, (26) is a concave function with a maximum derived from the following first-order condition wrt. h

$$\frac{\partial E\left[U^O\right]}{\partial h} = 0 \Rightarrow \frac{\partial p_0}{\partial h}\left(\gamma - E\left[U_2^{NO}\right]\right) = \frac{1}{2}(e_H - h)^{1/2}$$

Since $1/2\left(e_H-h\right)^{1/2}\geq 0$ and $\partial p_0/\partial h=-e_H^{1/2}\alpha\Delta x<0$, this implies that $E\left[U_2^{NO}\right]$ needs to be greater than γ, $E\left[U_2^{NO}\right]\geq\gamma$, in order to ensure the existence of a maximum. Assuming this is the case provides the following optimal level of firm-specific human capital

$$h_{e_1H}^O=e_1-\frac{c_{1H}^2}{4\left(\frac{\partial p_0}{\partial h}\left(\gamma-E\left[U_2^{NO}\right]\right)\right)^2}$$

Hence, for each effort level available at $t=0$, the optimal investment in firm-specific human capital can be determined as follows

$$h_{LH}^O=e_L-\frac{c_{1H}^2}{4\left(\frac{\partial p_0}{\partial h}\left(\gamma-E\left[U_2^{NO}\right]\right)\right)^2}\qquad\text{and}\qquad h_{HH}^O=e_H-\frac{c_{1H}^2}{4\left(\frac{\partial p_0}{\partial h}\left(\gamma-E\left[U_2^{NO}\right]\right)\right)^2}\tag{28}$$

Given h_{LH}^O and h_{HH}^O, it is possible to establish the total expected utility for each effort level

$$\begin{aligned}E\left[U_{LH}^O\right] &= \left(e_L-h_{LH}^O\right)^{1/2}c_{1H}+p_0\left[h_{LH}^O\right]\gamma+\left(1-p_0\left[h_{LH}^O\right]\right)E\left[U_2^{NO}\right]\\ E\left[U_{HH}^O\right] &= \left(e_H-h_{HH}^O\right)^{1/2}c_{1H}+p_0\left[h_{HH}^O\right]\gamma+\left(1-p_0\left[h_{HH}^O\right]\right)E\left[U_2^{NO}\right]\end{aligned}$$

Finally, on the basis of these expressions the principal's constrained maximisation problem can be stated as

$$\begin{aligned}\max_{c_{1H},\gamma}E\left[\pi^O\right]=&\left(e_H-h_{HH}^O\right)^{1/2}\left(x_H-c_{1H}\right)+e_H^{1/2}\left(1+\alpha h_{HH}^O\right)x_H\\&-e_H^{1/2}\frac{\kappa_H}{e_H^{1/2}-e_L^{1/2}}+\frac{1}{2}\left(p_0\left[h_{HH}^O\right]\right)^2\end{aligned}\tag{29}$$

s.t.

$E\left[U_{HH}^O\right]\geq 0\qquad$ (PC)

$E\left[U_{HH}^O\right]\geq E\left[U_{LH}^O\right]\qquad$ (IC)

In relation to whether the outsourcing flexibility is of value to the principal, I immediately observe that when γ can be chosen unconstrained or is bounded from below, $\gamma\in[\gamma_{\min};\infty[$ for $\gamma_{\min}\geq 0$, the outsourcing flexibility can never be a bad to the principal, as he can simply pick γ arbitrarily large to ensure $p_0=0$ and $E\left[\pi^O\right]=E\left[\pi^{NO}\right]$ if necessary. Thus, the first interesting question is if the principal will ever select an optimal severance fee, $\gamma^*<\infty$, that makes the outsourcing flexibility valuable compared to the case of no outsourcing. To illustrate that this might happen, I have constructed the following example.

Outsourcing											
$\gamma^*=0.021674$				$\mathbf{c}_{1H}^O$	$\mathbf{c}_{2H}^O$	$\boldsymbol{\kappa}_H$	$\mathbf{x}_H$	$\mathbf{x}_L$	$\mathbf{e}_H$	$\mathbf{e}_L$	$\boldsymbol{\alpha}$	$\boldsymbol{\eta}$
h_{HH}^O	0	$p_0\left(h_{HH}^O\right)$	0.547474	1.357478	1.357478	1	10	0	0.7	0.01	0.85	0.78
h_{LH}^O	0	$p_0\left(h_{LH}^O\right)$	0.547474	$E\left[\pi^O\right]=14.611569$								
$E\left[U_{HH}^O\right]$	0.209043	$\partial p_0/\partial h$	-7.111610									
$E\left[U_{LH}^O\right]$	0.209043	$e_H\alpha$	0.595									

No Outsourcing										
h_{HH}^{NO}	c_{1H}^{NO}	c_{2H}^{NO}	κ_H	x_H	x_L	e_H	e_L	α	$E\left[\pi^{NO}\right]$	$E\left[U_{HH}^{NO}\right]$
0	1.357478	1.357478	1	10	0	0.7	0.01	0.85	14.461705	0.271500

Table 1: The principal chooses a $\gamma^*<\infty$ to maximise his profit under outsourcing compared to no outsourcing.

From table 1 it appears that the principal uses the severance fee to limit the agent's incentive to invest in firm-specific human capital ($\gamma^*\approx 0.02$). At first this might seem counterintuitive as h is productive ($e_H\alpha=$

$0.595 > 1/2$). However, the outsourcing offer is relatively lucrative ($\eta = 0.78$) and so ex ante the principal is better off incentivising the agent to exert physical effort, a, in period 1 only. In total, the principal strictly benefits from the outsourcing possibility since $E\left[\pi^{O}\right] \approx 14.61 > 14.46 \approx E\left[\pi^{NO}\right]$ due to the real option effect, $1/2p_0^2 \approx 0.15$, while the agent is worse off as $E\left[U_{HH}^{O}\right] \approx 0.21 < 0.27 \approx E\left[U_{HH}^{NO}\right]$.

3.4 Can outsourcing flexibility be a bad to the company under short-term contracting?

The next question I will raise is whether the outsourcing flexibility can ever make the principal worse off. Based on the analysis in section 3.3 above, only a scenario where the severance fee is capped, $\gamma \in [0; \gamma_{\max}]$ with $0 \leq \gamma_{\max} < E\left[U_2^{NO}\right]$, is of interest in this respect and can make it ambiguous as to whether the outsourcing flexibility is of value to the principal. Intuitively, an upper bound on the severance fee might exist for several reasons not modelled in the current setup. Perhaps the principal is interested in maintaining some flexibility with regard to future employment, as he expects different employee skills to be needed for future production. Hence, this may constrain the severance fee that the principal is willing to pay the current worker. Moreover, a too lucrative severance fee might incentivise the agent to behave non-optimally – possibly even destructively – in order to provoke dismissal. Consequently, an upper bound on the severance fee is not unrealistic and will be assumed in what follows next.

If firm-specific human capital is unproductive ($e_H\alpha \leq 1/2$), the principal wants to induce $h_{HH}^{O} = h_{FB} = 0$ which matches with the agent's non-existing incentive to invest in h under short-term contracting, cf. proposition 5. Therefore, the principal will only introduce the outsourcing flexibility if the real option value embedded herein is lucrative. Yet, if $\gamma_{\max} << E\left[U_2^{NO}\right]$, the benefit to the agent from continued in-house production is large, and so a situation may arise where the agent, in spite of γ being set at $\gamma_{\max}$, overinvests heavily in firm-specific human capital in order to make himself sufficiently attractive to the principal and reduce the risk of layoff (recall (28)). Under such circumstances, the only way the principal can reduce the agent's incentive to invest in h is by increasing c_{1H} – but if the agent overreacts too much it may be disproportionately expensive to induce a sufficiently large reduction in h. Put differently, when firm-specific human capital is unproductive, the behavioural effect (i.e. the agent's investment in h) is always negative and so the outsourcing flexibility is only valuable to the principal when the real option value exceeds the value destruction caused by the behavioural effect.

The same line of reasoning can be applied when firm-specific human capital is productive ($e_H\alpha > 1/2$) and the principal, all things being equal, wants to induce $h > 0$ – although matters are slightly complicated. From proposition 5 and 6, I know that $h > 0$ can never be implemented given no outsourcing but can be ensured under outsourcing. Hence, for small levels of h, the behavioural effect generates value to the principal. Yet, even when firm-specific human capital is productive, a situation may arise where the agent due to $\gamma_{\max} << E\left[U_2^{NO}\right]$ overinvests dramatically in h to stay attractive, thereby destroying value. Consequently, determining the value of the outsourcing flexibility to the principal boils down to comparing the value of the behavioural effect against the value of the real option. If the agent invests reasonably in firm-specific human capital and the value of the behavioural effect is positive, the outsourcing flexibility is per definition of value to the principal. If the agent overinvests in firm-specific human capital, thus destroying value to the principal, the outsourcing flexibility is only beneficial to the principal when the real option value exceeds the value destruction caused by the behavioural effect. This is illustrated in figure 5 below for a hypothetical case.

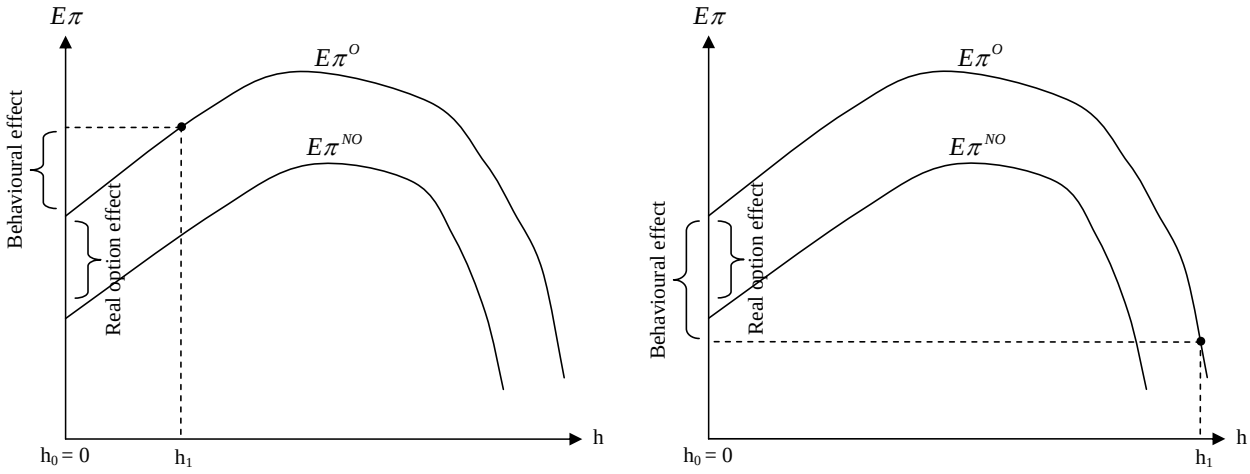

Figure 5: Illustrations of the behavioural effect and the real option effect when γ is capped and h is productive. Left: Outsourcing flexibility is a good. Right: Outsourcing flexibility is a bad.

These mechanisms can be illustrated with appropriately chosen examples, and so I will initially exemplify that a capped γ can lead the agent to overinvest in h, thereby turning the outsourcing flexibility into a bad. I will focus on the case where h is productive ($e_H\alpha > 1/2$) since evidence provided under these conditions immediately implies that a similar example can be constructed when h is unproductive ($e_H\alpha \leq 1/2$) and the behavioural effect is always negative. To make the illustration more obvious I shall set $\gamma_{\max} = 0.2$.

Outsourcing											
$\gamma^* \equiv 0.2 = \gamma_{\max}$				c_{1H}^O	c_{2H}^O	κ_H	x_H	x_L	e_H	e_L	α	η
h_{HH}^O	0.430741	$p_0\left(h_{HH}^O\right)$	0.211438	4.632998	2.178456	1.5	10	0	0.7	0.1	0.75	0.8
h_{LH}^O	0	$p_0\left(h_{LH}^O\right)$	1	$E\left[\pi^O\right] = 10.628842$								
$E\left[U_{HH}^O\right]$	1.665083	$\partial p_0/\partial h$	−6.274950									
$E\left[U_{LH}^O\right]$	1.665083	$e_H\alpha$	0.525									
$\gamma^* = 0.8 > 0.2 = \gamma_{\max}$				c_{1H}^O	c_{2H}^O	κ_H	x_H	x_L	e_H	e_L	α	η
h_{HH}^O	0	$p_0\left(h_{HH}^O\right)$	1	2.882219	2.882219	1.5	10	0	0.7	0	0.75	0.8
h_{LH}^O	0	$p_0\left(h_{LH}^O\right)$	1	$E\left[\pi^O\right] = 12.410325$								
$E\left[U_{HH}^O\right]$	1.711438	$\partial p_0/\partial h$	−6.274950									
$E\left[U_{LH}^O\right]$	1.711438	$e_H\alpha$	0.525									

No Outsourcing										
h_{HH}^{NO}	c_{1H}^{NO}	c_{2H}^{NO}	κ_H	x_H	x_L	e_H	e_L	α	$E\left[\pi^{NO}\right]$	$E\left[U_{HH}^{NO}\right]$
0	2.882219	2.882219	1.5	10	0	0.7	0.1	0.75	11.910325	1.822876

Table 2: A capped γ leads the agent to overinvest in h and turns outsourcing flexibility into a bad.

Table 2 demonstrates that introducing outsourcing flexibility is advantageous to the principal when γ^* is not constrained. Under such circumstances the principal will choose $\gamma^* = 0.8$ and realise a profit of $E\left[\pi^O\right] \approx 12.41 > 11.91 \approx E\left[\pi^{NO}\right]$, since the agent's investment in firm-specific human capital is reduced to $h_{HH}^O = 0$. Again, this large reduction in h is due to the outsourcing offer being relatively lucrative ($\eta = 0.8$), for which reason the principal prefers to incentivise the agent to spend time on physical productive effort in period 1 only. However, if γ^* is constrained by $\gamma_{\max} = 0.2$, the principal cannot sufficiently reduce the agent's overinvestment in firm-specific human capital ($h_{HH}^O \approx 0.43$) through the period 1 compensation, in spite of this being much higher than under no outsourcing , $c_{1H}^O \approx 4.63 > 2.88 \approx c_{1H}^{NO}$. Consequently, the overinvestment causes a re-

duction in expected profit under outsourcing compared to no outsourcing, $E\left[\pi^{O}\right] \approx 10.63 < 11.91 \approx E\left[\pi^{NO}\right]$. Hence, table 2 illustrates that outsourcing flexibility need not be beneficial to the principal when the severance fee is bounded from above.

To show that the possibility of outsourcing can also be a good to the principal even when the severance fee is capped, I only need to set the cap arbitrarily close yet below 0.8. Thus, assume that $\gamma_{\max} = 0.6$ and keep the rest of the parameters from the example above unchanged.

Outsourcing												
$\gamma^* \equiv 0.6 = \gamma_{\max}$				c_{1H}^{O}	c_{2H}^{O}	κ_H	x_H	x_L	e_H	e_L	α	η
h_{HH}^{O}	0.064040	$p_0\left(h_{HH}^{O}\right)$	1	3.116927	2.750131	1.5	10	0	0.7	0.1	0.75	0.8
h_{LH}^{O}	0	$p_0\left(h_{LH}^{O}\right)$	1	$E\left[\pi^{O}\right] = 12.346062$								
$E\left[U_{HH}^{O}\right]$	1.585659	$\partial p_0/\partial h$	−6.274950									
$E\left[U_{LH}^{O}\right]$	1.585659	$e_H\alpha$	0.525									

Table 3: A capped γ leads the agent to invest reasonably in h and turns outsourcing flexibility into a good.

Comparing table 3 to 2 demonstrates that $\gamma_{\max} = 0.6$ makes the outsourcing flexibility a good to the principal since $E\left[\pi^{O}\right] \approx 12.35 > 11.91 \approx E\left[\pi^{NO}\right]$. The reason is that the relatively high bound on the severance fee makes it possible for the principal to reduce the agent's overinvestment in h to a reasonable level by increasing $c_{1H}^{O} \approx 3.12 > 2.88 \approx c_{1H}^{NO}$.

Conclusively, it is ambiguous whether the outsourcing flexibility makes the principal better off when the severance fee is bounded from above and the principal cannot commit to the second period contract. However, what is essential here is that the outsourcing flexibility can in fact turn out to be a bad to the principal even when firm-specific human capital is productive. This will happen when the agent overinvests in h and causes a value destruction that exceeds the real option value of the outsourcing flexibility.

3.5 Can outsourcing flexibility create a complete win-win situation for the company and the worker?

Having clarified the potential value creation as well as value destruction of the outsourcing flexibility from the principal's perspective, I will in closing take a closer look at the agent's situation. What the examples provided in table 1, 2, and 3 have in common is that the agent is worse off in all cases from the introduction of the outsourcing alternative. I will therefore pose the question whether introducing an outsourcing alternative can create a complete win-win situation for the principal and the agent.

To answer this question, I have constructed the following example.

Outsourcing											
$\gamma^* = 0.388260$				c_{1H}^O	c_{2H}^O	κ_H	x_H	x_L	e_H	e_L	α	η
h_{HH}^O	0.063638	$p_0\left(h_{HH}^O\right)$	0	1.648073	1.500000	1	10	0	0.9	0.1	0.85	0.85
h_{LH}^O	0	$p_0\left(h_{LH}^O\right)$	0.124907	$E\left[\pi^O\right] = 16.138072$								
$E\left[U_{HH}^O\right]$	1.007209	$\partial p_0/\partial h$	-8.063808									
$E\left[U_{LH}^O\right]$	1.007209	$e_H\alpha$	0.765									

No Outsourcing										
h_{HH}^{NO}	c_{1H}^{NO}	c_{2H}^{NO}	κ_H	x_H	x_L	e_H	e_L	α	$E\left[\pi^{NO}\right]$	$E\left[U_{HH}^{NO}\right]$
0	1.581139	1.581139	1	10	0	0.9	0.1	0.85	15.973666	1.000000

Table 4: Both the agent and the principal benefit ex ante from introducing outsourcing flexibility.

Table 4 demonstrates how the outsourcing flexibility ex ante makes the principal as well as the agent better off. To explain the intuition and dynamics, I will decompose the expected utilities as follows using the parameter values from table 4.

$$E\left[U_{HH}^{NO}\right] \approx \underbrace{0.500}_{e_H^{1/2}c_{1H}-\kappa_H} + \underbrace{0.500}_{e_H^{1/2}c_{2H}-\kappa_H} \approx 1 \tag{30}$$

$$E\left[U_{HH}^{O}\right] \approx \underbrace{0.507}_{\left(e_H-h_{HH}^O\right)^{1/2}c_{1H}-\kappa_H} + \underbrace{0}_{p_0\gamma} + \underbrace{0.500}_{(1-p_0)\left[e_H^{1/2}\left(1+\alpha h_{HH}^O\right)c_{2H}-\kappa_H\right]} \approx 1.07 \tag{31}$$

From (30) it can initially be observed that $E\left[U_2^{NO}\right] \approx 0.5$ is greater than the optimal severance fee $\gamma^* \approx 0.39$, for which reason the agent is incentivised to invest in $h_{HH}^O \approx 0.06$. Consequently, it is seen from (30) and (31) that even though the agent invests in firm-specific human capital, and thus lowers the probability of realising the high outcome, $x_H = 10$, the expected rent in period 1 is still increased under outsourcing compared to no outsourcing. The reason is that the principal, in order to avoid/limit the agent's incentive to overinvest in h, increases the compensation under outsourcing compared to no outsourcing, $c_{1H}^O \approx 1.65 > 1.58 \approx c_{1H}^{NO}$. This means that in spite of the positive investment in firm-specific human capital, the expected utility in period 1 increases under outsourcing. Furthermore, given the fact that the principal cannot commit to the contract in period 2, the investment in h leads the principal to choose $c_{2H}^O \approx 1.50 < 1.58 \approx c_{2H}^{NO}$, so the agent expectedly will not benefit from his increased productivity in period 2. Consequently, the agent will receive the same expected utility in period 2 as under no outsourcing. In total, this implies that he is better off under outsourcing, $E\left[U_{HH}^O\right] \approx 1.07 > 1 \approx E\left[U_{HH}^{NO}\right]$.

Next, breaking up the principal's expected profit in each scenario provides the following insights

$$E\left[\pi^{NO}\right] \approx \underbrace{7.99}_{e_H^{1/2}(x_H-c_{1H})} + \underbrace{7.99}_{e_H^{1/2}(x_H-c_{2H})} \approx 15.98 \tag{32}$$

$$E\left[\pi^{O}\right] \approx \underbrace{7.64}_{(e_H-h)^{1/2}(x_H-c_{1H})} + \underbrace{8.50}_{e_H^{1/2}(1+\alpha h)(x_H-c_{2H})} + \underbrace{0}_{\frac{1}{2}p_0^2} \approx 16.14 \tag{33}$$

Calculation (32) and (33) clarify that the increased compensation in period 1, c_{1H}^O, together with the reduction in the probability of the high outcome, reduces the expected profit in period 1 under outsourcing compared to no outsourcing. Yet, at the same time the increased investment in h increases the probability of realising the high outcome in period 2 when production is kept in-house, which in combination with a lower period 2 compensation, c_{2H}^O, increases the profit from continued in-house production under outsourcing compared to no outsourcing. Adding to this that the probability of outsourcing is 0 implies that the expected profit in total

increases when the outsourcing alternative is introduced, $E\left[\pi^{O}\right] \approx 16.14 > 15.98 \approx E\left[\pi^{NO}\right]$.

Therefore, this example clearly demonstrates that scenarios do exist where outsourcing flexibility can create an ex ante win-win situation for both the principal and the agent altogether. This is interesting since outsourcing is normally considered as a benefit to the company only, while rarely regarded as potentially valuable to the employee as well. However, it is important to stress that the value to the agent only exists expectedly and so what seems lucrative ex ante, might ex post turn out to be a bad if layoff is realised.

4 Conclusion

Shapiro and Stieglitz (1984) show how the fear of layoff (unemployment) can discipline employees not to shirk. In this article I have elaborated on this idea by specifically focusing on employee incentives to invest in firm-specific human capital when threatened by layoff (outsourcing). However, contrary to Shapiro and Stieglitz (1984), the rate of unemployment is not the essential disciplining device that corrects behaviour in my model. What drives the incentive is instead the interdependency between the firm-specificity of the employee's investment and the risk of layoff. That is, an investment in firm-specific human capital increases future in-house productivity, yet leaves the employee more exposed to layoff since the value in alternative use is minimal. My analysis of this incentive mechanism has been conducted under full commitment as well as short-term contracting, although my main results are related to the latter.

Most importantly, I have shown that a company forced to operate under short-term contracting will always exploit the firm-specificity of the employee's competence investment and enforce a salary cut ex post the improvement. Knowing this in advance, the worker does not upgrade his skills, which reduces expected company profitability if firm-specific human capital is productive. To overcome this problem, I have proposed the idea of the company introducing outsourcing flexibility. Contrary to the obvious assumption that the threat of outsourcing only makes the employee more reluctant to carry out long-term actions, I have shown how the threat of layoff can in fact help trigger competence improvements. That is, the risk of discharge makes the employee concerned with realising future rents for which reason he invests in firm-specific human capital to stay attractive to the company (career concerns).

More generally, I have clarified how outsourcing comprises two potentially value creating effects to the company; a real option effect that increases with the attractiveness of the outsourcing alternative and a behavioural effect that mimics the changes in employee behaviour caused by the risk of layoff. Contrary to short-term contracting, outsourcing flexibility is not needed under full commitment to incentivise learning since incentives can be regulated through commitment to a certain compensation ex post the investment. Still, based on comparative statics I have explained how outsourcing may be beneficial for the company to bring about even under full commitment, partly due to the real option effect, but also due to the behavioural effect which reduces the cost of inducing firm-specific investments. In relation to this, I have described how increasing the severance fee under full commitment can help further the employee's incentive to undertake learning when appropriately combined with a compensation ex post the firm-specific investment. The reason is that the severance fee moderates the probability of outsourcing while a higher compensation ex post the investment makes continued in-house production lucrative to the worker. Under short-term contracting the lack of contract commitment destroys the moderating effect of the severance fee and induces the worker to reduce his investment in firm-specific human capital as the severance fee increases.

In practice, and perhaps in particular for companies operating under short-term contracting, the idea of employing outsourcing as an incentive mechanism to ease or trigger firm-specific learning inside the company may thus prove useful. Even when employees are hired continuously on short-term contracts, developing firm-specific

skills may be important for company profitability. As such, my model shows that if outsourcing flexibility is managed properly, the use of short-term contracting is not necessarily restricted to jobs requiring low-skilled labour but can in fact be applied to high-skilled work as well. The real beauty of this is that the competence improvement is private to the employee and comes at no extra cost to the company, since it only hinges on the *introduction*, but not necessarily the *use*, of an outsourcing alternative. Actually, not even the employee is automatically harmed by the threat of layoff. In fact, I have illustrated that the outsourcing flexibility can create an ex ante win-win situation where both parties benefit from the introduction.

Also, considering the discussion in recent years on privatisation of tasks performed by public companies operating in monopoly-like markets characterised by long-term contracts, this article offers an interesting reflection. Proponents of privatisation usually substantiate their arguments with the need to minimise the bureaucracy and inefficiency believed to naturally hamper public companies (Hatry 1985; Morgan and England 1988); in my setup this could be modelled as being too costly to provide the employee with sufficient incentive to undertake the necessary investment in firm-specific human capital through the ex post investment compensation. Yet, automatically favouring privatisation, and thus simply seeking to replace public companies with private alternatives, may overlook the potential improvement in efficiency that comes about when public employees change their behaviour and invest in firm-specific human capital to meet the threat of replacement. Instead, my analysis suggests that tasks may advantageously be put out to tender so that public and private companies can compete on equal terms.

Having argued for the potential benefits of introducing a third party supplier, however, I stress that this is not in all instances the solution to problems regarding long-term actions, and so companies need to apply the principle with caution. Specifically, I have illustrated that a severance fee encumbered by an upper bound can turn the outsourcing flexibility into a bad for the company if the employee overinvests significantly in firm-specific human capital in order to stay attractive and avoid layoff. Put differently, when the behavioural effect is highly negative and dominates the real option effect, the outsourcing alternative will harm the company.

On a final note, my modelling of investments in firm-specific human capital provides an interesting insight in relation to the continuing debate on fair value accounting (mark-to-market valuation) versus historical cost accounting (original cost) and the trade-off between credibility and relevance (Bleck and Liu 2007). To briefly explain this, let me consider the valuation of an ongoing project that requires no initial monetary investment by the company but only private investments in firm-specific human capital by the employees. Under fair value accounting, the valuation of the project, and thus the accounting information reported, will come to reflect the employee investment in skill improvement, since the expected cash flow to be discounted reflects the investments of firm-specific human capital through the probabilities. That is, the accounting information provided under fair value accounting (partly) reveals the company's pool of talent. Contrary to this, only the explicit monetary investment of zero will be reflected in the accounting information reported under historical cost accounting, which in consequence implies that the company's pool of talent will never be revealed using this regime. Hence, if expected cash flows are highly responsive to employee investments in firm-specific human capital, this increases the need for relevance and points towards the use of fair value accounting.

References

Anderhub, V., M. Königstein, and D. Kübler (2003, August). Long-term work contracts versus sequential spot markets: experimental evidence on firm-specific investment. *Labour Economics 10*(4), 407–425.

Barney, J. B. (1991). Firm resources and sustained competitive advantage. *Journal of Management 17*(1), 99–120.

Becker, G. S. (1964). *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Edu-*

cation. New York: National Bureau of Economic Research.

Bleck, A. and X. Liu (2007, May). Market transparency and the accounting regime. *Journal of Accounting Research 45*(2), 229–256.

Calvo, G. (1979, May). Quasi-walrasian theories of unemployment. *The American Economic Review 69*(2), 102–107.

Dewatripont, M., I. Jewitt, and J. Tirole (1999a, January). The economics of career concerns, part i: Comparing information structures. *The Review of Economic Studies 66*(1), 183–198.

Dewatripont, M., I. Jewitt, and J. Tirole (1999b, January). The economics of career concerns, part ii: Application to missions and accountability of government agencies. *The Review of Economic Studies 66*(1), 199–217.

Edvinsson, L. and P. Sullivan (1996, August). Developing a model for managing intellectual capital. *European Management Journal 14*(4), 356–364.

Gibbons, R. and K. J. Murphy (1992, June). Optimal incentive contracts in the presence of career concerns: Theory and evidence. *The Journal of Political Economy 100*(3), 468–506.

Hatry, H. P. (1985, September). Privatization pros and cons and ways to make government agencies more competitive. *Urban Resources 4*, 15–17.

Holmström, B. (1999, January). Managerial incentive problems: A dynamic perspective. *The Review of Economic Studies 66*(1), 169–182.

Kogut, B. and U. Zander (1993). Knowledge of the firm and the evolutionary theory of the multinational corporation. *Journal of International Business Studies 24*(4), 625–646.

Milgrom, P. and J. Roberts (1992). *Economics, Organization & Management*. Prentice Hall, International Edition.

Morgan, D. R. and R. E. England (1988, November - December). The two faces of privatization. *Public Administration Review 48*(6), 979–987.

Nonaka, I. and H. Takeuchi (1994). *The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation*. Oxford: Oxford University Press.

Peteraf, M. A. (1993, March). The cornerstones of competitive advantage: A resource-based view. *Strategic Management Journal, 14*(3), 179–191.

Prahalad, C. K. and G. Hamel (1990, May - June). The core competence of the corporation. *Harvard Business Review 68*(3), 79–92.

Shapiro, C. and J. E. Stiglitz (1984, June). Equilibrium unemployment as a worker discipline device. *The American Economic Review 74*(3), 433–444.

Spender, J. C. and R. M. Grant (1996). Knowledge and the firm: Overview. *Strategic Management Journal 17*(Special Issue: Knowledge and the Firm (Winter)), 5–9.

Wernerfelt, B. (1984, April - June). A resource-based view of the firm. *Strategic Management Journal 5*(2), 171–180.