Discussion paper

Organizational Design with Portable Skills

BY

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This series consists of papers with limited circulation, intended to stimulate discussion

Organizational Design with Portable Skills[*]

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Abstract

Workers can move across firms and take with them portable skills. This has an impact on how firms are organized and allocate tasks across workers. To reduce mobility, a profit maximizing firm may inefficiently allocate talented workers on tasks that reduce their outside option. In the existing literature, asymmetric information about workers' talents makes this retention strategy profitable, although inefficient. In this paper we let workers' skills be observable across firms, but task allocation to be non-contractible. Inefficient assignment of tasks to workers persists in this environment. We show that by organizing a firm as an equity-partnership, in which the total profit is shared, the efficient task allocation can be implemented and profit increased. This result is attained through shifting control rights to workers that become partners and decide over task allocation. Both partners and workers are retained in equilibrium. This paper provides a new rationale for the widespread presence of partnerships in human-capital intensive industries.

JEL classification: D86, J24, J54, M52.

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1   Introduction

Workers' mobility is a particularly relevant issue for firms operating in human capital-intensive industries: in these sectors employers cannot bind the main input of production to the firm. This generates retention costs that may prevent employers from efficiently matching workers to jobs within the firm. While moving across firms, workers can use skills acquired along their career in firms differing from the ones that trained them[1]. These skills are referred to as *portable* [2] (Grosyberg et al. 2008; Groysberg, 2010). The degree of portability of the skills acquired by a worker depends inversely on their firm-specific proportion.

Anecdotal evidence about talent-intensive industries, shows a constant increase in the number of firms organized as profit-sharing partnerships[3]. In this paper we analyze the impact of workers' mobility on the organizational design of human capital-intensive firms.

We study inefficiencies in the allocation of workers within the firm. When skills are portable, employers use several tools to retain their best workers. Some examples are given by increases in wages, non-compete clauses and perks. Another common strategy is to allocate talented workers on tasks that make them less attractive for competitors in the industry (Greenwald, 1986 ; Waldman, 1984). This reduces their outside option.[4]

We address two questions. First, will a profit maximizing firm efficiently allocate workers across tasks differing in productivity and portability ? Second, will partnership make task allocation more efficient than a corporation and thereby increase the realized profit?

To answer these questions, we consider a firm with two tasks has a productivity depending on the talent of workers dealing with it. The other task has a fixed productivity. The first task is more portable than the second one. The employer hires a pool of workers from a perfectly competitive labor market, offering spot take-it-or-leave-it wage contracts.[5] Workers' abilities are initially unknown. After the execution of a standard task (a "training period"), employees acquire firm-specific human capital. At this stage abilities become public information

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[1]See for instance Becker (1964), Rosen (1972), Acemoglu and Pischke (1998), Moen and Rosen (2004) for analyses on the mobility of human capital.

[2]One could also think of portable resources. For instance a lawyer working for a certain company, by moving to a competitor, or by starting up a spin-out firm, can carry with her a certain fraction of clients from the source firm's pool. However, in this paper we will stick on the analyses of skills as portable.

[3]IRS Data on the amount of professional partnerships in the U.S. highlight a significant increase in the last ten years, with an average growth rate of 5.6% per year.

[4]For further implications of workers' mobility and portability of their human capital, Acharya and Volpin (2010) show how the competition for workers on the labour market affects the quality of corporate governance in a firm. Ellingsen and Kristiansen (2016) describe the impact of portability on managerial compensation, describing a rationale for the wide use of composite salaries, with a fixed part plus non-indexed stock options. Donangelo (2014) shows that firms operating in industries characterized by higher labor mobility, deliver higher returns on stocks.

[5]This assumption can be relaxed without altering our results. Allowing the employer to offer long-term contracts would not change the predictions of the model.

and workers are assigned to a task. We assume task allocation to be non-contractible.[6] This assumption can be interpreted as the impossibility to verify workers' talent in courts, as the employer chooses task allocation contingent on abilities.

We derive the Pareto-efficient cutoff value of ability such that workers who (do not) fulfill it, shall be allocated to the more (less) portable task. Workers dealing with a more portable task require higher wages to stay with the current firm at the interim stage. Then we describe two benchmark contracts that allow the attainment of the first-best task allocation. First, we assume that the contracting parties can sign a contract limiting workers' mobility. Second, we let task allocation be contractible. In this case, complete contingent contracts are feasible. In this scenario, the employer states an allocation rule depending on workers' ability. Enforceable contracts serve as a commitment device for the employer to comply with efficient task allocation.

When neither bonding contracts nor complete ones are feasible, a profit-maximizing firm assigns the more portable task to fewer workers than in the efficient outcome. This implies that some workers' talent is not efficiently used in the production process. The magnitude of this inefficiency depends on the relative portability of the skills required to execute the two tasks (namely on workers' outside options deriving from task allocation). Workers who are inefficiently allocated on the less portable task are not productive enough to justify a too high wage (deriving from a better outside option) to be retained.

More elaborate contracts may reduce the cost of inefficient task allocation. We examine two examples. First, a long-term contract defining *transfers* from the worker to the employer who announces an efficient task allocation. These transfers allow the inefficiently allocated workers to internalize the increase in wages earned when efficiently matched with the more portable task rather than being assigned the alternative one. This contract may be considered as an internship one, in which a worker accepts a lower wage than her current outside option to obtain a better outside option later on. However contracts are incomplete and there is an holdup problem on the employer's side hindering the implementation of efficient task allocation. Then we introduce an *up-or-out contract.* This contractual form is widely used in human capital intensive firms (Waldman, 1990). It states that a worker not satisfying a certain performance requirement will be dismissed, otherwise she will be promoted to a higher position. This mechanism restores the efficient task allocation if two conditions are simultaneously fulfilled. First, the cutoff ability to be kept in the firm needs to be the Pareto-efficient one for task allocation. Second, both tasks should be perfectly portable. If

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[6]This is a realistic assumption. Indeed usually workers are hired to work in a certain branch of a firm. However contracts do not specify a particular task for workers. Many legal environments allow for an easy mobility of workers within firms.

this is the case, for the firm it is easy to replace workers who are let go with others coming from competing companies. However, by assumption, only one task may be perfectly portable (the two task can never be equally portable). This implies that the employer will face losses in human capital in order to substitute the dismissed workers and earn no profit from the less portable task.

The model predicts that a change in the organizational form of the firm improves efficiency. If the current employer sells the firm out to some employees who run it as an equity partnership, the optimal allocation can be attained. This is the most common type of partnership in countries adopting the common law legal system. It requires prospective partners to buy a share of the firm (equity) in advance, and then they will be remunerated with realized dividends. By giving control power to some workers, the partnership organizational form eases the ex-post retention of both partners and salaried workers. We let the partnership be characterized by a *"meritocratic"* sharing rule. This rule entitles more productive workers to higher shares of the realized profit (i.e. to more equity and control rights). This sharing mechanism, as compared to the *equal sharing* one, incentivizes the best workers to become partners instead of remaining salaried workers in the corporation ran by a single owner.

Partners can choose task allocation so as to maximize the profit to be shared. This change in control rights makes room for efficiency as partners allocate themselves on the task in which they are more productive. Henceforth, we show that if (at least) all the inefficiently allocated workers are made partners, the Pareto-efficient outcome is attained.

The paper is structured as follows. The following subsection reviews the related literature. Section 2 sets up the basic model. Section 3 derives the Pareto-efficient task allocation.We show that the efficient outcome can be implemented if workers' mobility can be limited or contracts are complete. Section 4 introduces the allocative inefficiency due to portability of talent and contractual incompleteness. Section 5 slightly modifies the initial model introducing the possibility for the current owner to sell the firm out to some workers who run it as a partnership. We analyze the optimal choice of partners. Section 6 concludes.

1.1 Related Literature

This paper contributes both to the literature in personnel economics dealing with optimal allocation of workers within the firms and to the literature in organizational economics, analyzing the design of organizations and the allocation of control rights.

Workers' allocation across tasks has been analyzed in settings characterized by asymmetric information among firms. Greenwald (1986) shows that if the current employer has an informational advantage about a worker's ability, it can be exploited to prevent poaching raids by

rival firms. The latter can be refrained from poaching a worker whose ability is uncertain, to avoid paying too much for a "lemon" (winner's curse).[7] Task allocation may be perceived by the uninformed parties as a signal of workers' talent. Waldman (1984) considers a framework in which information about workers' ability is observed only by the current employer. Future potential employers receive a signal from the task assigned to a worker. Henceforth, the current employer may exploit her informational advantage and allocate workers inefficiently in order to send an incorrect signal to the opponents.[8]

In this paper we show that allocation inefficiencies persist when workers' abilities are observable in the industry, but task allocation is not contractible.[9]. We argue that observing workers' talents is not enough to obtain efficient outcomes if the employer cannot commit to a certain task allocation.

Another branch of the literature on organizational design has focused on the role of asymmetric information between firms and clients. Levin and Tadelis (2005) argue that partnerships abound in human capital-intensive markets because clients cannot perfectly observe the quality of the products supplied.[10] The authors show that firms organize as partnerships in order to signal the quality of their output. They assume partners to share the profit equally. Such assumption is fundamental for the signaling purpose. In this setting, partners are concerned with maximizing the average profit instead of the total one. This implies that they will be eager to hire the best workers on the market (the more productive ones).

In this paper we develop a different framework than the one in Levin and Tadelis (2005) in several respects. First, we assume the quality of the output produced to be observable. Second, we do not consider a monopolistic firm. We assume our economy to be characterized by perfect competition. Third, in our model the firm hires workers who develop all the possible talents. Indeed at the beginning of the job relationship abilities are unobservable. Fourth, we depart from the assumption that partnerships are equal-sharing ones as we are not concerned with the signaling problem. This allows us to analyze a more empirically recurrent organizational hierarchy in partnerships such that the more productive a partner, the higher the share of profit she is entitled to.

The present paper can also be related to the one by Rebitzer and Taylor (2006). The latter

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[7]This result hinges on the general one provided by Akerlof (1970).

[8]The same argument is featured by Bernhardt (1995) to justify the existence of the so-called "Peter principle" in some firms. This principle describes the empirical evidence that some promoted workers turn out to be less productive than before, when they were working on a simpler task.

[9]This assumption makes the model similar to the matching model presented by Jovanovic (1979) in which workers' abilities are perfectly observable and they need to be allocated between firms depending on complementarities and technologies so as to attain efficient matches.

[10]For instance, a patient cannot tell whether a diagnosis is correct, or a plaintiff could not perfectly evaluate a lawyer's technical advice.

focuses on the role of *"up-or-out contracts"* in law partnerships. In their model there is a continuous turnover of associates, in an overlapping generation framework. However, dismissed workers can carry along human capital acquired during the time within the firm. This loss is not featured in Rebitzer and Taylor (2006), whereas the present paper emphasizes that also "low-skilled" workers' departure causes a loss for the source-firm. Indeed the employer bears the cost to train the freshly hired workers to substitute the dismissed ones. If these are poached from a competing firm, they cannot produce as well as the dismissed workers because of imperfect portability of skills.

Other theoretical contributions on the economics of partnerships are provided by Alchian and Demsetz (1972), emphasizing the incentive to monitor peers in such organization; Farrell and Scotchmer (1988) showing that many law firms have few partners because the best workers do not want to equally share their earnings with weaker ones; Kochan and Rubinstein (2000); Garicano and Santos (2004) showed how a firm organized as a partnership can favor the transmission of human capital between partners and associates and senior and junior partners; Morrison and Whilelm (2005); Poblete (2015).

2 The Basic Model

The owner of a firm takes prices as given and hires a continuum of size 1 of workers from a perfectly competitive labor market.

Let us assume the output price to be normalized to 1 and workers' productive effort to be costless. For the sake of simplicity we assume the employer and the employees to be risk-neutral. The latter have utility over the wage earned. Workers' heterogeneous productivities are denoted as $y \in [\underline{y}, \bar{y}]$, with $\underline{y} > 0$. Productivities are distributed according to a cumulative distribution function $F(y)$ with $\frac{\partial F(y)}{\partial y} = f(y)$.[11] Workers' productivities are unobservable at the beginning of the game.[12]

Initially the employer asks the new employees to execute a standard task. By executing this task, workers will acquire skills which are observable in the industry, but not verifiable in courts. This last assumption makes contracts contingent on workers' skills, not enforceable. Since the employer chooses task allocation depending on abilities, we can sum up by saying that task allocation is non-contractible.

Once abilities are observed, the employer allocates workers on either of two tasks. This

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[11]Note that y is not a random variable in this model, as it will be fully observable. The probability density function just denote the frequency of a certain ability level.

[12]With this assumption we follow a vast branch of the literature such as Waldman (1984) and Greenwald (1986). For example, suppose these workers are all freshly graduated from law school and there is no information about their talents.

allocation is determined by a new spot contract defining a task and a new wage. Tasks differ in productivity and portability (or specificity) rate of the skills needed to be executed.

We assume that workers may leave the source firm only after they are assigned to a certain task. This is equivalent to say that the skills acquired by executing the standard task are firm-specific.

2.1 Contracts and Tasks

The employer offers spot wage contracts. Let w_1 be the wage offered to a worker at the beginning of the game. Let $w_2^i(y)$, with $i = \{A, B\}$, denote the wage offered to the worker after her talent is observable and she has been allocated on task i.

Let θ_i define the *portability rate,* of task *"i"* (namely, the share of task productivity that a leaving worker can reproduce outside the source firm). The two tasks are characterized as follows:

Assumption 1. Task A *produces βy with $\beta \in [1; \infty)$ and has a portability rate $\theta_A \in (\theta_B; 1]$.*[13] Task B *produces x and has a portability rate $\theta_B \in (0\,;\,\theta_A)$.*

We assume workers to be homogeneous at the beginning of the game, so they all have the same outside option. Let $\bar{w}$ be the reservation wage (or valuation of leisure) for all workers. After abilities become observable in the industry and task allocation takes place, every worker will have an heterogeneous outside option. An employee working on task A and leaving the firm can reproduce

$$\theta_A \beta y.$$

On the other hand, a worker assigned to task B, when leaving the source-firm, can reproduce

$$\theta_B x.$$

Assumption 2. *Let $\theta_A \beta y > \bar{w}$ for all y and $\theta_B x > \bar{w}$.*

A worker acquiring some firm-specific human capital needs to be compensated more than her reservation wage, because of the loss in bargaining power (Becker, 1962). This assumption makes working beneficial for all employees, rather than being unemployed.

Assumption 3. *Let $\theta_A \beta \bar{y} \leq 2\bar{w}$.*

This assumption ensures that a worker cannot be paid a negative wage in one of the two periods of the job relationship.

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[13]We are assuming that a worker leaving her current firm may not be able to perfectly replicate the same output elsewhere. The assumption fits with the existence of conversion or searching fixed costs, or some constraining property rights (see Williamson, 1979 and Coff, 1997).

2.2 The Timing

We consider a dynamic game extending along five stages:

1. Firm owner offers wage contracts to workers. Those who accept will work on a standard task.

2. Workers' productivities become observable to them and to all the firms in the industry. Wages for the standard task are paid.

3. Workers are offered a new spot contract specifying task and wage

4. Workers can leave the firm where they work for a new one.

5. Production process is completed and wages are paid.

3 Efficient Task Allocation

Let us derive the Pareto-optimal threshold value y^*. It is such that all workers with ability larger or equal (smaller) than y^* are assigned to task A (task B).

The employer signs two spot contracts with the employees. At the beginning of the job relationship (stage 1), the entrepreneur pays a wage w_1 to convince workers to join the firm. After the execution of the standard task, workers' abilities are revealed and they are allocated one of the two tasks. At this stage, workers are offered a wage depending on task allocation $w_2^i(y)$. Given these wage, let us define the social welfare as

$$W(y) = \underbrace{\int_{\underline{y}}^{\bar{y}} \beta y f(y) dy + F(y)x - w_1 - \int_{\underline{y}}^{\bar{y}} w_2^i(y) f(y) dy}_{\pi} + w_1 + \int_{\underline{y}}^{\bar{y}} w_2^i(y) f(y) dy. \quad (1)$$

The term denoted as π is the profit of the firm organized as a corporation, whereas the other terms define the sum of wages earned by the employees.

The Pareto-efficient cutoff value for workers' productivity is defined as:

$$y^* \in argmax_{\{y\}} W(y).$$

The first-order condition delivers the optimal threshold value

$$y^* = \frac{x}{\beta}. \quad (2)$$

This cutoff value maximizes total productivity, since wages are pure transfers. We note that, ceteris paribus, the higher the production enhancer β, the lower y^*. Hence more workers would be allocated on task A.

On the other hand, when x increases, the threshold value becomes more demanding. Namely, only very productive workers shall work on task A.

3.1 Implementing the Efficient Outcome

We will now show two contractual forms that can implement the efficient task allocation. First, a contract limiting workers' mobility. Would such a contract be feasible, workers' ex-post retention would not be an issue for the employer. Indeed, the latter does not need to use task allocation to endogenously reduce the cost of retention. Task allocation will be based on the Pareto-optimal cutoff value for productivity, denoted in equation (2).

The second contractual form we analyze is a *complete contract*. We relax the assumption made about the impossibility to contract upon task allocation. Notably, workers' talent will be considered to be both observable in the industry and verifiable in courts. We assume contracts to be long-term.[14] A complete contract serves as a commitment device for the employer upon efficient task allocation.

3.1.1 Mobility-Constraining Contract

Let us assume that employer and workers can sign unconstrained contracts limiting workers' mobility. In this environment, the employer implements efficient task allocation. This result is expressed in the following proposition.

Proposition 1. *If the employer and the employees can sign unconstrained contracts, limiting workers' mobility, the Pareto-efficient task allocation is attained, with cutoff value for ability $y^{**} = \frac{x}{\beta} = y^*$.*

The proof of all propositions and lemmas is relegated to the Appendix. Intuitively, if retention is not an issue, the employer will allocate tasks only considering employees' marginal productivity. This leads to a Pareto-efficient outcome. The ability cutoff for a worker to be allocated on task A will equal y^*, which indeed maximizes total production.

3.1.2 Complete Contract

We now relax the assumption that task allocation is not contractible. Notably, a contract contingent on talent can be enforced. Suppose that employer and employees agree upon a

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[14]For the rest of the paper we analyze spot contracts. This does not change the results of the model.

menu of contracts:

$$\big\{w(y)\,,\,i(y)\big\}.$$

The employer allocates workers across tasks and pays them a certain wage, depending on the realized productivity. Let us assume no discounting across periods. Since these contracts are signed before talents are observed, the employer cannot modify their prescriptions. Through such contract, the employee can commit to the efficient task allocation and extract as much rent as she can ex-ante.

Proposition 2. *If workers' talent is observable and verifiable, the employer can offer long-term contracts, contingent on talent. These contracts can implement the Pareto-efficient task allocation. The employer can commit to allocate workers across tasks according to the cutoff value $y^* = \frac{x}{\beta}$ and extract all the surplus generated ex-ante.*

A complete contract is a commitment device for the employer to efficiently match workers with tasks. Efficient task allocation generates extra surplus. The employer will be able to extract such surplus when hiring workers. Contracts are long-term and the employer commits to efficient task allocation. Given the expectation of high future wages after talent revelation, workers are willing to give up some rent ex-ante. Hence, the employer hires workers for a salary smaller than the reservation one.[15] This allows for a profit-maximizing rent-extraction by the employer. In fact, the wage paid ex-post to workers matched with task B, is smaller than the expected wage ex-ante. These workers face a positive cost ex-post. All workers for whom the ex-post outside option is smaller than the expected wage ex-ante face a cost (which is decreasing in workers' talent). On the other hand, some other workers will enjoy a positive (or at least null) surplus.

This equilibrium is a sort of *cross-subsidization* solution.[16] A complete contract allows the employer to increase the total surplus and maximize her profit. This is possible because the employer extracts rent ex-ante (by paying workers less than the reservation wage) and pays workers their outside option ex-post.

We have seen that by removing alternatively workers' mobility and contract incompleteness, the efficient outcome can be attained. In the next section we will restore the assumptions of the basic model to derive the inefficient outcome.

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[15]How smaller depends on how large the expected wage is. For more details, see the proof of Proposition 2 in the Appendix.

[16]This contractual form resembles the very usual ones in large firms. Young workers are paid very low salaries, for an "apprentice" or "internship" period. These salaries are accepted because of the expectation of a brilliant career ex-post, yielding higher wages.

4   Portability and Inefficiency

Let us now analyze the case in which workers can leave the firm after being matched with a task. In the new firm, workers can reproduce a fraction of what they produced in the source firm, depending on the task they execute. Therefore workers' outside option depends on task allocation and on their talent.

Proposition 3. *If workers can leave after task allocation, it is profit maximizing to assign task A to fewer workers with respect to the Pareto-efficient equilibrium.*
The new threshold value will be $\hat{y} = \frac{(1-\theta_B)x}{(1-\theta_A)\beta} > y^*$. *The degree of inefficiency depends on the portability of the human capital that workers acquire by working on tasks.*

This result shows that if worker can leave the source-firm, $F(\hat{y}) - F(y^*)$ of them are inefficiently allocated to task B. These workers could potentially be assigned to task A (since $\beta y > x$ for them), but they are not (see Figure 1). Their productivity is not large enough to compensate the spread between θ_A and θ_B. Namely, the wage they require not to leave the firm at the interim stage while working on task A, is too high. Due to higher portability of the skills acquired through task A, these workers' outside option would be too high. To reduce retention costs, it is profit maximizing for the employer to match them with the less portable task.

Figure 1: Inefficiency

This is not a surplus maximizing outcome. Inefficiently allocated workers will operate on task B rather than on task A. Hence, their talent is inefficiently used and developed. If a worker is matched with task B, she will not be able to work on task A in another firm, although her talent would potentially allow her to do so.
We notice that if θ_A increases, ceteris paribus, the threshold value $\hat{y}$ becomes more demanding. As in Waldman (1984), the degree of allocational inefficiency is decreasing in "firm-specificity" of workers' human capital. However in this paper, the result is delivered through a different mechanism. In our setting we do not consider informational asymmetries across firms, about workers' talent. We study an informational setting similar to those used in matching models, with symmetric information (Jovanovic, 1979). This methodological difference strengthens our result compared to the existing ones. To better explain this concept, let us consider the possibility for workers to execute a signaling action, in the setting presented by Waldman (1984). Such action affects the signal about their ability derived

from task allocation. Workers could do *signal jamming* (as in Holmström, 1982/1999 and Gibbons, 2005) to send a more precise information about their ability, out of task allocation. The better the signal (the more important the signal jamming activity), the less effective is task allocation for firms to retain the best workers. Indeed, if a very talented worker is allocated to a simple task, she can signal her actual skills. This would increase her probability of being hired by a competing firm seeking for highly productive employees. On the other hand, in the model we present, task allocation is an effective retention tool. A key role, for this result to exist, is played by contract incompleteness and by firm and task-specificity of the skills acquired by the employees. In fact, the impossibility to design contract specifying task allocation contingent on workers' talent, does not allow for a Pareto-optimal outcome.

4.1   More Elaborate Contracts

If tasks differ in productivity and portability, a profit maximizing employer allocates them inefficiently among workers. Thus far we have considered a simple wage contract to analyze the problem. Let us now verify whether a more elaborate contractual form could improve efficiency. We will consider two cases. First, we allow workers and employer to agree upon an ex-ante transfer to attain efficienct task allocation. This transfer would allow the inefficiently allocated workers to internalize the extra cost of efficient allocation. Second, we study the case when the employer can commit to an *"up-or-out" policy.*

Let us first consider the effect of a transfer before task allocation. Let us assume that the firm owner can ask workers who would be inefficiently allocated in a second-best equilibrium, to pay an intermediary transfer. Such transfer would be paid at a stage between the revelation of workers' talent and task allocation.[17] Those workers who accept to pay the transfer are promised to be efficiently allocated on task A.

Proposition 4. *Suppose that the employer can ask workers with ability $y \in [y^*, \hat{y})$, to pay an intermediary transfer $\tau = \theta_A \beta y - \theta_B x \ \forall y \in [y^*, \hat{y})$. The employer claims that they will be matched to task A if they accept to pay τ. This cannot be an equilibrium, since workers' talent is not verifiable in courts. Contracts are incomplete and the employer has an incentive to holdup.*

If a worker cannot prove her talent in a court, a contract contingent on it cannot be enforced. In such environment the employer has no commitment device. Even if the inefficiently allocated workers can internalize the extra cost to retain them if efficient allocation

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[17]This situation may be thought of in two equivalent ways. The first is that, ex-ante, the employer pays a wage $\bar{w} - \tau$ to all workers, and then repay τ only to those workers who realize abilities outside the set $[y^*, \hat{y})$. The second is that, after the execution of the standard task, the employer pays a wage $\bar{w} - \tau$ to these workers.

is in place, the equilibrium assignment will be inefficient. In fact, the profit maximizing employer, after having collected the transfers, will allocate the $F(\hat{y}) - F(y^*)$ workers on task B (since for them $\theta_B x < \theta_A \beta y$, and task B allocation increases the profit realized. see Figure 2). Workers will rationally anticipate this and will not accept to pay the transfer.
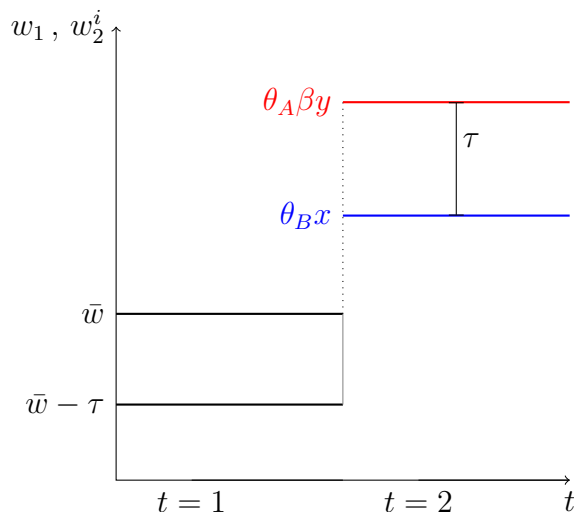

Figure 2: Wages and Transfer

The second contract we analyse is an *up-or-out* one. In human capital-intensive industries, up-or-out contracts are widely diffused. Through these mechanisms, employers set a certain "performance" cutoff for employees. Only those fulfilling it will be kept in the firm, whereas the others will be dismissed. Rebitzer and Taylor (2006) claim that up-or-out contracts can solve the retention problem with no loss of welfare. In the model presented in this paper, this shall not be the case.

Proposition 5. *If an up-or-out clause is in place, such that after the execution of the standard task, the employer keeps in the firm only workers worth earning $w_2 \geq \theta_A \beta y^*$, the efficient task allocation could be attained without cost, would task B be perfectly portable ($\theta_B = 1$).*

If the performance standard for employees to stay in the firm is high enough, efficient task allocation is attained. Nevertheless, this mechanism is characterized by costs in terms of human capital. The more firm-specific is the human capital acquired from task B, the higher is the cost. If all the workers who would execute task B are dismissed, the employer will substitute them with workers poached from competing firms. These workers will not be able to produce the same amount as those who were trained inside the firm. There is a fixed cost to be faced. The firm owner will have no incentive to adopt this contract instead of the

simple wage contract.

5 The Role of Partnerships

In this section we analyse the role of partnerships in human capital-intensive industries. We assume that the employer can decide whether to keep running the firm as a corporation, or to sell it to some workers. In the second case, the buyers will run the firm as a partnership. A partnership is an organizational form in which some workers (or partners) earn a share of the profit and have control rights. Most of the firms operating in professional services industries are organized as partnerships (Teece, 2003).

Levin and Tadelis (2005) provide a rationale for the abundance of partnerships in human capital-intensive industries. This is based on an asymmetric information issue between the producer and the clients. They state that firms can signal the quality of their products by organizing as partnerships. They assume partners to share the profit of the firm equally. As a result, partnerships hire the most talented workers on the market as they maximize the average profit. We define a parallel argument to justify the abundance of partnerships in service markets. We claim that partnerships abound because they can mitigate the allocative inefficiencies due to the competition for talent on the labor market and the portability of skills. We consider an equity-based partnership in which prospective partners will buy a share of the firm (equity) and earn dividends as compensation.

We now assume that the employer may sell the firm out to some workers who then become partners. In order to maximize the sale price of the firm, the employer will select a bounded segment of abilities for prospective partners. The sale price depends on the profit of the partnerships, which in turn depends on who is made partner.

5.1 Equity, Shares and Fees

In order to analyse task allocation in an equity partnership, let us define some notation. Let ϕ denote the equity fee every prospective partner pays to the current firm owner in order to buy her stake in the firm.[18] The total amount the employer earns from the sale will be $\int_{y_1}^{y_2} \phi(y)f(y)dy$. Let π^P denote the profit of the firm organized as a partnership, as compared

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[18]This fee may also be considered as a reduction in the ex-ante wage that a prospective partner pays in order to gain a higher wage ex-post. However, let us keep in mind that this fee entitles the worker with control rights, differently from the ex-ante fee τ analyzed in section 4.1.

to the profit of a corporation

$$\pi = F(\hat{y})(1 - \theta_B)x + \int_{\hat{y}}^{\bar{y}} (1 - \theta_A)\beta y f(y) dy - \bar{w}. \tag{3}$$

When selecting prospective partners, the firm owner defines a segment y_P, on the line $\bar{y} - \underline{y}$. Let y_1 and y_2 be respectively the lower and the upper bound of y_P. These bounds are endogenously chosen by the employer.[19]

Every partner is entitled to a share of profit $s(y) \in [0\,,\,1]$ and we assume the firm owner to sell the firm out, so that $\int_{y_1}^{y_2} s(y)f(y)dy = 1$.

The owner contracts *vis-a-vis* with each prospective partner offering a "partnership contract" $\{\phi(y)\,,\,s(y)\} \forall\, y \in y_P$.

5.2   New Timing

We slightly modify the timing of the baseline model. Since we are interested in the task allocation process, which takes place after workers' talents revelation, we do not analyze the ex-ante participation problem. The new timing of the game is the following:

1. The firm owner selects the length of the segment y_P and offers a partnership contract $\{\phi(y)\,,\,s(y)\}$.

2. Potential partners accept or reject.

3. Partners choose task allocation for themselves and salaried workers.

4. Partners and salaried workers can leave the firm.

5. Production process is completed and wages are paid.

5.3   New Constraints

Prospective partners decide whether to buy or not the firm by accepting the partnership contract offer. A generic worker accepts the offer as long as a feasibility condition (defined as *"willingness-to-pay" (WTP) constraint*) is satisfied. Depending on the task she would had been matched to in a corporation, either of two conditions needs to be satisfied:

$$\phi(y) \leq s(y)\pi^P - \theta_B x \quad \forall y \in [\underline{y}\,,\,\hat{y}) \tag{WTP_B}$$

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[19]We will consider only one segment, and in the Appendix will be shown that the initial firm owner would not benefit from picking more segments.

or

$$\phi(y) \leq s(y)\pi^P - \theta_A\beta y \ \ \forall y \in [\hat{y}\,,\,\bar{y}]. \tag{WTP_A}$$

In stage 1, the employer selects the boundaries of the segment y_P, in order to maximize $\int_{y_1}^{y_2} \phi(y)f(y)dy$. The owner is willing to sell the firm if

$$\int_{y_1}^{y_2} \phi(y)f(y)dy \geq \pi. \tag{4}$$

Partners are endowed with both payoff and control rights: they earn a share of the realized profit of the firm rather than a fixed wage and decide over task allocation for themselves and all the other employees. This affects the employer's choice on whether to sell the firm or to keep running it as a corporation, since it changes the profit generated and whereby the surplus to be extracted through fees ϕ.

For a segment y_P of length $y_2 - y_1$, and a certain task allocation, partners and salaried employees earn, respectively, a dividend or a wage. These remunerations should suffice to implement retention at the interim stage $(t = 4)$. The "interim" participation constrains for salaried workers are the same as in the maximization program for a corporation in section 4. On the other hand, we need to introduce new constraints for partners, depending on task allocation. A partner working on task A will not leave the firm if

$$s(y)\pi^P(y_1\,,\,y_2) \geq \theta_A\beta y. \tag{IPC_A}$$

On the other hand, a partner working on task B will not leave the firm if

$$s(y)\pi^P(y_1\,,\,y_2) \geq \theta_B x.. \tag{IPC_B}$$

Given the interim participation constraints, the following lemma holds:

Lemma 1. *The firm owner will offer each prospective partner a nondecreasing share of the firm with respect to her ability, so that*

$$\frac{\partial s(y)}{\partial y} \geq 0. \tag{5}$$

For all prospective partners to break even at least when accepting the partnership contract, the owner needs to offer personalized contracts. This result rules out the possibility for the partnership to be an equal-sharing one. This result is far from obvious as most of the results in the existing literature (see, for instance, Levin and Tadelis, 2005) are based on equal-sharing mechanisms. In our model, workers' abilities are continuously distributed and

this requires the best partners to obtain different rents with respect to the less productive ones in order to break even. For this reason, in this paper we focus on a *"meritocratic"* partnership, featuring a sort of piece rate.

5.4 The Employer's Program

We will now analyze the employer's optimal selection of partners and check whether it can restore the efficient task allocation.

Lemma 2. *Efficiency in task allocation cannot be improved by selling the firm to workers who are efficiently allocated in a corporation.*

Partners' selection is fundamental for the implementation of the surplus maximizing task allocation. If none of the workers who is allocated inefficiently within a profit maximizing corporation is made partner, running the firm as a corporation or as a partnership makes no difference in terms of surplus. Profit maximizing partners would match tasks and workers in the same way as a unique employer would.There is no improvement with respect to the corporation case: the same rent is differently distributed.

Let us now focus our analysis to cases in which the inefficiently allocated workers are offered a partnership contract. We need to verify that they accept it, and that the dividend they earn will suffice to retain them. The following proposition states the result we obtain.

Proposition 6. *If at least all workers with ability $y \in [y^*, \hat{y})$ are made partners, the efficient task allocation is implemented. The partnership generates a higher profit with respect to the corporation.This allows for optimal retention of all partners and salaried workers.*

A necessary condition for the implementation of efficiency is that workers with ability $y \in [y^*, \hat{y})$ are made partners. When this is the case, they will have an incentive to accept the partnership contract and not to leave it at the interim stage: remunerating them with a share of profit facilitates the retentive scope. Partners earn control rights over the firm and this implies two features. First, partners are committed to choices made. This allows to circumvent the holdup issue generated by contract incompleteness when only the firm owner had control rights. Second, partners do not earn a fixed wage depending on task allocation, but their remuneration is given by a share of the profit realized. Therefore, they have an incentive to allocate themselves and the other partners on tasks that maximize their productivity, hence increasing the profit generated[20].

A Pareto-optimal task allocation generates a larger profit to be split between partners and

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[20]Given linearity of the problem at hand and perfect information, such result is attainable with both majoritarian and proportional voting rule.

the previous firm owner (through the equity fees paid to buy the firm). Moreover, the previous employer is indifferent on how many workers should be made partners apart of those with ability in $[y^*, \hat{y})$. In the case in which the owner offers contracts such that both the WTP and the interim participation constraints bind, she is able to extract all the surplus generated by the partnership, as she charges positive fees $\phi = \theta_A \beta y - \theta_B x$ for workers who are inefficiently allocated in a corporation environment. Notice that, as opposed to the transfer τ proposed in section 4, in this case, there is no holdup problem on the owner's side. By selling the firm, she transfers payoff and control rights to partners who will then attain efficient task allocation in order to maximize the dividend they earn.

In sum, the model shows that when all workers with ability larger or equal to y^* (namely, all those who would had worked on task A in a Pareto-efficient outcome) are made partners, the partnership generates the highest profit possible compared to a corporation. This result fits well with the anecdotal evidence according to which the best workers in a firm are chosen to become partners. In our model, task A can be considered to be an "elite" task. Organizing the firm as a partnership allows to allocate all the most talented workers on it. These workers will be those who will manage the firm as partners. Hence, all the workers with control rights will work on the more portable task in the firm.

6   Conclusions

In this paper we have analyzed the impact of the portability of workers' skills on the design of organizations. We first focused on a setting in which the representative firm is organized as a corporation. We let the labor market be perfectly competitive at the beginning of the game, but after the acquisition of more or less portable skills, the employer gains some bargaining power against employees. Such partial portability of skills acquired within one firm may generate opportunistic behavior on the employer's side. In order to reduce retention costs for talented workers, a profit maximizing firm will match workers to tasks inefficiently. This result fits with a vast branch of the literature predicting inefficient allocation (or promotion) of valuable workers to reduce the cost of mobility (Waldman, 1984; Greenwald, 1986; Ricart i Costa, 1988; Bernhardt, 1995). Our result differs from the existing literature as it is driven by contract incompleteness rather than by asymmetric information about employees' talent across firms.

Given the impossibility to contract upon task allocation, the firm owner has no commitment device to comply with an efficient task allocation. We have shown that organizing the firm as a partnership can implement the optimal task allocation and generate a higher profit than the one of a corporation. This prediction is corroborated by the fact that the commitment

problem is solved by giving control and payoff rights to some workers.This solution can be intended as a "vertical integration" one. More generally, the transfer of control rights is a widely used mechanism to solve issues generated by contract incompleteness, as shown by for Grossman and Hart (1986) and Hart and Moore (1990). These results fit well the anecdotal evidence on firms operating in human capital-intensive industries. We observe that most of these firms are organized as partnerships rather than corporations.

We have studied the choice of a single owner who decides whether to sell the firm out to some employees. The buyers would become partners and turn the corporation into a partnership. The results provided are still valid if we consider the initial firm owner to be an individual partner, looking for new partners. Namely, at the beginning of the game, the firm can be assumed to be organized as a partnership with a unique partner who wants to enlarge the pool of partners. She picks partners evaluating whom among her employees increases most the total surplus to be shared. The initial partner would sell shares of the firm to new partners. After production is completed, every partner earns a dividend consistent with the equity acquired.

Throughout this paper we have assumed the task producing an outcome dependent on workers' ability to be the more portable one, referring to the idea that a worker can better reproduce in a new firm what she produced earlier in her career, if this outcome depends mostly on her talent. However, the ordering of the portability rates could be reversed, and inefficiency would still hold but in a the opposite way: there would be too many workers dealing with the more talent-sensitive task, so that efficient production is foregone in favor of profit maximization. Another assumption that may seem strong is that a worker who deals with one task, cannot deal with the other immediately after. Such assumption is justified by various fixed costs a worker has to face when moving not just from a firm to another, but also across tasks (for instance, training costs, foregone economies of scale, etc.).

For future research, In this paper we have assumed all the parties to be risk-neutral and production to be deterministic. Including uncertainty about outcomes (notably, about profits) will change the incentives for workers to accept partnership contracts. In fact, salaried workers have limited liability, whereas partners do not (depending on the type of partnership one considers). Such framework could be analyzed to deepen our knowledge about the role of *limited-liability partnerships*, in which some (or all) partners have limited-liability. This hybrid organizational form presents some features of a partnership and some of a corporation and may be studied in a simple and versatile theoretical framework as the one presented in this paper. In our model, we kept a partial equilibrium perspective of the partnership equilibrium. A general equilibrium analysis could provide predictions about industry structures, organizational design and skills' portability.

Appendix

Proof of Proposition 1

Proof. The employer chooses the allocation of workers across tasks to maximize her profit. To do so, she designs the following allocative mechanism:

$$\mathcal{A}(y) = \begin{cases} Task\ A & \forall\ y \in [y^{**},\ \bar{y}], \\ Task\ B & \forall\ y \in [\underline{y},\ y^{**}). \end{cases}$$

Let the profit of the firm organized as a corporation be denoted as $\pi(y)$ and be given by

$$\pi = \int_{y}^{\bar{y}} \beta y f(y) dy + F(y) x - w. \tag{6}$$

with threshold productivity

$$y^{**} \in argmax_{\{y\}}\ \pi(y) \tag{7}$$

$$\text{subject to}\ \ \{w \geq 2\bar{w}\} \tag{PC}$$

Since the firm owner has all the bargaining power, the participation constraint (labelled PC) will bind in a Nash-equilibrium. If not, then she could always find it profitable to reduce w up to the point in which it is actually equal to $2\bar{w}$.

Hence the contract offered is $\{w = 2\bar{w}\}$ and the first-order condition for the profit maximization problem is

$$f(y^{**})x - \beta y^{**} f(y^{**}) = 0$$

delivering the optimal threshold value

$$y^{**} = \frac{x}{\beta} = y^{*}. \tag{8}$$

Therefore the employer would allocate all workers with ability $y \geq \frac{x}{\beta}$ on task A, and all the others on task B in a first-best equilibrium without portability. $\qquad \square$

Proof of Proposition 2

Proof. Let us assume that the employer offers long-term complete contracts $\{w(y), i(y)\}$. These will state the following:

$$\{w(y), A\} \quad \forall y \in [y^*, \bar{y}] \tag{9}$$

and

$$\{w(y), B\} \quad \forall y \in [\underline{y}, y^*) \tag{10}$$

with $y^* = \frac{x}{\beta}$.

At the end of the game, every worker earns a total wage $w(y) = w_1 + w_2^i(y)$. In the sum, w_1 denotes the wage paid to the worker to join the firm rather than being unemployed. The second term, $w_2^i(y)$, is the wage needed to refrain the worker from leaving the firm after task allocation. It depends on worker's talent, which affects both task allocation and the outside option of task A.

Let us recall that a worker with ability y dealing with task A can reproduce $\theta_A \beta y$ outside the firm. On the other hand, a worker dealing with task B, can reproduce $\theta_B x$ outside the firm. Solving the game by backward induction, we see that the ex-post wage for workers not to leave the firm should be

$$w_2^A \geq \theta_A \beta y \quad \forall y \in [y^*, \bar{y}] \tag{11}$$

and

$$w_2^B \geq \theta_B x \quad \forall y \in [\underline{y}, y^*). \tag{12}$$

Since the employer has all the bargaining power, these constraints will bind in equilibrium. The employer earns a positive profit from the execution of tasks, because of firm-specificity of some of the skills needed. This mechanism allows to attain ex-post efficiency in task-allocation. Furthermore, the employer extracts all the rent available. Let us now go one step back and analyse the wage needed to satisfy the "ex-ante" participation constraint. At the beginning of the job relationship workers' talents are unobservable. So, given the commitment to efficient task allocation, the expected wage is

$$\mathbb{E}(w_2) = \int_{y^*}^{\bar{y}} \theta_A \beta y f(y) dy + F(y^*) \theta_B x. \tag{13}$$

To convince workers to enter the job relationship, at stage 1 of the game, the employer needs to satisfy the "ex-ante" participation constraint

$$w(y) = w_1 + \mathbb{E}(w_2) \geq 2\bar{w}. \tag{14}$$

Let us recall that $\bar{w}$ is a fixed and homogeneous reservation wage for workers before their talent is reveled. In the ex-ante participation constraint, the employer needs to make sure that the expected flow of payments will suffice to convince workers to work for two stages. Ex-ante, no one can observe talents, hence workers have just an expectation about what will their wage later on be. We assume that $\theta_B x > \bar{w}$, $\theta_A \beta y > \bar{w}$ for all y and $\theta_A \beta \bar{y} \leq 2\bar{w}$. These assumptions yield

$$\bar{w} < \theta_B x < \mathbb{E}(w_2) < \theta_A \beta \bar{y} \leq 2\bar{w}. \tag{15}$$

Since the employer has all the bargaining power, the "ex-ante" participation constraint will bind in equilibrium. Hence, by extracting all the rent, the employer can pay all employees an initial wage smaller than the reservation one. In fact, for the constraint (14) to bind, given the inequalities in (15), we will have that

$$0 \leq w_1 < \bar{w}. \tag{16}$$

In this fashion, the employer is committing to an efficient task allocation and maximizing her profit.

Such mechanism may be perceived to be a *cross-subsidization* one. Some workers have too high (respectively, too low) expectations about their future wage in the firm. These will pay (be paid) ex-post when their ability is revealed. After task allocation , the firm owner will keep all the employees on their outside option. $\square$

Proof of Proposition 3

Proof. As in the proof for Proposition 1, the owner allocates workers across tasks so as to maximize the profit of the corporation; she defines an allocative mechanism $\mathcal{A}(y)$ such that

$$\mathcal{A}(y) = \begin{cases} \text{Task A} & \forall \ y \in [\hat{y} \, , \, \bar{y}], \\ \text{Task B} & \forall \ y \in [\underline{y} \, , \, \hat{y}). \end{cases}$$

She maximizes the profit of the firm by choosing the threshold $\hat{y}$. By backward induction, she takes into account both the "ex-ante" and the "interim" participation constraints, so the employer's maximization program will be:

$$Max_{\{\hat{y} \in [\underline{y} \, ; \, \bar{y}]\}} \ \pi = \int_{\hat{y}}^{\bar{y}} \beta y f(y) dy + F(\hat{y}) x - w_1 - \int_{\hat{y}}^{\bar{y}} w_2^A(y) f(y) dy - F(\hat{y}) w_2^B \tag{17}$$

subject to the *"ex-ante" participation constraint*

$$w_1 \geq \bar{w} \tag{EAPC}$$

and the *"interim" participation constraints* depending on task allocation

$$w_2^A \geq \theta_A \beta y \tag{IPC_A}$$

$$w_2^B \geq \theta_B x \tag{IPC_B}$$

Let us recall that we consider two spot contracts (i.e. w_1 and w_2^i are defined in two separate stages of the game) and that the firm owner has all the bargaining power, thus all the three constraints bind at optimum. By plugging the constraints in the objective function and maximizing with respect to $\hat{y}$, we are left with the following first-order condition:

$$(1 - \theta_A)\beta \hat{y} f(\hat{y}) - f(\hat{y})(1 - \theta_B)x = 0$$

yielding the second-best threshold value

$$\hat{y} = \frac{(1 - \theta_B)x}{(1 - \theta_A)\beta} \tag{18}$$

Comparing the second-best threshold (18) with the first-best one (8) , given that we assume $\theta_B < \theta_A$, it is immediate to see that $\hat{y} > y^*$. This result is robust as it persists in the limit values of θ_A and θ_B. $\qquad \square$

Proof of Proposition 4

Proof. Let us suppose that after workers execute the standard task and their abilities are publicly observable (stage 2), but before task allocation takes place (stage 3), the employer can approach all the employees with realized productivity $y \in [y^*, \hat{y})$ and propose them to pay the positive amount $\tau = \theta_A \beta y - \theta_B x$. By doing so, these workers would internalize the increase in the cost of retention that would refrain the firm owner from assigning them task A. However, since the contracts between the employer and the employee do not specify which task will be assigned to the latter, this type of agreement cannot be enforced. The employer collects the total amount

$$T = \int_{y^*}^{\hat{y}} \theta_A \beta y f(y) dy - \left[F(\hat{y}) - F(y^*) \right] \theta_B x > 0.$$

We can see that for all workers with ability $y \in [y^*, \hat{y})$, $\theta_A \beta y > \theta_B x$. Hence, the firm owner finds it profit maximizing to allocate these workers on task B again, so that retention will be easier. Henceforth, the second-best allocation persists, and the employer can extract more rent from the inefficiently allocated employees.

Notice that, in case of holdup by the employer, the inefficiently allocated workers would earn a total wage

$$\bar{w} - \theta_A \beta y + 2\theta_B x. \tag{19}$$

On the other hand, if they refuse to pay the intermediary transfer τ, they would earn in total

$$\bar{w} + \theta_B x. \tag{20}$$

Since for all these employees $\theta_A \beta y > \theta_B x$, no worker would accept the initial wage reduction to attain the efficient allocation, as they can anticipate the fact that the firm owner will holdup. $\qquad\square$

Proof of Proposition 5

Proof. Let us assume the employer to set the wage for a worker not to be dismissed, to $w_2 = \theta_A \beta y^*$. After the standard task is completed, all workers' abilities become observable in the industry. All workers with talent $y \in [y^*, \bar{y}]$ are kept in the firm; all the others are dismissed.

All the employees that are kept in the firm will be allocated on task A. Workers who would had been inefficiently allocated in a second-best outcome, are now paid the amount they reproduce outside the source-firm if allocated on task A. Furthermore, because we assume the labor market to be perfectly competitive, all workers will be paid their marginal productivity outside the source-firm.

On the other hand, all workers with productivity $y \in [\underline{y}, y^*)$ are dismissed. If she wants task B to be executed, the employer needs to replace the dismissed workers. She has two options: either hiring freshly graduated students from labor market or poaching workers with abilities suitable for task B from competing firms. Since fresh graduates would need a preemptive training period, it is more convenient for the owner, to hire workers already trained by other firms.

Workers who were assigned to task B in a competing firm would be able to reproduce $\theta_B x$ outside of it. In order to poach them, the owner of the representative firm needs to pay their marginal productivity, so that the profit on task B will be null. Let us define the profit of

the corporation under up-or-out regime as

$$\pi_{UO} = \int_{y^*}^{\bar{y}} (1 - \theta_A)\beta y f(y)dy - \bar{w} \tag{21}$$

With this mechanism, the firm is substituting workers who would had produced x with others that will produce $\theta_B x$. Hence the loss in human-capital due to the up-or-out contract is

$$F(y^*)(1 - \theta_B)x > 0. \tag{22}$$

The benefit from implementing an up-or-out contract in the corporation is

$$\Delta_{UO} = \pi_{UO} - \pi = \int_{y^*}^{\hat{y}} (1 - \theta_A)\beta y f(y)dy - F(\hat{y})(1 - \theta_B)x \tag{23}$$

which can be rewritten as

$$\Delta_{OU} = \underbrace{\int_{y^*}^{\hat{y}} (1 - \theta_A)\beta y f(y)dy - \left[F(\hat{y}) - F(y^*)\right](1 - \theta_B)x}_{\leq 0} \underbrace{-F(y^*)(1 - \theta_B)x}_{<0}. \tag{24}$$

The first term is at most null. This conclusion is derived form the profit maximization program of the corporation. The second term is strictly negative, as $F(y^*)(1 - \theta_B)x > 0$. One can see that if $\theta_B = 1$, the benefit of using up-or.out contracts would be positive, as $\int_{y^*}^{\bar{y}} (1 - \theta_A)\beta y f(y)dy \geq 0$.

Since we assume $0 < \theta_B < \theta_A \leq 1$, implementing the first-best task allocation through an up-or-out policy, has a positive cost in terms of human capital. The social welfare would not be maximized in equilibrium. Moreover, we are assuming the performance requirement for a worker to be kept in the firm, to be $w_2 = \theta_A \beta y^*$. Would this be $w_2 = \theta_A \beta(y^* + a)$, for all $a \in (0, \hat{y} - y^*)$, then the size of the benefit from using up-or-out contracts would be decreasing in a. □

Proof of Lemma 1

Proof. For the owner to charge non-negative fees, partners need to receive a non-negative rent. This condition is embedded in the interim participation constraints. By backward induction, the owner knows to what task partners will be allocated. For partners operating task B, the share to be offered is

$$s(y) \geq \frac{\theta_B x}{\pi^P} \tag{25}$$

which is constant for a given set of prospective partners and profit, such that $\frac{\partial s(y)}{\partial y} = 0$. On the other, hand for partners that will be allocated on task A, the owner needs to offer a share

$$s(y) \geq \frac{\theta_A \beta y}{\pi^P} \tag{26}$$

which is increasing in y, namely, $\frac{\partial s(y)}{\partial y} > 0$.

□

Proof of Lemma 2

Proof. Let us consider two cases:

1. *Let $y_1 \in [\underline{y}, y_2]$ and $y_2 \in [y_1, y^*)$*

    Proceeding by backward induction, we know that at stage 4 of our game, partners and workers may leave. However the interim participation constraint for partners depends on task allocation which is given for granted at stage 4. In Lemma 1 we have shown that the firm owner sets the stake $s(y)$ so that the interim participation constraints are satisfied. Given the segment of abilities we are considering, when choosing over task allocation, partners will keep the same task allocation for salaried workers as in the case in which the firm is organized as a corporation. Hence, the "interim" participation constraints for salaried workers are the same as the ones analyzed in section 4 and bind in equilibrium as partners have all the bargaining power.

    When maximizing the firm's profit, partners face the following choice:

    $$max \left\{ \left[F(y_2) - F(y_1)\right]x \ , \ \int_{y_1}^{y_2} \beta y f(y) dy \right\}.$$

    Since we are considering y_1 and y_2 to be smaller than y^*, from the profit maximization problem (both first-best and second-best case), we know that all workers with a lower productivity than y^* would be better off producing on task B, independently of whether they need to be incentivized not to leave the firm ex-post, or not. Moreover, given the linearity of our problem, we know that there is no profitable deviation from allocating all partners on the same task. Thus, the profit of the partnership will be

    $$\pi^P = \left[F(y_1) + F(y^*) - F(y_2)\right](1 - \theta_B)x + \int_{\hat{y}}^{\bar{y}} (1 - \theta_A)\beta y f(y) dy + \left[F(y_2) - F(y_1)\right]x \tag{27}$$

    Then the employer's problem will be:

$$Max_{\{y_1, y_2\}} \quad \int_{y_1}^{y_2} \phi(y)f(y)dy$$

subject to the feasibility constraint for prospective partners

$$\phi(y) \leq s(y)\pi^P(y_1, y_2) - \theta_B x. \qquad (WTP_B)$$

Their interim participation constraints yield

$$s(y) \geq \frac{\theta_B x}{\pi^P(y_1, y_2)} \quad \forall y \in [y_1, y_2] \qquad (28)$$

Whenever the employer earns at least zero-profit from running the corporation, the interim participation constraints shall always hold, indeed, would this not be the case, the firm owner would be eager to pay some workers for them to run the firm. Indeed, would IPC_B not be satisfied, then WTP_B shows that the highest fee that the employer can require to the prospective partners would be negative. Hence, we are sure that as long as there is a change in the firm management, no partner would leave the firm at the interim stage.

As the employer makes take-it-or-leave-it offers, all the WTP_B constraints will bind in equilibrium , so the equity fee for any prospective partner in the segment analyzed is $\phi = s(y)\pi^P - \theta_B x$. By summing up all the fees, we derive the price at which the owner will sell the firm:

$$\int_{y_1}^{y_2} \phi(y)f(y)dy = \int_{y_1}^{y_2} s(y)\pi^P f(y)dy - \int_{y_1}^{y_2} \theta_B x f(y)dy$$

boiling down to the following maximization program

$$Max_{\{y_1, y_2\}} \quad \pi^P - \left[F(y_2) - F(y_1)\right]\theta_B x = \pi \qquad (29)$$

Namely, the employer ends up maximizing again the profit of the firm as a corporation, which is independent on the bounds of the y_P line. The owner of the firm is indifferent between selling the firm or keep running it as a corporation, for all y_1 and y_2 smaller than y^* as the surplus is unchanged.

2. _Let $y_1 \in [\hat{y}, y_2]$ and $y_2 \in [y_1, \bar{y})$_

In this case all prospective partners would be allocated on task A in a corporation. As in the previous case, all the salaried employees are allocated across tasks according to the same mechanism used in a profit maximizing corporation.

The task allocation process for partners, through

$$max \left\{ \int_{y_1}^{y_2} \beta y f(y) dy , \ \left[F(y_2) - F(y_1) \right] x \right\} \tag{30}$$

leads to a profit

$$\pi^P = F(\hat{y})(1 - \theta_B)x + \int_{\hat{y}}^{y_1} (1 - \theta_A)\beta y f(y) dy + \int_{y_2}^{\bar{y}} (1 - \theta_A)\beta y f(y) dy + \int_{y_1}^{y_2} \beta y f(y) dy. \tag{31}$$

The employer's maximization problem will be:

$$Max_{\{y_1, y_2\}} \ \int_{y_1}^{y_2} \phi(y) f(y) dy$$

subject to the willingness-to-pay conditions for all the prospective partners

$$\phi \leq s(y)\pi^P - \theta_A \beta y \ \forall \, y \in [y_1, y_2] \tag{WTP_A}$$

and the interim participation constraints delivering

$$s(y) \geq \frac{\theta_A \beta y}{\pi^P(y_1, y_2)} \ \forall \, y \in [y_1, y_2]. \tag{32}$$

As in the previous case, as long as the firm as a corporation generates at least zero profit, the interim participation constraints shall be satisfied if a change in the management of the firm takes place. Would this not be the case, the employer would pay a positive amount to the prospective partners in order to sell them the firm.

Since the firm owner has all the bargaining power, the WTP-constraints will all bind in equilibrium, hence the price at which the firm can be sold is

$$\int_{y_1}^{y_2} \phi(y) f(y) dy = \int_{y_1}^{y_2} s(y)\pi^P f(y) dy - \int_{y_1}^{y_2} \theta_A \beta y f(y) dy$$

yielding the objective function

$$\int_{y_1}^{y_2} \phi(y)f(y)dy = \pi^P - \int_{y_1}^{y_2} \theta_A \beta y f(y)dy = \pi. \tag{33}$$

Again, the employer is indifferent about who shall be made partner in the pool of workers with ability larger than $\hat{y}$. This result hinges on the fact that these workers would not generate any extra surplus through the profit of the firm as a partnership with respect to the case in which it is organized as a corporation. Namely, such a choice of partners would not generate a Pareto-improvement.

It is straightforward to see that the firm owner would be indifferent between selling the firm or running it as a corporation.

$\square$

Proof of Proposition 6

Proof. To prove this proposition, we consider three alternative cases:

1. <u>*Let $y_1 \in [y^*, y_2]$ and $y_2 \in [y_1, \hat{y})$*</u>

   When task allocation is chosen, all salaried employees will be allocated on the same task as in a corporation. Hence,partners are allocated to tasks by choosing

   $$max \left\{ \int_{y_1}^{y_2} \beta y f(y)dy, , \; \left[F(y_2) - F(y_1)\right]x \right\}.$$

   The crucial element here is that if workers with ability included in the segment $[y^*, \hat{y})$ do not need to be paid a fraction of their productivity for retention purposes, they just add their output to the profit of the partnership. We know from the first-best solution that, for the above mentioned segment of abilities, it will always be the case that

   $$\int_{y_1}^{y_2} \beta y f(y)dy > \left[F(y_2) - F(y_1)\right]x$$

   therefore, the profit of the partnership after task allocation will be

   $$\pi^P = \left[F(y_1) + F(\hat{y}) - F(y_2)\right](1 - \theta_B)x + \int_{y_1}^{y_2} \beta y f(y)dy + \int_{\hat{y}}^{\bar{y}} (1 - \theta_A)\beta y f(y)dy. \tag{34}$$

And the employer's maximization program is

$$Max_{\{y_1, y_2\}} \quad \int_{y_1}^{y_2} \phi(y) f(y) dy$$

subject to the willingness-to-pay constraints for prospective partners

$$\phi \leq s(y) \pi^P(y_1, y_2) - \theta_B x \quad \forall y \in [y_1, y_2] \quad (WTP_B)$$

their interim participation constraints yield

$$s(y) \geq \frac{\theta_A \beta y}{\pi^P(\cdot)} \quad \forall y \in [y_1, y_2]. \quad (35)$$

All the (WTP_B) constraints will bind in equilibrium. The employer's objective function shall be

$$\int_{y_1}^{y_2} \phi(y) f(y) dy = \int_{y_1}^{y_2} s(y) \pi^P(\cdot) f(y) dy - \int_{y_1}^{y_2} \theta_B x f(y) dy$$

boiling down to

$$\int_{y_1}^{y_2} \phi(y) f(y) dy = \pi^P - \big[F(y_2) - F(y_1)\big] \theta_B x \quad (36)$$

by further working out (36) the employer's objective function becomes

$$\int_{y_1}^{y_2} \phi(y) f(y) dy = \pi + \int_{y_1}^{y_2} \beta y f(y) dy - \big[F(y_2) - F(y_1)\big] x \quad (37)$$

So the (WTA) constraint for the firm owner will always be satisfied, as workers with ability in the considered segment will produce more when allocated to task A rather than to task B.

The first-order condition with respect to y_1 is

$$f(y_1) x - \beta y_1 f(y_1) = 0 \quad (38)$$

which is concave with respect to y_1, so that $y_1 = \frac{x}{\beta} = y^*$ is a maximum.
The first-order condition with respect to y_2 boils down to

$$\beta y_2 f(y_2) - f(y_2) x = 0 \quad (39)$$

in this case the second derivative is positive with respect to y_2, hence the objective

function is convex with respect to y_2 and the resulting equilibrium level $y_2 = \frac{x}{\beta} = y^* = y_1$ is a minimum. Since we are maximizing. Linearity of the problem, implies that we need to pick the maximum value achievable $\hat{y}$ for y_2 in order to maximize the objective function: whenever the employer picks partners in the segment of abilities $[y^*, \hat{y})$, in equilibrium she offers the partnership contract to all of them.

In equilibrium the profit of the partnership is

$$\pi^P = F(y^*)(1 - \theta_B)x + \int_{y^*}^{\hat{y}} \beta y f(y) dy + \int_{\hat{y}}^{\bar{y}} (1 - \theta_A)\beta y f(y) dy. \tag{40}$$

Organizing the firm as a partnership makes room for a an increase of surplus at stake as the profit of the firm is increased by

$$\Delta \pi = \pi^P - \pi = \int_{y^*}^{\hat{y}} \beta y f(y) dy - \big[F(\hat{y}) - F(y^*)\big](1 - \theta_B)x > 0 \tag{41}$$

We have a continuum of possible equilibria, depending on the value of $s(y)$. It is worth analyzing the case in which all the interim participation constraints bind, so that $s(y) = \frac{\theta_A \beta y}{\pi^P}$. In this case, the equilibrium fee required to each prospective partner is $\phi = \theta_A \beta y - \theta_B x$ so that the owner extracts all the extra surplus generated by the partnership. In this case, the first-order condition with respect to y_1 delivers

$$y_1 = \frac{\theta_B x}{\theta_A \beta} < y^*$$

but since y_1 is bounded between y^* and y_2, in equilibrium $y_1 = y^*$ consistent with the general solution we provided above. In this case, the owner manages to extract all the extra rent generated by efficient task allocation.

2. _Let $y_1 \in [y^*, \hat{y})$ and $y_2 \in [\hat{y}, \bar{y}]$_

In this case, during the task allocation process, partners take into account the following:

$$max \left\{ \int_{y_1}^{\hat{y}} \beta y f(y) dy , \big[F(\hat{y}) - F(y_1)\big]x \right\}+$$

and

$$max \left\{ \int_{\hat{y}}^{y_2} \beta y f(y) dy , \big[F(y_2) - F(\hat{y})\big]x \right\}. \tag{42}$$

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Given the segment of abilities that we are considering, it is better off if all partners are allocated on task A. The profit thereby generated is

$$\pi^P = F(y_1)(1 - \theta_B)x + \int_{y_1}^{y_2} \beta y f(y) dy + \int_{y_2}^{\bar{y}} (1 - \theta_A)\beta y f(y) dy \qquad (43)$$

The employer's maximization program will be

$$Max_{\{y_1, y_2\}} \quad \int_{y_1}^{y_2} \phi(y) f(y) dy$$

subject to the willingness-to-pay constraints for prospective partners, which differ depending on their abilities:

$$\phi(y) \leq s(y)\pi^P(\cdot) - \theta_B x \quad \forall\, y \in [y^*, \hat{y}) \qquad (WTP_B)$$

and

$$\phi(y) \leq s(y)\pi^P(\cdot) - \theta_A \beta y \quad \forall\, y \in [\hat{y}, \bar{y}]. \qquad (WTP_A)$$

The interim participation constraints are instead equal for all prospective partners and deliver

$$s(y) \geq \frac{\theta_A \beta y}{\pi^P(\cdot)} \quad \forall y \in [y_1, y_2]. \qquad (44)$$

As all the willingness-to-pay constraints will bind in equilibrium, the objective function for the employer will be

$$\int_{y_1}^{y_2} \phi(y) f(y) dy = \pi^P - \big[F(\hat{y}) - F(y_1)\big]\theta_B x - \int_{\hat{y}}^{y_2} \beta y f(y) dy \qquad (45)$$

the first-order condition with respect to y_1 for this problem is

$$f(y_1)(1 - \theta_B)x - \beta y_1 f(y_1) + f(y_1)\theta_B x = 0 \qquad (46)$$

yielding the maximizer $y_1 = \frac{x}{\beta} = y^*$.

The first-order condition with respect to y_2 is

$$\beta y_2 f(y_2) - (1 - \theta_A)\beta y_2 f(y_2) - \beta y_2 f(y_2) = 0 \qquad (47)$$

which implies indifference for the employer.

The firm owner just needs to make all workers with ability on the segment $[y^*, \hat{y})$ partners and then she is indifferent on the same choice among the most productive workers. This happens because the increase in surplus is deriving from the previously inefficiently allocated workers, whereas workers who are efficiently allocated in a corporation do not increase the surplus at stake in a partnership.

In this case the increase in the realized profit with respect to the case in which the firm is organized as a corporation will be

$$\Delta\pi = \int_{y^*}^{\hat{y}} \beta y f(y) dy + \int_{\hat{y}}^{\bar{y}} \theta_A \beta y f(y) dy - \left[F(\hat{y}) - F(y^*)\right](1 - \theta_B)x > 0 \qquad (48)$$

It is straightforward to see that the (WTA) for the employer is definitely satisfied in this scenario.

In this case, if the employer offers stakes $s(y)$ such that the interim participation constraints bind, she charges strictly positive fees only on workers with ability $y \in [y^*, \hat{y}]$.

3. *Let $y_1 \in [\underline{y}, y^*)$ and $y_2 \in [y^*, \hat{y})$*

In this case, when choosing upon task allocation, partners select:

$$max \left\{ \int_{y^*}^{y_2} \beta y f(y) dy , \ \left[F(y_2) - F(y^*)\right]x \right\}+$$

and

$$max \left\{ \int_{y_1}^{y^*} \beta y f(y) dy , \ \left[F(y^*) - F(y_1)\right]x \right\}+$$

Given the segment of abilities that we are considering, the resulting profit for the partnership is

$$\pi^P = \left[F(y_1) + F(\hat{y}) - F(y_2)\right](1 - \theta_B)x + \int_{y^*}^{y_2} \beta y f(y) dy+$$

$$+[F(y^*) - F(y_1)]x + \int_{\hat{y}}^{\bar{y}} (1 - \theta_A)\beta y f(y) dy \qquad (49)$$

The employer's maximization problem is

$$Max_{\{y_1, y_2\}} \quad \int_{y_1}^{y_2} \phi(y) f(y) dy$$

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subject to the willingness-to-pay constraints for all partners

$$\phi \le s(y)\pi^P(\cdot) - \theta_B x \quad \forall\, y \in [y_1\,,\, y_2] \qquad (WTP_B)$$

and the interim participation constraints yield

$$s(y) \ge \frac{\theta_B x}{\pi^P(\cdot)} \quad \forall\, y \in [y_1\,,\, y^*) \qquad (50)$$

and

$$s(y) \ge \frac{\theta_A \beta y}{\pi^P(\cdot)} \quad \forall\, y \in [y^*\,,\, y_2] \qquad (51)$$

Given that the (WTP)-constraints will bind in equilibrium, summing them up delivers the objective function for the firm owner:

$$\pi^P - \big[F(y_2) - F(y_1)\big]\theta_B x$$

The first-order condition with respect to y_1 is

$$f(y_1)(1 - \theta_B)x - f(y_1)x + f(y_1)\theta_B x = 0 \qquad (52)$$

so that the owner is indifferent on where to set the lower bound for the segment y_P in the considered segment of abilities.

The first-order condition with respect to y_2 is

$$\beta y_2 f(y_2) - f(y_2)(1 - \theta_B)x - f(y_2)\theta_B x = 0 \qquad (53)$$

so we are left with the stationary value $y_2 = \frac{x}{\beta} = y^*$ which is a minimum, given that the second derivative with respect to y_2 is positive. For the linearity of the problem, the owner selects $y_2 = \hat{y}$ as a maximizer.

So the employer is indifferent on how many workers would be made partners in the interval of abilities below y^*, but she wants to make all workers with ability between y^* and $\hat{y}$ partners.

Such a result is in line with the one we derived in the previous case.

The increase in the profit realized is

$$\Delta\pi = \int_{y^*}^{\hat{y}} \beta y f(y)dy + F(\hat{y})\theta_B x - \big[F(\hat{y}) - F(y^*)\big]x > 0 \qquad (54)$$

which ensures us that the employer will be willing to sell the firm (i.e the WTA-constraint is satisfied).

Even in this case, if the interim participation constraints bind in equilibrium, the owner charges strictly positive fees only on workers with ability $y \in [y^*, \hat{y}]$.

$\square$

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