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The pioneering spirit

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THE OPTIMAL UPSKILLING CONTRACT

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Abstract

Upskilling is an investment in human capital that allows a worker to successfully undertake a new task or new project within his/her existing job. It involves costly effort on behalf of the employee to acquire new skills and new knowledge. In this context, one essential question for managers is whether to invest in workers' upskilling or let them pay for the investment in human capital and compensate them accordingly. Using traditional contract theory analysis, we show that the latter choice is not cost-neutral since the most flexible workers benefit of an informational rent. A profit comparison shows that it might be in the interest of a company to invest in worker upskilling, rather than to rely on worker self-training.

Keywords: Contract theory, Upskilling, Screening, Training policy
JEL Classification: J33, J41, D86

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1 Introduction

The constant need for companies to set up processes to ensure that their workforce adapts to technological advances is a characteristic of modern industrial societies. The HR management literature refers to the processes set up by firms to improve the correlation between the capabilities of their employees and the broad requirements of new tasks as "upskilling" (Capelli and Rogovsky 1994, Leigh et al., 1999, Cohen, 2019). This skill transformation reached preeminence with the advent of the information technology revolution in the 1990s, driven by the massive deployment of computers and the Internet (Gordon, 2000; 2012). In the 2010s, the digital transformation shifted to the systematic generation and exploitation of big data via machine learning and AI. Automation is also displacing traditional tasks (Acemoglu and Restrepo, 2019), requiring new interactions between humans and machines that heavily draw on new skills, new knowledge, and new work-attitudes (Grand-Clement et al., 2017). Recently, the Covid-19 sanitary crisis rapidly imposed the massive deployment of distance work (Brynjolfsson et al., 2020) and a radical transformation of work organization in many sectors, including e-commerce, banking, health care, consulting, education (Agrawal et al., 2020). According to a recent survey of business executives (July 2020) by the consultancy firm McKinsey, changes in digital and technology adoption are taking place these days about 25 times faster than before the pandemic.[1]

Both the management and employees are concerned with the constant need to cope with these technological challenges. Before the recession caused by Covid-19, the shortage of skills was considered the main factor limiting the expansion of the US manufacturing sector, which planned to invest 26.2 billion dollars in upskilling programs.[2] In a survey of 22000 employees

[1] See McKinsey *Global Survey of Executives*, July 2020.

[2] CNBC, January 17, 2020. www.cnbc.com/2020/01/17/manufacturers-to-spend-26point2-billion-on-upskilling-workers-in-2020.html

in 2019, consulatancy firm PwC revealed that 77% of employees would learn new skills or be completely retrained to improve their future employability.[3] Another survey by PwC revealed that in January 2020, 74% of the managers of 1581 global companies were concerned about the availability of key skills within their workforce.[4] According to a survey of 300 US firms by the *TrainingJournal* in August 2020, 42% of companies stepped up their investment in upskilling and reskilling, while 42% of employees pursued training on their own after the coronavirus outbreak.

This paper addresses the question of the optimal upskilling contract when firms have only imperfect information about workers' skills. It also addresses the important managerial question whether a company or its employees should bear the cost of upskilling. Finally, the analysis allows to determine the equilibrium proportion of workers who choose to pay the learning cost (to upskill).

We therefore build a model that is largely inspired by the contract theory literature (Bolton and Dewatripont, 2005; Salanié, 2005; Laffont and Martimort, 2009). In the model, workers can perform a stepwise investment in human capital – for instance, learn a new software or a foreign language, or a new managerial method – that allows them to successfully carry out complex projects of high value added for their company. Employees are heterogenous with respect to the learning cost required to successfully upskill (Jackman, 2020). The proportion of employees who decide to invest in the new skills is endogenous. Information about the type of worker is either private or public, depending on who is investing in upskilling. The analysis reveals that when employees do upskill, it is in their interest to hide it from their manager. If their manager knows the distribution of types, but cannot identify

[3] PwC's report *Upskilling Hopes and Fears* survey was conducted in July 2019. www.pwc.com/gx/en/issues/upskilling/hopes-and-fears.html

[4] PwC's 23rd Annual Global CEO Survey, January 2020, *Navigating the rising tide of uncertainty.* See www.pwc.com/gx/en/ceo-survey/2020/trends/pwc-talent-trends-2020.pdf

the types, he/she must offer a menu of contracts that prompts employees to self-select for the projects where they are most efficient. This brings an informational rent to the most skilled workers. In an alternative setting, a firm offers vouchers for upskilling, which workers can use to cover their learning cost. The use of the voucher reveals the type of worker, thus allowing the firm to offer type-specific contracts.

A comparison of the profits reveals that depending on the parameters of the model, profits associated with the two educational strategies can be at best identical, with firm financed-training weakly dominating self-training. This conclusion holds if workers cannot cheat on the use of the voucher; if cheating is possible, the firm should set up additional incentive at a higher cost, which would make more interesting the self-finance scheme.

One important limitation of the analysis is its static nature; in our model, the manager does not consider the possibility of replacing obsolete-skill workers with more qualified workers. This is tantamount to assuming that the cost of upskilling is low compared to the cost of massive turnover, which is a plausible assumption for many sectors.[5] Modestino et al. (2019) explain that in recruitment, companies now require a higher level of competencies for the same jobs compared to the recent past, as they prefer upskilling to worker replacement. We do not consider the possibility that workers who benefit from a firm-financed upskilling program might leave for a better paying job elsewhere (Benson et al. 2004) or that upskilling could be an efficient worker retention policy (Manchester, 2010; 2012; Dietz and Zwick, 2020). In a dynamic setting, the fact that workers benefit from information rent when upskilling is self-financed might make self-financing a more interesting education strategy. Our static analysis is therefore better suited for sectors where human capital is highly specific. Despite these simplifications, the "static" situation sheds light on the design of the optimal upskilling

[5] The *World Economic Forum* argued that it costs roughly $4,425 to hire a new employee, and the *Association for Talent Development*'s discovery that upskilling an existing employee costs a company about $1,300.

contract, which is a meaningful question for both theorists and managers.

The paper is organized as follows. After introducing the main assumptions, we determine the optimal upskilling contract for each of the two education strategies, and compare the resulting profits. The last section presents our conclusion.

2 Main assumptions

The problem is cast as a game between workers, who must choose whether to undertake the upskilling effort or not, and the firm, which must decide on a compensation policy. We study two distinct cases: when the worker and when the firm pays for the upskilling program. The frequency of employees who upskill is endogenous.

The firm, which seeks to maximize profits, can develop a portfolio of projects based either on the old technology (of complexity q^L) or on the new technology (of complexity q^H). The level of complexity is exogenously given. If properly implemented, a complex project brings more value to the firm, $v^H > v^L$. The difference $\left(v^H - v^L\right)$ can be interpreted as *the value of upskilling* (for the firm).

There is a continuum of employees of mass one; at the outset of the game, they are all of the s type (standard type) with basic competencies. With an investment in human capital c, they can evolve toward the flexible type, denoted f. This is tantamount to acquiring a fixed amount of knowledge that is essential for the implementation of a complex project.[6] This *learning (upskilling) cost* is uniformly distributed in the interval $[0, \bar{c}]$ and this distribution is common knowledge.[7] To rule out corner solutions, we assume that the upper bound of the cost distribution is large enough, $\bar{c} > \left(v^H - v^L\right)$.

[6] For instance, people who aim to make efficient use of large Internet databases might need to invest in learning programming language such as Python.

[7] Jackman (2020) documents that the ability to acquire new human capital quickly varies considerably among a large sample of Danish workers.

A flexible-type worker (f) can efficiently implement any project q^H (or q^L) and deliver the value v^H (and v^L, respectively). A standard-type worker (s) can efficiently implement only a project q^L, and not a project q^H. If he/she takes a project H, the value of the project is v^L because he/she lacks the essential skills for the successful implementation of this project. Such an asymmetry is revealed by Jeremy and Postel-Vinay (2020) who argue that employing a worker who is under-qualified in either cognitive or manual skills is several orders of magnitude more costly than employing an over-qualified worker.

Let r^H and r^L be the compensation offered by a firm to a worker for undertaking a project of complexity H and L, respectively. In other words, the firm offers bundles of project complexity-compensation (q^H, r^H) and (q^L, r^L). Thus r^H and r^L are the key variables to be optimally determined by the firm.

The personal effort required by a project depends on the nature of the project, and the type (skills) of the worker. The flexible type of worker can easily switch from simple to complex projects. The s type of worker can also work on a complex project but at a higher personal cost (and without performing well). Let e_f^H and e_f^L be the "execution effort" required of $f-$workers to carry out one of the projects. Let e_s^H and e_s^L be the execution effort required to type s workers to execute one of the projects. We assume that for a given type of worker i, the execution effort on the complex project is higher than the execution effort on the basic project: $e_i^H > e_i^L$ with $i = (f, s)$. We also assume that for a given project (q^j), the execution effort is higher for the standard type compared to the flexible type, $e_s^j > e_f^j$, with $j = (H, L)$.[8]

To keep the analysis as simple as possible, we assume that the effort structure is $e_f^L = e_0$, $e_s^L = e_f^H = e_1$ and $e_s^H = e_2$ with $e_0 < e_1 < e_2$. Working on a complex project (instead

[8] The effort to execute a project, e, depends on the type of worker, but is unrelated to the learning (upskilling) cost, c. The latter is a "personal characteristic" reflecting learning abilities, while the former is specific to the difficulty of the project, requiring given skills.

of a basic one) requires an extra effort $(e_1 - e_0)$ to the flexible worker and $(e_2 - e_1)$ to the standard worker. The problem presents the richest set of solutions if, in line with intuitive reasoning, the incremental effort is lower for a flexible worker compared to a standard worker:

$$(e_1 - e_0) < (e_2 - e_1)\,. \tag{1}$$

We assume throughout this paper that this condition holds.

Table 1 summarizes the execution effort (for the worker) and project value for the firm, by type of worker and type of project.

	project L	project H
Employee s	(e_1, v^L)	(e_2, v^L)
Employee f	(e_0, v^L)	(e_1, v^H)

Table 1: Execution effort and value, by type of employee and type of project

The utility of a worker of type i from executing a project of complexity q^j and receiving compensation r^j is simply his/her compensation minus his/her execution effort:

$$U_i(q^j, r^j) = r^j - e_i^j \text{ with } i = (f, s) \text{ and } j = (H, L). \tag{2}$$

If workers accept all contracts that provide them with positive utility, the participation constraints (PC) to any project of complexity j are:

$$U_s = r^j - e_s^j \geq 0 \tag{3}$$

$$U_f = r^j - e_f^j \geq 0. \tag{4}$$

Finally, we remark that the problem under scrutiny makes sense only if the value of upskilling is larger than the incremental effort of upskilling for a flexible worker:

$$\left(v^H - v^L\right) > (e_1 - e_0) \tag{5}$$

otherwise no contract can ensure a positive gain for both the firm and the worker.

We notice that in a context in which uspkilling is not implemented, the firm offers only the contract (q_L, e_1) and realizes the profit $\pi_0 = v^L - e_1$.

A Nash equilibrium of this game is a situation in which employees choose their best education strategy depending on the firm compensation scheme, and the firm chooses the optimal compensation scheme given the workers' education strategy.

Two polar cases can be considered, depending on who bears the cost of the upskilling program. In the first case the firm pays for the upskilling; the information about the type is common knowledge, which involves a zero surplus compensation policy. In the second case, the worker pays for the upskilling; then, he/she can hide this information from the employer.

3 Optimal contracts under firm-financed training

3.1 The benchmark case

The firm may choose to pay for the upskilling program by offering, at the outset of the game, education vouchers (to be decided optimally by the firm) to any employee who applies for the programme. Rather than enrolling all employees in one-size-fits-all classes, a voucher-based policy is highly recommended under the plausible assumption that the employee knows better than the firm what are his/her missing skills.

While the firm would be eager to engage in perfect educational discrimination and provide to each worker the exact amount required to cover his/her upskilling cost c, it is in the interest of the worker to hide information about this cost. Furthermore, in many countries trade unions would oppose to any form of educational discrimination, or what can be perceived as educational discrimination. We therefore assume that the firm must offer a voucher *of the same amount b to all workers* who commit to engage in an upskilling program. We analyze the simpler situation in which educational discrimination is feasible (and which leads to higher profits for the firm) in the Appendix A.

We further assume that the principal can contract on the complexity (or value) of the project and not only on its execution. Therefore, if an agent divest the money from the voucher in his/her private interest and cannot deliver q^H (or v^H) he/she will incur a sanction akin at dissuading him/her from cheating. We show in Appendix B that if cheating is possible, then the firm-financed training is no longer a viable option.

Because the principal knows who has applied for the training program, the information about the type of employee is no longer private to the employee. Let us assume that the company offers to all voucher applicants the contract $(q^H, r^H = e_1)$ and offers to non-applicants the contract $(q^L, r^L = e_1)$. These contracts fulfill the participation constraints of employees.

Under these assumptions, workers with a learning cost $c > b$ do not apply for the up-skilling program. If they apply for the voucher they will receive a complex project, which they can execute successfully, but the learning cost exceeds the training cost.

Denoting by α the proportion of workers who apply for the upskilling programme ($\alpha = \Pr[c < b]$), the profit function is:

$$\begin{aligned}\tilde{\pi} &= \alpha(v^H - e_1) + (1-\alpha)(v^L - e_1) - b\int_0^b dc \\ &= (v^L - e_1) + \frac{b}{\bar{c}}(v^H - v^L) - \frac{1}{\bar{c}}b^2, \end{aligned} \tag{6}$$

Or, given the assumption of the uniform distribution ($\alpha = \frac{b}{\bar{c}}$) :

$$\tilde{\pi} = (v^L - e_1) + \frac{b}{\bar{c}}(v^H - v^L) - \frac{1}{\bar{c}}b^2 \tag{7}$$

The FOC for profit maximization allows us to determine the optimal amount of the voucher:

$$\tilde{b} = \frac{(v^H - v^L)}{2}, \tag{8}$$

leading to optimal profit:

$$\tilde{\pi} = (v^L - e_1) + \frac{1}{4\bar{c}}(v^H - v^L)^2. \tag{9}$$

which is an improvement with respect to the no-upskilling case.

3.2 Optimal contract and truth-telling

Is it possible that among the workers *who do not apply* for the voucher ($c > \tilde{b}$) some will choose to train by themselves (i.e., pay out-of-pocket the learning cost c) and keep this information hidden? This flexible worker would be offered the contract $(q^L, r^L = e_1)$, and obtain the surplus $(e_1 - e_0)$. Obviously, if the value of upskilling is relatively low, $\frac{(v^H - v^L)}{2} < (e_1 - e_0)$, then workers characterized by:

$$\frac{(v^H - v^L)}{2} < c < (e_1 - e_0), \tag{10}$$

can benefit from this self-training strategy.

This result welcomes another question: can it be optimal for the firm to offer a contract that is not truth-revealing? If the principal aims at inducing generalized truth-telling he/she should grant the surplus $(e_1 - e_0)$ to all workers choosing to upskill and receive project q^H. The truth-revealing contracts would be $(q^L, r^L = e_1)$ and $(q^H, r^H = e_1 + (e_1 - e_0))$, leading to profit:

$$\begin{aligned}
\pi &= \alpha(v^H - e_1 - (e_1 - e_0)) + (1 - \alpha)(v^L - e_1) - b\int_0^b dc \\
&= (v^L - e_1) + \alpha\left[v^H - v^L - (e_1 - e_0)\right] - \alpha b \\
&= (v^L - e_1) + \frac{b}{\bar{c}}\left[v^H - v^L - (e_1 - e_0)\right] - \frac{1}{\bar{c}}b^2
\end{aligned} \tag{11}$$

The FOC allows us to determine the optimal amount of the voucher, $b' = \frac{(v^H - v^L) - (e_1 - e_0)}{2}$. The optimal profit is:

$$\pi' = (v^L - e_1) + \frac{1}{4\bar{c}}\left[(v^H - v^L) - (e_1 - e_0)\right]^2. \tag{12}$$

We remark that $\pi' < \tilde{\pi}$: it is optimal for the principal *not to propose* a fully truth-revealing contract. This is contrasting with the revelation principle in contract theory, yet it can be explained by the productivity improvement as it applies also to workers working on the low complexity project, and not only on the high complexity project.

We can now turn to the polar education strategy in which the firm lets workers invest in upskilling.

4 Optimal contracts under self-financed training

In this context, the sequence of decisions is as follows. At the outset of the game, the firm posts a menu of contracts. Then, employees chose whether to pay the cost of upskilling or not. They then choose the preferred contract from the menu offered by the firm.

If employees undertake the upskilling program on their own, the information about their type is private information to them. Because the firm does not know which worker is of the flexible type, it must offer a menu of bundles (r^H, q^H) and (r^L, q^L) that prompts workers to self-select: all f workers choose complex projects q^H and are paid r^H, and all s workers choose simple projects q^L and are paid r^L. The research question (and a managerial one) is how to determine r^H and r^L to achieve this goal.

In the equilibrium with self-selection, the participation constraints (equations 3 and 4) become:

$$(PC_f) \qquad r^H \geq e_f^H = e_1 \tag{13}$$

$$(PC_s) \qquad r^L \geq e_s^L = e_1 \tag{14}$$

since the execution effort of the $f-type$ worker who takes the H project is e_1, and the effort of the $s-type$ worker who undertakes a L project is also e_1.

If the firm sets the compensation to the minimum levels that satisfy the PCs, $r^H = r^L =$

e_1, $s-type$ workers would take the $L-project$, and obtain a zero surplus. They would never chose a q^H project, since $U_s = r^H - e_1 = (e_1 - e_2) < 0$. However, the $f - type$ workers have no incentive to take the H project, but they have an incentive to take the L project, as they obtain utility $U_f = r^L - e_0 = (e_1 - e_0) > 0$. Any contract tailored for them should provide them with at least this lowest rent.

To ensure that each worker selects a contract tailored for his/ her type of employee, and rejects a contract tailored for the other type of employee, we need to take into account the incentive compatibility (IC) constraints (Bolton and Dewatripont, 2005; Salanié, 2005; Laffont and Martimort, 2009):

$$(IC_f) \qquad U_f(r^H, q^H) \geq U_f(r^L, q^L) \tag{15}$$

$$(IC_s) \qquad U_s(r^H, q^H) \leq U_s(r^L, q^L) \tag{16}$$

or:

$$(IC_f) \qquad r^H - e_f^H \geq r^L - e_f^L \Leftrightarrow r^H - r^L \geq e_1 - e_0 \tag{17}$$

$$(IC_s) \qquad r^L - e_s^L \geq r^H - e_s^H \Leftrightarrow r^H - r^L \leq e_2 - e_1 \tag{18}$$

The saturated PC for $s - type$ workers requires $r^L = e_1$. Thus, the two IC conditions can be written:

$$(IC_f) \qquad r^H \geq 2e_1 - e_0. \tag{19}$$

$$(IC_s) \qquad r^H \leq e_2 \tag{20}$$

The firm profit maximization problem with employee self-training has a solution if:

$$(2e_1 - e_0) \leq r^H \leq e_2 \tag{21}$$

which requires the necessary condition for the existence of the separating contracts:

$$2e_1 - e_0 < e_2 \Leftrightarrow (e_1 - e_0) < (e_2 - e_1)\,. \tag{22}$$

stating that the incremental effort (of working on the H project instead of L) of the standard worker is higher than the incremental effort of the flexible worker. We have assumed in Section 2 that this condition is fulfilled. The optimal bundles are (q^L, r^L) and (q^H, r^H), with compensations defined as:

$$r^L = e_1 \tag{23}$$

$$r^H \in [(2e_1 - e_0); e_2] \tag{24}$$

This is an important result, *under self-training, upskilling brings a positive informational rent* $\left(r^H - e_1\right) \geq (e_1 - e_0) > 0$ *to employees who choose the upskilling strategy.* This rent is required to induce truthful revelation of the type.

Why would a firm pay an f-worker more than the compensation that saturates IC1, $r^H = (2e_1 - e_0)$? *By paying more than the minimum required for self-selection, it might prompt more workers to invest in upskilling* (workers with a higher learning cost would have an incentive to incur it) and then undertake the high-value project.

We have assumed that the cost of upskilling c is uniformly distributed on $[0, \bar{c}]$ and is paid by the worker. Obviously, all workers with a learning cost $c < \left(r^H - e_1\right)$ have an incentive to invest in learning.

We denoted with α the share of employees who choose to invest in upspkilling. Under the assumption of a uniformly distributed c, its explicit form is:

$$\alpha^* = \frac{1}{\bar{c}} \left(r^H - e_1\right). \tag{25}$$

The profit can be written as a function of r^H:

$$\begin{aligned} \pi(r^H) &= \alpha v^H + (1-\alpha) v^L - \alpha r^H - (1-\alpha) r^L \\ &= \left(v^L - e_1\right) + \alpha \left[\left(v^H - v^L\right) - \left(r^H - e_1\right)\right] \\ &= \left(v^L - e_1\right) + \frac{1}{\bar{c}} \left(r^H - e_1\right) \left[\left(v^H - v^L\right) - \left(r^H - e_1\right)\right]. \end{aligned} \tag{26}$$

If no worker follows the upskilling strategy, the profit is $\left(v^L - e_1\right)$. Obviously, an equilibrium with self-training in which the firm offers the (q^H, r^H) contract and $\alpha > 0$ workers pay the cost of upskilling is possible only if: $\left(r^H - e_1\right) < \left(v^H - v^L\right)$. But the highest compensation is $r^H = e_2$. This entails as a necessary condition for this equilibrium: $(e_2 - e_1) < \left(v^H - v^L\right)$.

The FOC indicates as the first-best optimal r^H:

$$r^H = e_1 + \frac{\left(v^H - v^L\right)}{2} \Leftrightarrow \left(r^H - e_1\right) = \frac{\left(v^H - v^L\right)}{2} \tag{27}$$

For the firm, this is the same payment as in the firm-financed scheme, $e_1 + \tilde{b}$ (the employee receives either the voucher in the firm financed scheme or a wage income in this case).

However, it must be verified that this first-best compensation fulfills the two ICs (equations 19 and 20), otherwise the effective compensation is a corner solution as indicated by the saturated constraint.

$$(IC_f) \qquad r^H - e_1 = \frac{\left(v^H - v^L\right)}{2} \geq (e_1 - e_0) \tag{28}$$

$$(IC_s) \qquad r^H - e_1 = \frac{\left(v^H - v^L\right)}{2} \leq (e_2 - e_1). \tag{29}$$

Three cases can be taken into account, depending on the parameters of the problem. In the first case, IC_s is not binding, yet IC_f is binding (thus the f-employee receives the lowest compensation $r^H = 2e_1 - e_0$); in the second case, none of the two IC constraints is binding thus the first-best optimum prevails; the later case is the situation in which IC_s is binding, thus the employee receives the highest possible compensation in this problem $r^H = e_2$ (for a higher compensation, $s-$employees would accept the H project).

The optimal compensations (in their implicit form $r^H - e_1$) are:

$$r^H - e_1 = \begin{cases} (e_1 - e_0) & \text{if } \frac{\left(v^H - v^L\right)}{2} < (e_1 - e_0) & IC_f \text{ saturated, } IC_s \text{ non-saturated} \\ \frac{\left(v^H - v^L\right)}{2} & \text{if } (e_1 - e_0) \leq \frac{\left(v^H - v^L\right)}{2} \leq (e_2 - e_1) & IC_f \text{ and } IC_s \text{ non-saturated} \\ (e_2 - e_1) & \text{if } \frac{\left(v^H - v^L\right)}{2} > (e_2 - e_1) & IC_s \text{ saturated, } IC_f \text{ non-saturated} \end{cases} \tag{30}$$

For an intermediate value of upskilling $\left(v^H - v^L\right)$, the payment $\frac{\left(v^H - v^L\right)}{2}$ suffices to induced truthful revelation of whether the agent is upskilled. For a low value of upskilling, the payment is not enough for a flexible agent to take project H, and an additional payment is needed. For a high value of upskilling, the payment $\frac{\left(v^H - v^L\right)}{2}$ exceed the minimum required for truthful revelation.

Leading to the case-specific optimal profits:

$$\begin{array}{ll} \pi^*_{ICf} = \left(v^L - e_1\right) + \frac{1}{\bar{c}}\left(e_1 - e_0\right)\left[\left(v^H - v^L\right) - \left(e_1 - e_0\right)\right] & \text{if } \frac{\left(v^H - v^L\right)}{2} < \left(e_1 - e_0\right) \\ \pi^*_{FB} = \left(v^L - e_1\right) + \frac{1}{4\bar{c}}\left(v^H - v^L\right)^2 & \text{if } \left(e_1 - e_0\right) \leq \frac{\left(v^H - v^L\right)}{2} \leq \left(e_2 - e_1\right) \\ \pi^*_{ICs} = \left(v^L - e_1\right) + \frac{1}{\bar{c}}\left(e_2 - e_1\right)\left[\left(v^H - v^L\right) - \left(e_2 - e_1\right)\right] & \text{if } \frac{\left(v^H - v^L\right)}{2} > \left(e_2 - e_1\right) \end{array} \tag{31}$$

It can be easily verified that the first-best optimal profit, as obtained when the two incentive compatibility constraints do not bind, corresponds to the highest profit in the self-training scenario:

$$\pi^*_{FB} > \max\{\pi^*_{ICf}, \pi^*_{ICs}\}$$

We can check that $\pi^*_{ICs} > \pi^*_{ICf}$ if $\left(v^H - v^L\right) > \left(e_2 - e_0\right)$ and vice-versa.

5 Discussion

We have determined the profits of the firm in the two polar cases in which the firm or the employee pays the bill for upskilling. If the employees are allowed to self-train, the highest profit $\pi^*_{FB} = \left(v^L - e_1\right) + \frac{1}{4\bar{c}}\left(v^H - v^L\right)^2$ is obtained for the specific configuration $\left(e_1 - e_0\right) \leq \frac{\left(v^H - v^L\right)}{2} \leq \left(e_2 - e_1\right)$ in which the two incentive compatibility constraints are not binding. If the ICs are binding, the profits are necessarily lower. If the firm provides vouchers, the profit is $\tilde{\pi} = (v^L - e_1) + \frac{1}{4\bar{c}}(v^H - v^L)^2$.

Proposition 1 *The self-financed scheme is weakly dominated by the firm financed scheme.*

Proof. Compare profit $\tilde{\pi}$ (Eq. 9) to profit π^*_{FB} (Eq. 31). ■

This conclusion raises several comments.

In practice there is likely significant uncertainty about the parameters of the problem $(v^H, v^L, e_0, e_1, e_2)$. Because the strategy of self-training is weakly dominated (profits are equivalent only for a narrow range of the parameters), it might be in the interest of the firm to opt for the strategy of directly investing in upskilling.

In both systems (and for intermediate valued of upskilling), flexible workers receive the same payment $e_1 + \tilde{b}$, and spend c to upskill themselves. For the workers, the two policy are neutral if the utility of the "voucher money" is equivalent to the value of cash. In the probable situation where one dollar of voucher worth less than one dollar cash, workers are better-off in the self-financed scheme.

Furthermore, Proposition 1 is correct if the principal can contract on quality (or value) as we assumed. If the principal can contract only on the execution of a project and not on its quality, some workers with a relatively high learning cost might divest the voucher in their own private interest (use it for training unrelated to the production needs) and work on the complex project knowing that they will deliver v^L. In this context, all workers (honest and dishonest) would apply for the voucher. We show (in Appendix B) that in this case, the firm should never implement the firm-financed training scheme. To avoid cheating, it must add new incentives or controls, with a higher cost. If cheating is an option, then self-training is a better option.

6 Conclusion

Many surveys, as presented in the introduction, have revealed that a shortage of skills is one essential factor limiting firm development all over the world. In the nineties, the Internet revolution tremendously changed the nature of work, placing substantial value on computer literacy. In the wake of the Covid-19 crisis, the massive and unexpected need for reducing direct work contacts and increasing physical and social distance brought about important changes in the organization of work. Distance work and distance learning draw heavily on new competencies, both technical and psychological, from online endurance to online communication talent. In the waves of massive adaptation of competencies to the new needs of firms, employees appear to be heterogeneous, with substantial variability in their ability to learn and adapt to the new work requirements. The process through which workers raise their human capital to align their skills to new needs has been referred to as upskilling.

Traditionally the learning cost of upskilling is paid by both firms, which set up specific programs, and employees, who train themselves in their free time. Currently, the development of online education is giving new momentum to the self-improvement strategy. This paper has addressed one important managerial question: Should employee or companies bear the cost of upskilling?

To answer this question, this paper has developed an analysis of the optimal upskilling contract, building on traditional contract theory principles. The analysis has revealed the complex compensation structure a firm must use to achieve worker truthful revelation of types when their skills are private information to them. As an original element of this analysis, the frequency of employees who decide to incur the upskilling effort is endogenous. We also have analyzed the optimal contract to be offered by a firm that finances in-house the training program. We pointed out that in this case, some workers might train on their own, and prefer to work on the low complexity projects.

In an uncertain environment and without cheating on voucher use, firm-financed training weakly dominates self-financed training. This situation can change if workers can cheat on the use of the training vouchers. In this case, the self-financing strategy could be more appealing. Whether it is optimal for the firm to pay for the upskilling or not, it depends on the relative size of these incentive costs: one from hidden action on how the voucher is used, and another one related to the hidden information about ability.

References

Acemoglu, Daron, and Pascual Restrepo. 2019. Automation and new tasks: how technology displaces and reinstates labor, *Journal of Economic Perspectives* 33.2: 3-30.

Agrawal, Sapana, Aaron De Smet, Sébastien Lacroix, and Angelika Reich, 2020. To emerge stronger from the COVID-19 crisis, companies should start reskilling their workforces now. *Mackinsey article*, Online, May 7.

Benson, George S., David Finegold, and Susan Albers Mohrman, 2004. You paid for the skills, now keep them: Tuition reimbursement and voluntary turnover, *Academy of Management Journal* 47.3: 315-331.

Bolton, Patrick, and Mathias Dewatripont, 2005. *Contract Theory.* MIT Press.

Brynjolfsson, E., Horton, J. J., Ozimek, A., Rock, D., Sharma, G., & TuYe, H. Y., 2020. COVID-19 and remote work: an early look at US data. NBER WP27344. *National Bureau of Economic Research.*

Cappelli, P. & Rogovsky, N. 1994. New work systems and skill requirements, *International Labour Review*, 133, 2: 205-220

Cohen, Mark A., 2019. Upskilling: Why it might be the most important word in the legal lexicon, *Forbes*, Sept 3.

Dietz, Daniel, and Thomas Zwick, 2020. The retention effect of training: Portability, visibility, and credibility, *The International Journal of Human Resource Management*: 1-32.

Gordon, Robert J. 2000. Does the "new economy" measure up to the great inventions of the past?. *Journal of Economic Perspectives* 14.4: 49-74.

Gordon, Robert J. 2012. Is US economic growth over? Faltering innovation confronts the six headwinds, NBER WP18315, *National Bureau of Economic Research.*

Grand-Clement, S., Devaux, A., Belanger, J., & Manville, C. 2017. *Digital Learning.* Santa Monica, CA: RAND corporation and Corsham institute.

Jackman, Robert, 2020. *Learning Speeds and Labor Market Adjustments*, ProQuest Dissertations Publishing Nr. 27958728, University of Chicago.

Jeremy, Lise and Fabien Postel-Vinay, 2020. Multidimensional skills, sorting, and human capital accumulation, *American Economic Review*, 110, 8.

Laffont, Jean-Jacques, and David Martimort, 2009. *The Theory of Incentives: The Principal-Agent Model.* Princeton University Press.

Leigh, Duane E., and Kirk D. Gifford, 1999. Workplace transformation and worker upskilling: the perspective of individual workers. *Industrial Relations*, 38, 2: 174-191.

Manchester, Colleen F., 2010. Investment in general human capital and turnover intention, *American Economic Review* 100.2: 209-13.

Manchester, Colleen F., 2012. General human capital and employee mobility: How tuition reimbursement increases retention through sorting and participation. *Intranational Labor Relations Review,* 65(4), 951-974.

Modestino, Alicia Sasser, Daniel Shoag, and Joshua Ballance, 2019. Upskilling: do employers demand greater skill when workers are plentiful? *Review of Economics and Statistics*: 1-46.

Salanié, Bernard, 2005. *The Economics of Contracts: A Primer.* MIT Press.

A Appendix. Firm-financed training with perfect educational discrimination

We assume that the firm is able to provide to each worker with a voucher that covers exactly his/her own learning cost, $b = c$. It offers to all voucher applicants the contract $(q^H, r^H = e_1)$ and offers non-applicants the contract $(q^L, r^L = e_1)$. These compensations fulfill the participation constraints of both standard and flexible workers.

Workers with a learning cost $c > b$ do not apply for the upskilling program. If they apply for the voucher they will receive a complex project, which they can now execute successfully, and obtain zero surplus. But the learning cost exceeds the training cost.

Denoting with α the share of the workers who decide to apply, the profit for the firm is:

$$\pi = \alpha(v^H - e_1) + (1 - \alpha)(v^L - e_1) - \frac{1}{\bar{c}} \int_0^b cdc. \tag{32}$$

For the uniform distribution, $\alpha = \frac{b}{\bar{c}}$, and $\frac{1}{\bar{c}} \int_0^b cdc = \frac{1}{2\bar{c}} b^2$. The profit becomes:

$$\pi = (v^L - e_1) + \frac{b}{\bar{c}}(v^H - v^L) - \frac{1}{2\bar{c}} b^2. \tag{33}$$

The first-order condition for profit maximization allows us to obtain the optimal amount of the voucher:

$$\hat{b} = (v^H - v^L). \tag{34}$$

Under the assumption $\bar{c} > (v^H - v^L)$, the optimal proportion of f-types is:

$$\hat{\alpha} = \frac{(v^H - v^L)}{\bar{c}} < 1, \tag{35}$$

leading to maximum profit:

$$\hat{\pi} = (v^L - e_1) + \frac{1}{2\bar{c}}(v^H - v^L)^2. \tag{36}$$

In this context too, would some workers who do not apply for the voucher train themselves and keep the information hidden? If they pay out-of-pocket the learning cost c they become flexible which requires them the effort e_0 to execute the low complexity project. The principal, who does not know that they are flexible, would assign them the contract $(q^L, r^L = e_1)$, which would bring them the surplus $(e_1 - e_0)$. Considering these, an agent would not self-train if $c > (e_1 - e_0)$. However, this condition is fulfilled for all those who do not apply for the voucher, since they are characterized by $c > \hat{b} = (v^H - v^L)$ and $(v^H - v^L) > (e_1 - e_0)$.

B Appendix. Cheating in the firm-financed program

We assume here that the firm the firm cannot verify the quality (or the value) and therefore can contract only on the execution of a contract. In this case, a worker can apply for the upskilling program and divest all of the voucher in his own private interest, by undertaking training unrelated to the productive needs of the firm. Because he is not uspkilled, working on a q^H project would cost him $e_2 - e_1$. Let $u(x)$ be the utility of the voucher funds, with $u(0) = 0, u' > 0$ and $u'' < 0$. If the worker cheats, he obtains the private utility $u(b)$, if he is honest, he uses c to upskill, and obtains a private utility $u(b - c)$.

The cheating condition is:

$$u(b) - (e_2 - e_1) > u(b - c) \tag{37}$$

Let us denote by c_0 the solution to;

$$u(b) - u(b - c_0) = (e_2 - e_1) \tag{38}$$

Workers with $c < c_0$ will be honest, those with $c > c_0$ will be dishonest (i.e., apply for the upskilling funds but do not use them in the interest of the firm). In this context, all workers do apply for upskilling. The honest one will produce v^H, the dishonest ones v^L.

Differentiating condition (38), we obtain:

$$\frac{dc_0}{db} = \frac{u'(b - c_0) - u'(b)}{u'(b - c_0)} > 0 \tag{39}$$

The frequency of honest persons increases with the amount of the voucher. However, we can check that $\frac{dc_0}{db} < 1$. This has an important implication for the optimal profit.

Let us denote the probability of being honest by $\mu = \Pr[c < c_0]$. The profit of the firm is:

$$\pi = \mu v^H + (1 - \mu)v^L - b \tag{40}$$

of, under the assumption of the uniform distribution of c,

$$\pi = v^L + c_0 \left(\frac{v^H - v^L}{\bar{c}} \right) - b. \tag{41}$$

Because $\left(\frac{v^H - v^L}{\bar{c}} \right) < 1$ and $\frac{dc_0}{db} < 1$, it turns out that $\frac{d\pi}{db} < 0$: the optimal voucher is the corner solution $b = 0$, i.e., the voucher policy cannot be beneficial to the firm if workers have the option to cheat.

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