

# Talent Discovery, Layoff Risk and Unemployment Insurance\*

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## Abstract

In talent-intensive jobs, workers' performance reveals their quality. This enhances productivity and wages, but also increases layoff risk. If workers cannot resign from their jobs, firms can insure them via severance pay. If instead workers can resign, private insurance cannot be provided, and more risk-averse workers will choose less informative jobs. This lowers expected productivity and wages. Public unemployment insurance corrects this inefficiency, enhancing employment in talent-sensitive industries and investment in education by employees. The prediction that the generosity of unemployment insurance is positively correlated with the share of workers in talent-sensitive industries is consistent with international and U.S. evidence.

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# 1 Introduction

Discovering workers' talent is increasingly important in the knowledge economy, whose ability to innovate – e.g., by introducing a new app or investment strategy – crucially depends on the quality of employees' human capital (Kaplan and Rauh, 2013). The hallmark of talent-intensive industries is that their technology does not rely on the ability to perform routine tasks efficiently, but rather on employees' qualities such as imagination and intelligence, as well as their education. In this setting, corporate success often hinges on identifying the most talented workers and assigning them to the task they are best at.

If the labor market is competitive, talented workers share in the productivity gains they generate, in the form of high salaries or bonuses. However, *ex ante* talent discovery is a source of risk for workers, if they are not fully aware of their own quality: *ex post*, they may turn out to be worse than expected, and if so they may be laid off and forced to seek a more suitable job. Such risk imposes considerable welfare losses on workers (Low, Meghir and Pistaferri, 2010): laid off workers experience earnings losses, not only while unemployed but also upon reentry (Jacobson, LaLonde and Sullivan, 1993), and typically cut back on their expenditures (Gruber, 1997; Browning and Crossley, 2001).

In principle, this risk is privately insurable: firms might commit to give generous severance pay to laid-off employees, and thus compensate them upon being found untalented. But firms can provide such insurance only if the labor market is not fully competitive, in that workers are not free to switch to other employers once their talent is discovered. If they are, firms cannot provide severance payments to low-talent employees: this would require cross-subsidizing them at the expense of high-talent ones, who would react to such a scheme by switching to a competing employer (Harris and Holmström, 1982).

Hence, in the presence of *ex-post* competition for talent, workers are left to bear the layoff risk arising from the talent discovery process, absent any public unemployment insurance. We show that in this situation, risk-averse workers have the incentive to mitigate or eliminate such risk by choosing to work for firms and industries whose projects convey little information about employees' quality. These firms and industries naturally feature less efficient talent allocation than those where employers can learn more about their employees' quality. Therefore, they also feature

no layoff risk, but pay lower average wages than the latter. As a result, industries with talent-sensitive technologies (where on-the-job performance reveals a worker's ability) will find it difficult to hire workers and develop: only the least risk-averse workers – if any – will want to work in such industries.

As pointed out by Hirshleifer (1971), information revelation brings benefits in terms of productive efficiency, but also has costs due to forgone insurance opportunities. In this paper, we show that this destruction of insurance opportunities can impair the development of talent-sensitive industries or technologies. By the same token, this market failure highlights a hitherto neglected efficiency rationale for public unemployment insurance (UI), whereby society – rather than firms – supports laid-off workers, funding their benefits with payroll taxes on employees who retain their jobs. Being buffered against layoff risk, even risk-averse workers will prefer jobs in talent-sensitive industries, which pay high wages. The prediction is that such industries should be able to flourish in one of two alternative settings: either in economies with little labor market competition (because of employee loyalty, switching costs or regulatory frictions) or in economies where competition for workers' talent is associated with a generous public safety net against layoff risk.

Compared with public UI, trying to protect workers against job loss by limiting firms' ability to fire them is socially inefficient. Employment protection legislation (EPL) effectively forces firms to keep also low-quality workers on board: this will induce firms in more talent-intensive industries to refrain from hiring in the first place, in order to break even. This is because, due to limited liability, workers can share in the firm's surplus but are protected from the losses that they generate. Thus EPL leads to an inefficiently low level of learning about workers' talent, and results in lower average wages, not just reduced layoff risk. Hence, in our framework it is dominated by UI.

We also investigate the impact of talent discovery and layoff risk on workers' accumulation of human capital. To this purpose, we expand the baseline model to allow for an initial stage where workers can invest in education, and find that the introduction of UI spurs such investment by workers, as it decreases the risk of the return to human capital. Insofar as it encourages employment in talent-sensitive industries, it also increases the total number of workers who acquire education. Hence, UI acts both on the intensive and the extensive margin of education acquisition – a channel that in turn compounds the impact of UI on talent discovery.

Our model produces several testable predictions. One of these is a positive correlation between the generosity of UI and the share of workers employed in talent-sensitive firms. We show that such correlation is broadly consistent both with OECD country-level data and with U.S. state-level data from the Bureau of Labor Statistics (BLS), using in both cases the income replacement rate (i.e. the ratio between unemployment benefits and the last wage) as a measure of the generosity of the UI system.

The structure of the paper is as follows. Section 2 sets our contribution against the backdrop of the relevant literature. Section 3 lays out the model's assumptions. Section 4 derives the evolution of beliefs about employees' talent and firms' resulting optimal layoff rule. Sections 5.1 and 5.2 characterize equilibrium in the absence and in the presence of labor market competition, and compare them. Section 6 shows how public UI affects the equilibrium. Section 7 investigates the effects of employment protection legislation, and compares them with those of UI. Section 8 extends the model to a setting where workers can invest in education before entering the labor market. Section 9 summarizes the empirical predictions of the model and provides evidence for some of them. Section 10 concludes.

## 2 Related Literature

This paper lies at the intersection of two strands of research: the literature on learning about the quality of workers, and that on the insurance that they receive by employers and public institutions. What naturally joins these two strands of research is the simple fact that learning about one's talent is a source of risk.

Learning about talent can occur either within the firm (from one's work performance with a given employer) or in the market (from sequential matching with different employers). In our model, learning occurs within the firm, as in career concerns models dating back to Fama (1980) and Holmström (1999). Since however such learning spills over to other potential employers, as in Harris and Holmström (1982) competition prevents firms from being able to insure workers against talent uncertainty. In our setting, the non-insurability of human capital risk leads not only to inefficient risk-sharing within firms, but also to low average productivity: efficient talent discovery within firms takes place only if employees are insured against the implied risk, and this cannot occur in a competitive labor market, as in Acharya,

Pagano and Volpin (2016). This result differs sharply from that by Jovanovic (1979) and other search models of the labor market, where learning about workers' quality occurs in the marketplace: in those models, mobility allows employees and firms to attain efficient matches.

In our setting, workers bear the cost of talent discovery in the form of layoff risk. In reality, also firms bear costs in such a learning process, since experimenting with novices requires forgoing employment of senior employees with a proven track record. Terviö (2009) shows that, in a search model with uncertain worker quality, this implicit screening cost deters efficient talent discovery: firms pay inefficiently high wages to mediocre incumbent workers rather than testing promising novices. Also in Terviö's model labor market competition leads to inefficiently low talent discovery, but in our framework this inefficiency arises from uninsurable layoff risk rather than screening costs.

Far from being inessential, however, this feature of our model is at the root of its main prediction: that public provision of UI can restore efficiency in talent discovery even in the presence of labor market competition. Interestingly, a substitutability relationship between firm-level insurance provision and public UI is documented empirically by Ellul, Pagano and Schivardi (2017).

By highlighting that UI enhances productive efficiency, our paper contributes to the literature on the costs and benefits of UI. This literature has recognized that UI stabilizes workers' consumption (Gruber, 1997) and avoids mortgage defaults by the unemployed (Hsu, Matsa and Meltzer, 2017), but also stressed its disincentive effects on labor search by the unemployed, and the resulting increase in the duration of unemployment spells (Moffitt and Nicholson, 1982; Meyer, 1990, and Katz and Meyer, 1990).<sup>1</sup> But other papers show that UI also allows workers to search longer so as to identify better matches, thus raising aggregate productivity (Diamond 1981; Acemoglu 1997; Marimon and Zilibotti 1999). Indeed, Nekoei and Weber (2017) document empirically that UI improves the quality of the firms where the unemployed find jobs and raises their wages. While in these papers UI raises productivity by subsidizing talent discovery in the marketplace, in our setting it acts as a subsidy to

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<sup>1</sup>Moffitt and Nicholson (1982) find that a 26-week extension of the benefit duration lengthens the average unemployment spell by about 2.5 weeks. Meyer (1990) shows that the probability of leaving unemployment is negatively affected by the level of benefits, and increases just before the entitlement period expires.

talent discovery within the firm.

The only search-theoretic model of UI with risk-averse workers is Acemoglu and Shimer (1999, 2000). In their general equilibrium setting, if firms choose a labor-intensive technology, they create many job vacancies and can fill them offering low wages: risk-averse workers will accept such low wages because they have a high probability of filling a vacancy, and thus avoiding unemployment. If instead firms choose a capital-intensive technology, they create few vacancies: even if they offer high wages, few workers will bid for them for fear that the job will be filled by a competing applicant. This creates vacancy risk for firms, which will deter them from opting for such a technology. UI changes this result, as it makes even risk-averse workers willing to bear the unemployment risk associated with a capital-intensive technology.

Hence, also in Acemoglu and Shimer UI implies higher productivity of employed workers, as well as higher level and risk of unemployment, as in our model. But the two models differ in two important respects. First, in ours unemployment risk arises from the danger of being laid off, not from the risk of the job being filled by a competing applicant. Second, in our model the productivity-enhancing effect of UI comes from better talent discovery, whereas in Acemoglu and Shimer it stems from firms choosing a more capital intensive technology. This translates into different predictions about the effects of UI: according to our model, UI reallocates employment towards talent-intensive industries, while according to Acemoglu and Shimer UI induces all firms to adopt a more capital-intensive technology.

### 3 The Model

We study a two-period model with Bayesian learning about workers' talent. The economy is populated by competitive firms owned by risk-neutral shareholders and a continuum of measure  $N$  of workers. Each worker can operate at most one project. Each project lasts for two periods and in both it must be operated by the same worker: if the worker leaves the firm at the end of the first period, the project is terminated prematurely.

Firms belong to one of two industries,  $j = \{1, 2\}$ , whose respective technologies feature a specific sensitivity to employees' talent  $\lambda_j \in [0, 1]$ , as will be explained

below in greater detail. Industry  $j$  is populated by  $F_j$  firms, so that  $F = F_1 + F_2$  is the total number of firms in the economy. Each industry  $j$  is endowed with a continuum of measure  $G_j > N$  of homogeneous projects. As a result, in each industry there is at least one project per worker: workers – not projects – are the scarce factor of production. The model easily generalizes to any number of industries.

Workers are risk-averse: their instantaneous utility  $u(w_t)$  is increasing and concave in their time- $t$  wage  $w_t$ . Furthermore, they have no time-discounting, no initial wealth, and no access to financial markets.<sup>2</sup> Hence, their lifetime utility is  $U = u(w_1) + u(w_2)$ .

### 3.1 Types and Productivity of Workers

Workers differ in their talent: worker  $i$ 's quality is  $q_i = \{G, B\}$  (either “good” or “bad”) and initially it is unknown to everyone in the economy, including workers themselves. The common prior belief about workers’ quality is  $Pr(q = G) = p \in [0, 1]$ . The revenue produced by a worker in each period is observable by all firms, so that also Bayesian posterior beliefs about worker’s quality are common.

All workers have a reservation wage  $w_0 > 0$  per period, whose utility is standardized to zero, for simplicity:  $u(w_0) = 0$ . In each of the two periods of its life, a project produces revenue  $y_t$ . The revenue  $y_t$  can take either a high value  $\bar{y} > w_0$  or a low value  $\bar{y} - c$ , which does not cover the worker’s reservation wage  $w_0$ , leading to a negative surplus:  $\bar{y} - c - w_0 < 0$ . The revenue produced by a project depends on a combination of technological risk and talent of the worker in charge of it, as illustrated by Figure 1. With probability  $1 - \lambda$ , the payoff depends only on technological risk: the project’s revenue is  $\bar{y}$  with probability  $p$  and  $\bar{y} - c$  with probability  $1 - p$ . Instead, with probability  $\lambda$  the project’s revenue reflects the worker’s talent: if she is good, the project delivers revenue  $\bar{y}$ ; if she is bad, it yields  $\bar{y} - c$ .

Hence,  $\lambda$  can be seen as the project’s sensitivity to workers’ talent: the higher  $\lambda$ , the lower the “noise” in the project’s payoff, and the sharper the “signal” that it conveys about the talent of the project’s executor.<sup>3</sup> For example, in the extreme

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<sup>2</sup>This assumption allows us to focus on the firm and the labor market as the only sources of insurance against human capital risk. Otherwise, laid-off workers would be able to buffer their consumption by borrowing or decumulating their wealth.

<sup>3</sup>By the same token, we shall see that  $\lambda$  also determines workers’ returns to talent.

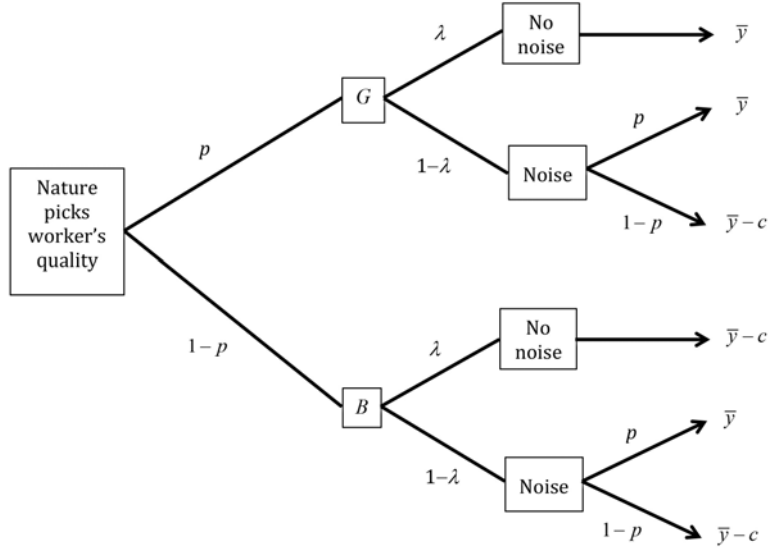


Figure 1: Project payoffs

case where  $\lambda = 1$ , the project always succeeds if executed by a good worker and fails otherwise, and therefore it is perfectly informative about the worker's talent. In the polar opposite case  $\lambda = 0$ , the project succeeds with the unconditional probability  $p$ , and therefore is totally uninformative about its executor's talent.

Notice that  $\lambda$  does not affect a project's unconditional probability of success and thus its expected revenue,  $\bar{y} - (1 - p)c$ , as well as its variance  $p(1 - p)c^2$ . As we shall see, in this model a project's sensitivity to talent,  $\lambda$ , raises its expected return and its risk only because it sharpens the firm's learning and thus increases its propensity to liquidate bad-performing projects before completion: the relationship between  $\lambda$  and payoff moments is driven by the firm's behavioral response, not by technology.

To make the problem interesting, we impose the following parameter restrictions:

$$\bar{y} - (1 - p)c \geq w_0 > \bar{y} - c > 0. \quad (1)$$

The left-hand-side inequality implies that initially it is efficient to hire any worker, since her unconditional expected revenue is positive. The right-hand-side inequality implies that the productivity of a bad worker is low enough that the employer does



not wish to retain her. Condition (1) can be rewritten as

$$p \geq \frac{c - \bar{y} + w_0}{c} > 0, \quad (2)$$

so that in what follows we restrict our attention to the interval  $p \in [1 - \frac{\bar{y} - w_0}{c}, 1]$ .

### 3.2 Labor Contracts

Firms are assumed to compete for workers when initially hiring them. After the first production period, workers can be fired by their employer or not. Regarding workers' mobility, we consider two labor market regimes: a non-competitive regime, where workers cannot resign from their current employer, because of loyalty or market frictions (such as search costs or regulation), and a competitive one, where workers are free to resign and switch to a new employer. Otherwise stated, in the first regime workers can commit to stay with their initial employer, whereas in the second they have no such commitment ability.

Instead, firms are assumed to be able to commit to long-term contingent contracts: when hiring workers, they offer wage contracts for both production periods,  $\{w_t\}_{t=1}^2$ , conditional on retaining the employee in the second period. In other words, workers' performance in each period is assumed to be not only observable but also verifiable.<sup>4</sup> Firms condition the wage to be paid in the first production period on their prior belief  $\theta_0 = p$  about workers' quality, and the wage to be paid in the second production period on the revenue  $y_1$  previously generated by the worker, and therefore on their posterior belief,  $\theta_1 = \Pr(q = G|y_1)$ . Hence, the second-period wage is effectively a function of their belief,  $w_2(\theta_1)$ . Wages can never be negative, as employees are protected by limited liability.

Once a worker is hired and assigned to a project, she generates revenue  $y_1$ . Based on this initial payoff, the firm decides whether to keep the worker running the project or not: if the expected "continuation revenue" produced by the worker, denoted by  $y_2$ , is negative, then the firm will want to liquidate the project and fire the worker. This decision is captured by an indicator variable  $\gamma = 1$  if the worker is retained within the firm and her project is continued, and  $\gamma = 0$  if she is laid off and the

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<sup>4</sup>Failing this, firms would not be able to offer any insurance, even in the non-competitive regime: see footnote 5 below.

project is liquidated. Once an employee's project is liquidated, the firm is better off firing her and producing nothing rather than keeping her idle and paying her reservation wage  $w_0$ .

Recalling that the firm's revenue at time  $t$  equals  $y_t$ , its profit equals  $y_t - w_t$ . Assuming no discounting, the firm maximizes expected profits:

$$\mathbb{E}_0 [y_1 - w_1 + \gamma(y_2 - w_2)], \quad (3)$$

and workers maximize expected utility as of the beginning of the game:

$$\mathbb{E}_0 [u(w_1) + \gamma u(w_2)], \quad (4)$$

with  $u(\cdot)$  increasing and concave.

### 3.3 Time Line

The time line of the model is composed of four stages, as shown in Figure 2.

At  $t = 0$ , firms compete for workers by offering two-period contingent wage contracts  $\{w_t\}_{t=1}^2$ , and workers choose which firm to work for.

At  $t = 1$ , each worker initiates a project in the chosen firm, produces revenue  $y_1$ , and earns wage  $w_1$ .

At  $t = 2$ , beliefs about each employee's quality are updated, and based on such beliefs firms decide whether to retain or fire workers; even if retained, workers can resign if the labor market features ex post competition.

At  $t = 3$ , retained employees continue to operate the project, produce revenue  $y_2$  and receive wage  $w_2$ ; otherwise, their project is liquidated and they earn the reservation wage  $w_0$  absent any insurance, a severance pay if pledged by the firm, or a unemployment benefit in the presence of public insurance.

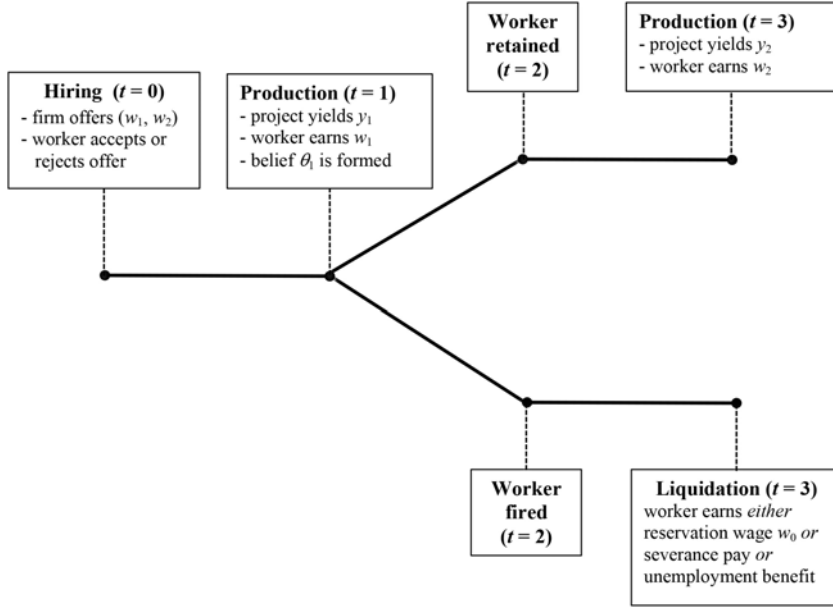


Figure 2: Time line

## 4 Profits, Beliefs and Layoffs

The expected revenue that projects produce at  $t = 1$  is the same for all firms, irrespective of  $\lambda$ :

$$\mathbb{E}_0(y_1) = \bar{y} - (1 - p)c. \quad (5)$$

However, the actual value of the revenue  $y_1$  will generally differ depending on the employee operating the project. Based on its realization, the belief about the quality of the employee in charge of the project is updated from the prior  $\theta_0 = p$  to the posterior  $\theta_1$ , which can take one of two values:  $\Pr(q = G|y_1 = \bar{y}) \equiv \theta_H$  for workers that generated a profit at  $t = 1$  or  $\Pr(q = G|y_1 = \bar{y} - c) \equiv \theta_L$  for those that produced a loss.

This Bayesian updating depends on the informativeness  $\lambda$  of the firm's technology:

$$\theta_H = \lambda + (1 - \lambda)p \geq p \quad (6)$$

and

$$\theta_L = (1 - \lambda)p \leq p. \quad (7)$$

Hence, the expected second-period revenue of the project upon good performance,

$y_{2H} \equiv \mathbb{E}_1(y_2|y_1 = \bar{y})$  is

$$y_{2H} = \bar{y} - (1 - \theta_H(\lambda))c, \quad (8)$$

while the corresponding expression upon bad performance,  $y_{2L} \equiv \mathbb{E}_1(y_2|y_1 = \bar{y} - c)$ , is

$$y_{2L} = \bar{y} - (1 - \theta_L(\lambda))c. \quad (9)$$

These two expressions bracket the first-period average revenue:  $y_{2H} \geq \mathbb{E}_0(y_1) \geq y_{2L}$ ,  $\forall \lambda$ : the revenue from the project is expected to increase upon good performance, and to drop upon bad.

Based on such updated beliefs, firms will choose different optimal firing policies depending on the informativeness of their technology,  $\lambda$ :

**Lemma 1** *If the revenue is  $y_1 = \bar{y}$ , the worker is retained and the project is continued, irrespective of the firm's talent-sensitivity  $\lambda$ . If  $y_1 = \bar{y} - c$ , the worker is laid off only by firms with talent-sensitivity  $\lambda \geq \hat{\lambda} = \frac{\bar{y} - (1-p)c - w_0}{pc}$  and the corresponding project is liquidated.*

This lemma, proved in the Appendix (as all subsequent results), is illustrated by Figure 2. The informativeness of the firm's technology,  $\lambda$ , ranges between 0 and 1. If  $\lambda$  exceeds the threshold value  $\hat{\lambda}$ , it becomes optimal for the firm to fire low-performing workers. Such policy raises the firm's productive efficiency, as measured by its ex-ante expected surplus  $\mathbb{E}_0(y_2) - w_0$ , because, when  $\lambda$  exceeds  $\hat{\lambda}$ , the firm's screening ability is sufficiently high to determine the liquidation of unpromising projects, and retain only those that are likely to be profitable, and thus able to pay a higher average wage. Such layoff policy is equivalent to an "up-or-out" mechanism, by which employees that prove successful at  $t = 1$  receive a wage increase and the others are laid off. Indeed, "up-or-out" contracts are typical of talent-sensitive industries, such as academia, professional services and high-tech.

However, this gain in productive efficiency is obtained at the cost of unemployment risk, as workers that happen to perform poorly at  $t = 1$  are fired. This can be seen in Figure 2, where the  $y_{2L} - w_0$  line flattens to the right of  $\lambda = \hat{\lambda}$ : highly talent-sensitive firms produce nothing when the project's expected surplus is negative, conditional on  $y_1$ , as they would make losses even if they paid workers just their reservation wage  $w_0$ . By firing workers upon bad performance at  $t = 1$ , such firms

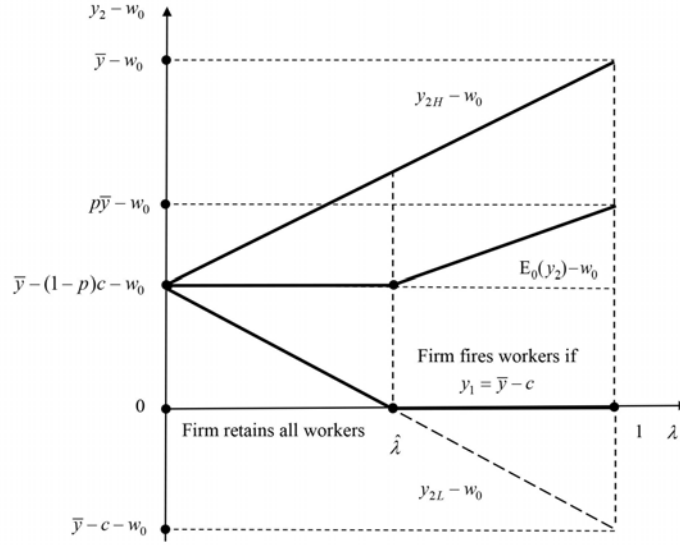


Figure 3: Informativeness of technology and firing policy

raise their unconditional expected revenue at  $t = 2$ :

$$\mathbb{E}_0(y_2) = \begin{cases} py_{2H}(\lambda) + (1-p)y_{2L}(\lambda) = \bar{y} - (1-p)c = \mathbb{E}_0(y_1) & \text{if } \lambda < \hat{\lambda}, \\ py_{2H} = p[\bar{y} - (1-p)(1-\lambda)c] > \mathbb{E}_0(y_1) & \text{if } \lambda \geq \hat{\lambda}, \end{cases} \quad (10)$$

where  $\theta_H$  is replaced by expression (6) in the expressions (8) and (9) for  $y_{2H}$  and  $y_{2L}$ .

## 5 Labor Market Equilibrium

We now turn to the analysis of the labor market equilibrium. First, we consider the benchmark case of the noncompetitive regime, where workers cannot be poached by other firms at  $t = 2$ , after projects have generated their first payoff. Second, we study the regime where such poaching is possible, so that there is competition for workers also at  $t = 2$ . Finally, we contrast the allocation of risk and workers across firms in these two labor market regimes.

## 5.1 Benchmark: Noncompetitive Labor Market

We start with a labor market regime without ex-post competition for workers, because – for instance – prohibitive switching costs or regulatory constraints prevent workers from resigning after  $t = 1$ . In this regime, when firms bid for workers' services at  $t = 0$ , they commit to pay workers a lifetime wage equal to the revenue that they are expected to generate during their whole career: ex-ante competition will lead each firm to bid wages up to the point where this is the case, so that total expected profits (3) are zero.

As a consequence, in this regime workers' lifetime compensation does not depend on the first-period payoff of their project: they are perfectly insured against human capital risk. Notice that firms with highly informative technology (i.e. such that  $\lambda \geq \hat{\lambda}$ ) will still optimally use the information about their employees' quality inferred from their first-period performance and terminate the projects that make losses in the first period. But even these firms will pay the same lifetime compensation to the workers in charge of loss-making projects as to those in charge of profit-making ones: upon liquidation of their projects, the former will receive a severance pay that equals the salary paid to the latter – or alternatively are kept idle within the firm and paid the same salary as other workers.

Formally, the lifetime compensation that each employee of the same firm receives is

$$w_1 + w_2 = \mathbb{E}_0(y_1) + \mathbb{E}_0(y_2) = \begin{cases} 2\mathbb{E}_0(y_1) & \text{if } \lambda < \hat{\lambda}, \\ \mathbb{E}_0(y_1) + py_{2H} & \text{if } \lambda \geq \hat{\lambda}, \end{cases} \quad (11)$$

drawing on expressions (5) and (10) above.

Notice that in firms where  $\lambda \geq \hat{\lambda}$  employees earn a strictly larger amount than in those where  $\lambda < \hat{\lambda}$ , since  $py_{2H} > \mathbb{E}_0(y_1)$ . Moreover, since in these firms the expected second-period payoff  $py_{2H}$  is increasing in  $\lambda$ , the employees of the most informative firms will receive the highest possible compensation, without bearing any risk. Therefore, in this labor market regime the firms with the highest value of  $\lambda$  – namely, those with the most informative technology and the highest expected productivity – will be able to attract all the employees, while other firms will not be able to operate. This is summarized in the following:

**Proposition 1** *If the labor market is noncompetitive at  $t = 2$ , efficiency in produc-*

tion and risk sharing is attained in equilibrium, as the most talent-sensitive firms employ the entire workforce, and insure their employees fully.

As we shall see in Section 5.2, this result breaks down if the labor market is competitive at  $t = 2$ .<sup>5</sup>

## 5.2 Competitive Labor Market

If the labor market is competitive both at  $t = 0$  and  $t = 2$ , the workers whose projects are profitable at  $t = 1$  can be poached by other firms at  $t = 2$ , who can attract them by offering a wage higher than the unconditional expectation of their revenue (i.e. the highest wage consistent with zero profits and full insurance by their current employer). Hence, their former employer would be left just with overpaid low-quality workers, as in Harris and Holmström (1982) and Acharya, Pagano and Volpin (2016).

In this labor market regime, competition allows workers to extract all the surplus that they generate *in each period*, so that the wage at time  $t$  is

$$w_t = \max\{\mathbb{E}_{t-1}(y_t), 0\}, \quad (12)$$

which guarantees also that the worker's participation constraints are satisfied: the expected wage of an employee in a firm with  $\lambda < \hat{\lambda}$  is  $\mathbb{E}_{t-1}(y_t) > w_0$  for both periods  $t = 1$  and  $t = 2$  (as shown by Lemma 1) and therefore her expected utility is

$$\mathbb{E}_0(U) = u(\bar{y} - (1-p)c) + pu(y_{2H}) + (1-p)u(y_{2L}). \quad (13)$$

Instead, employees in a firm with  $\lambda \geq \hat{\lambda}$  have unconditional expected utility

$$\mathbb{E}_0(U) = u(\bar{y} - (1-p)c) + pu(y_{2H}), \quad (14)$$

as in these firms a worker producing  $y_1 = \bar{y} - c$  yields a conditional expected revenue  $y_{2L} < w_0$  and is laid off at  $t = 2$ .

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<sup>5</sup>It is worth noticing that for this outcome to obtain in equilibrium, it is necessary not only that workers commit not to resign from their job, but also that firms commit to the payments envisaged in their contracts, conditional on workers' performance. Thus, commitment is required on both sides: otherwise, firms could hold up their employees and earn higher profits by paying less than the agreed wages. Clearly, this would prevent efficient risk-sharing.

We now analyze how workers choose among employment opportunities. The most interesting case is that in which workers can choose between “safe” jobs offered by firms with talent intensity  $\lambda_S < \hat{\lambda}$ , and “risky” jobs in firms with talent intensity  $\lambda_R \geq \hat{\lambda}$ . In this case, workers will self-select into the two sets of firms depending on their risk aversion, the more risk-averse opting for safe jobs, and the less risk-averse for risky ones:

**Proposition 2** *Workers prefer offers from firms with  $\lambda_S < \hat{\lambda}$  over those from firms with  $\lambda_R \geq \hat{\lambda}$  if and only if their risk aversion exceeds  $\hat{\rho} \equiv \frac{[1-(1-\lambda_R)p]c-\bar{y}+w_0}{y_{2L}^S-w_0} \geq 0$ , which is increasing in  $\lambda_R$ .*

The proof of this proposition relies on the fact that the expected benefit of a safe job compared to a risky one increases with workers’ risk aversion. Hence, workers with risk aversion below the threshold  $\hat{\rho}$  are willing to give up job security in order to earn higher expected wages, while the opposite applies to more prudent ones. The threshold risk aversion  $\hat{\rho}$  is monotonically increasing from 0 to a maximal value as the talent-sensitivity  $\lambda_R$  of the risky industry rises from  $\hat{\lambda}$  to 1: intuitively, as the informativeness of technology increases, jobs become more productive, hence pay higher wages, which induces even more risk-averse workers to accept the implied higher layoff risk. This prediction is far from obvious, because a more informative technology raises both risk and expected return to human capital; however, the implied increase in expected return dominates the increase in risk, resulting in a larger number of workers being attracted to the talent-sensitive industry.

If instead all the available jobs are either of the safe or of the risky variety, workers’ choices polarize:

**Proposition 3** (i) *If all firms have  $\lambda < \hat{\lambda}$ , risk-averse workers choose to work for those with the lowest  $\lambda$ .*

(ii) *If all firms have  $\lambda \geq \hat{\lambda}$ , all workers choose to work for those with the highest  $\lambda$ , irrespective of their risk attitudes.*

The intuition for the first part of the proposition is that firms with talent-intensity below  $\hat{\lambda}$  effectively offer wage lotteries that are mean-preserving spreads of those offered by firms with  $\lambda = 0$ , whose technology is completely insensitive to talent. Since all the wage lotteries at  $t = 2$  have the same unconditional expected payoff,



but variance that increases in  $\lambda$ , at  $t = 0$  risk-averse workers will prefer the least informative firm (i.e. choose the lowest-risk lottery in the sense of Rothschild and Stiglitz, 1970). If instead only firms with high talent-sensitivity are present on the market, workers cannot insure themselves against layoff risk by picking a safer but less lucrative job. Absent the possibility to limit downside risk, workers will want to maximize upside risk, and thus work for the most informative firm on the market, recalling that the expected wage is linearly increasing in  $\lambda$ .

Taken together, the results of the last two propositions enable us to address the more general case in which talent-sensitivity  $\lambda$  of the firms potentially active in the economy is distributed on a continuum that includes  $\hat{\lambda}$ . In this more general case, the model predicts that relatively risk-averse employees (those with  $\rho \geq \hat{\rho}$ ) will only accept offers from firms featuring the lowest level of talent-sensitivity; conversely, employees with risk-aversion  $\rho < \hat{\rho}$  will accept labor contracts only from the most talent-sensitive firms in the economy.

### 5.3 Inefficiency of Labor Market Competition

Section 5.2 shows that labor market competition at  $t = 2$  prevents firms from insuring their employees against layoff risk, and thus induces the more risk-averse workers to insure themselves by choosing less talent-sensitive jobs. In contrast, in the non-competitive labor market analyzed in Section 5.1, where workers cannot resign from their employer at  $t = 2$ , firms offer severance payments that implement efficient risk-sharing, so that all workers accept to be employed in the most talent-sensitive firms.

Hence, labor market competition destroys risk-sharing opportunities while leading to a less efficient allocation of the workforce. The model predicts that, if workers are sufficiently risk-averse (namely, at least some of them have risk aversion larger than  $\hat{\rho}$ ), labor market competition will lead to fewer workers choosing to be employed in talent-sensitive firms. In the limit, no such firm may be viable. Thus, the economy will feature less talent discovery, less layoff risk (hence, a lower unemployment rate), as well as lower average productivity (and consequently, wages) than if firms were able to provide severance payments to laid off employees.

If instead all workers have low risk aversion ( $\rho < \hat{\rho}$ ), they will choose jobs in highly talent-sensitive firms (those with  $\lambda > \hat{\lambda}$ ) even in a competitive labor market, but such

efficiency in production will be attained at the cost of less efficient risk-sharing. In principle, in this economy layoff risk is insurable, being idiosyncratic; however, firms cannot insure employees against it, being unable to cross-subsidize laid-off workers via severance payments funded by lower wage to retained, high-quality workers.

This suggests that, under labor market competition, public intervention can raise efficiency by providing the risk sharing that firms cannot provide. In the next two sections we will consider two alternative government interventions in this economy, and explore to what extent they can increase efficiency.

## 6 Public Unemployment Insurance

The government can intervene by introducing a public UI scheme to protect laid-off employees of talent-intensive industries. We assume the social security system to run UI on a balanced budget: the unemployment benefits  $b$  paid to laid-off workers are funded by taxing the income of employees in the same firms at rate  $\tau \in [0, 1]$ . Moreover, the insurance system is assumed to have no deadweight costs: the taxes levied to fund it require no collection costs and impose no distortion of labor supply decisions.<sup>6</sup> We discuss below what are the implications of relaxing the latter assumption.

The introduction of the UI system affects both firms' and workers' optimal strategies:

**Lemma 2** *With a public UI system, the employees of firms with  $\lambda_R \geq \lambda^* = \frac{\bar{y} - (1-p)c - (w_0 + b^*)}{pc} < \hat{\lambda}$  pay payroll taxes at the rate  $\tau^* = 1 - p$  and receive unemployment benefits  $b^* = py_{2H}^R$ , and therefore are fully insured against layoff risk.*

Intuitively, the UI system has two effects. First, the availability of the unemployment benefit raises the outside option of workers: when contracting with firms, their outside option is  $w_0 + b$  rather than the reservation wage  $w_0$ . As this raises retention costs, firms become more demanding in their layoff policy than they would be in the absence of UI: not only firms with talent sensitivity  $\lambda \geq \hat{\lambda}$ , but also those with  $\lambda \in [\lambda^*, \hat{\lambda})$  will lay off workers upon bad performance at  $t = 1$ . Second, UI eliminates all layoff risk by insuring workers against it.

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<sup>6</sup>Thus, it is irrelevant whether the taxes that fund the system are lump-sum or payroll-based.

Hence, UI implies that workers in risky firms have the same income whether employed or not. This affects the choice between risky and safe jobs:

**Proposition 4** *If offered labor contracts by firms with different talent sensitivity, in the presence of public UI workers accept the offer from the most talent-sensitive firm, regardless of their risk aversion.*

A key difference between firms' provision of severance pay and a public UI scheme is that the latter are universal in their coverage. As seen in Section 5.1, if a firm were to commit to provide severance pay in a competitive labor market regime, it would lose its best workers to its competitors, and be left with a pool of overpaid employees. Hence no firm can commit to insure laid-off workers via severance pay. In contrast, a public UI scheme effectively forces all firms to fund unemployment benefits via their payroll tax. Hence, when the government provides workers with insurance against layoff risk, labor market competition is no longer an issue.

Public UI will induce all workers – irrespective of their risk aversion – to accept jobs from the most talent-sensitive firms at  $t = 0$ , since these will be able to offer the highest possible expected salaries. This implies that the economy achieves efficient production, on top of efficient risk sharing.

This is clearly an extreme prediction, resulting from the assumption that the government designs UI to provide complete coverage against layoff risk: it is straightforward to show that, if coverage were less than complete, the most risk-averse workers may still prefer to take a job in a talent-insensitive firm. Hence, the empirical prediction is that the fraction of employees working in talent-sensitive firms is positively correlated with the coverage of layoff risk offered by public UI.

In fact, incomplete coverage of layoff risk may be an optimal feature of UI if there are deadweight costs in the redistribution from employed to unemployed workers, in the form of either costly tax enforcement or labor supply distortions. Cross-country differences in such costs may indeed explain why in practice public UI systems feature different coverage in terms of benefits relative to pre-layoff wages – i.e. different “replacement rates”.

In the model as laid out so far, workers are the only agents who respond to the introduction of public UI and can generate a reallocation of employment by accepting job offers from riskier firms. However, it is also possible to envisage a variant of the

model where firms themselves may increase the talent-sensitivity of their production technology at a cost, by investing in costly R&D. In this case, the introduction of UI may trigger an increase in such investment. To see this, consider an economy where initially all firms have talent-sensitivity  $\lambda_S < \hat{\lambda}$  and all workers have risk-aversion  $\rho \geq \hat{\rho}$ . In this case, even if firms could increase their talent-sensitivity to  $\lambda_R \geq \hat{\lambda}$  by investing in R&D, none of them would have an incentive to do so, because it would no longer be able to hire workers. However, if a UI system offering perfect insurance is set up in this economy, firms would have an incentive to invest in R&D and transform their technology in a talent-sensitive one, provided the cost of R&D investment is not prohibitively high: in fact, firms who were not to invest in R&D could no longer attract workers and thus would shut down.

## 7 Employment Protection Laws

An alternative public intervention that is often thought to reduce employment risk is to restrict the freedom of firms in their firing decisions, via “employment protection legislation” (EPL). Such restrictions can take several forms: (i) prohibition of layoffs, (ii) requirement that terminations be motivated by a “just cause”, or (iii) requirement of a pre-set payment to laid-off workers. When EPL takes the last of these three forms, it effectively amounts to a universal mandatory severance pay, and therefore it plays a function that is akin to that of a public insurance system. We will therefore focus on EPL restricting layoffs – in fact, for the sake of clarity, we shall focus on the case where it forbids them altogether.

Our main result is that, in a competitive labor market, the effects of such a restriction to layoffs are quite different from those of UI:

**Lemma 3** *If EPL forbids layoffs, firms with  $\lambda_R \geq \hat{\lambda}$  are not viable.*

If firms are forced to keep workers upon bad performance at  $t = 1$ , the more talent-sensitive ones will refrain from hiring them at  $t = 0$ , expecting not to break even otherwise. This result hinges on two key assumptions of the model: labor market competition and workers’ limited liability. Competition implies that workers appropriate all the surplus that they generate, when this is positive. Yet, limited liability shields them from the losses that they generate at  $t = 2$  when the firm

forcibly retains them despite a poor performance at  $t = 1$ . As a result, talent-sensitive firms will not break even in expectation: only firms with  $\lambda_S < \hat{\lambda}$  will be active in the market.

This result plays an important role in the effects of EPL, both when benchmarked against no government intervention and when compared with public UI:

**Proposition 5** *(i) When labor markets are competitive and EPL forbids layoffs, production is (weakly) less efficient than without government intervention.*

*(ii) Compared with public UI, EPL implies less efficient production, and (weakly) lower insurance against layoff risk.*

This proposition points out that government intervention via EPL weakly decreases welfare, because it eliminates the more talent-sensitive firms, whose jobs may appeal to the least risk-averse workers. Hence, the introduction of EPL decreases expected revenue and wages below the no-intervention level: the elimination of lay-off risk occurs at the cost of lower production efficiency. This result is consistent with the finding by Bartelsman et. al (2016) that, in countries with restrictive EPL, risky industries contributing to aggregate productivity growth are small or exhibit relatively low productivity.

The comparison with public UI contained in the second statement of the proposition is even starker, because with UI all workers prefer jobs in firms with high talent sensitivity and productivity, while with EPL all of them will have to take jobs in firms with low talent sensitivity and productivity. Moreover, this loss in productive efficiency does not imply better insurance of workers, since UI eliminates all layoff risk, while with EPL workers remain exposed to wage risk in firms with low talent sensitivity.

## 8 Education

So far in our model workers choose only which job to accept. In reality, career choices are preceded by educational ones. Insofar as education impacts on-the-job performance, it contributes to determine expected wages as well as layoff risk. In this section we show that the introduction of UI encourages investment in education by lowering the riskiness of their human capital, and via this channel it further enhances

workers' expected productivity (compared to the baseline model where workers make no educational choices).

In the context of this model, it is natural to posit that education reduces the importance of noise (“errors”) in production and thus increases the dependence of payoffs on the intrinsic quality of workers – that is, it raises the parameter  $\lambda$  for any given technology of the firm. In other words, the talent-sensitivity parameter will be dictated not only by technology, but also by workers' educational level.

To capture this idea with the smallest possible change to our setting, suppose that the economy is populated by identical (safe) firms with  $\lambda < \hat{\lambda}$ , and suppose that the process of education allows workers to increase the informativeness of the revenue they generate at  $t = 1$  to some  $\lambda' > \hat{\lambda}$ . For simplicity, initially assume education to be costless (below we relax this assumption). Then, by Proposition 3 only workers with sufficiently low risk aversion ( $\rho < \hat{\rho}$ ) will become educated: those with high risk aversion ( $\rho \geq \hat{\rho}$ ) would be damaged if they were to increase the informativeness of the revenue they generate. By getting educated, workers with low risk aversion will increase both the mean and the variance of their compensation, exposing themselves to layoff risk. Other workers will avoid such risk by not getting educated.

Now, assume that UI were to be introduced in this economy. Based on Proposition 4, being insured against layoff risk, also workers with high risk aversion ( $\rho \geq \hat{\rho}$ ) will become educated, and upon doing so they will increase their expected compensation, bringing it in line with that of less risk-averse workers. Hence, the introduction of UI enhances the investment in human capital, and also via this channel increases the expected productivity of firms and the expected income of workers, at the same time as it increases the unemployment rate.

In the setting considered above, workers' educational choice is assumed to be binary, so that UI increases the number of people who acquire education, i.e. the extensive margin, but not the amount of education that they acquire, i.e. the intensive margin. A simple way of capturing also the effect of UI on the intensive margin is to consider a variant where, beside costless basic education, workers can invest more in their human capital at a cost  $\psi$ . This investment further increases the informativeness of their performance to  $\lambda'' > \lambda'$ .

As a benchmark, consider the educational choice made by a risk-neutral worker: she will get costly education if and only if the cost  $\psi$  does not exceed the threshold

value  $\bar{\psi} \equiv p(1-p)(\lambda'' - \lambda')c$ , which measures the implied increase in the expected wage (i.e., the expected incremental return to education).<sup>7</sup> Instead, a risk-averse worker may wish not to invest in costly education even if  $\psi \leq \bar{\psi}$ , because – unlike a risk-neutral worker – she must consider the incremental layoff risk associated with higher education, not only its expected net benefit. Since however in the presence of UI also these workers effectively behave as if they were risk-neutral, its introduction will induce all of them to invest in costly education. More precisely:

**Proposition 6** *If  $\psi \leq \bar{\psi}$ , in the absence of UI workers with risk-aversion  $\rho < \hat{\rho}$  acquire costly education if and only if  $\rho \leq \rho_E \equiv \frac{\bar{\psi} - \psi}{(1-p)\psi} > 0$ . In the presence of UI, all workers invest in education regardless of their risk aversion, .*

Hence, if  $\psi \leq \bar{\psi}$ , educational choices in the absence of UI differ across three groups of workers, depending on their risk aversion:

- those with  $\rho \geq \hat{\rho}$  do not acquire any education;
- those with  $\rho \in [\rho_E, \hat{\rho})$  acquire only costless education;
- those with  $\rho \in [0, \rho_E)$  acquire both costless and costly education.

In the presence of UI, instead, all three types of workers will acquire both types of education. Hence, UI has both an effect on the extensive margin, by inducing workers with high risk-aversion ( $\rho \geq \hat{\rho}$ ) to become educated (and indeed to invest also in costly education), but also on the intensive margin, by encouraging workers with low risk-aversion ( $\rho \in [\rho_E, \hat{\rho})$ ) to acquire also costly education, which they would not have done in the absence of UI.

## 9 Empirical Predictions and Some Evidence

Despite its simplicity, our model provides a rich set of empirical predictions:

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<sup>7</sup>The value of  $\bar{\psi}$  is derived from the incentive constraint for a risk-neutral worker to invest in costly education:

$$p[\bar{y} - (1 - \theta_H(\lambda''))c] - \psi \geq p[\bar{y} - (1 - \theta_H(\lambda'))c]$$

This inequality implies that a risk-neutral worker will invest in further education for any  $\psi \leq p(1-p)(\lambda'' - \lambda')c \equiv \bar{\psi}$ .

1. Competition for talent in the labor market weakens the protection against layoff risk offered by firms, for instance in the form of severance pay.
2. In a competitive labor market and absent public UI, more talent-sensitive industries feature greater layoff risk, higher average wages and steeper career profiles.
3. The fraction of employees in talent-sensitive industries and firm investment in R&D are positively correlated with the generosity of public UI, other things being equal.
4. The introduction of UI increases the expected compensation of workers, as well as the unemployment rate.
5. In talent-sensitive industries, the returns to education are higher but riskier than in other industries, and the level of education of employees is increasing in the generosity of public UI.

To the best of our knowledge, most of these predictions have not been tested by empirical work. Here, we start to explore whether the evidence is consistent with the third prediction, namely that the generosity of UI systems is positively correlated with the fraction of employees in talent-sensitive industries, as well as with firm investment in R&D. We focus on these predictions in light of their great policy relevance: in spite of the vast literature on UI, there is no research on the correlation between its design and industrial structure, in terms of both employment allocation across industries and firms' technological choices.

In probing the evidence, we do not aim to pin down the direction of causality between UI generosity – as measured by the level and duration of UI benefits – and industrial structure. In principle, causality might go in either direction. On one hand, a more generous UI should make employees more inclined to work in talent-sensitive industries, and allow these to attract a larger fraction of the total workforce. On the other hand, if most employees work in talent-sensitive industries – for instance, because they have low risk aversion or are highly educated – there will be a strong constituency in support of a generous UI system, while the opposite will happen if most workers are employed in industries with low talent-sensitivity. Both of these lines of argument are consistent with our theoretical framework, and accordingly we investigate correlations rather than causal relationships.



Mapping the prediction of interest to the data requires finding an empirical counterpart for the talent-sensitivity of industries. We gauge it by the knowledge intensity of the sector’s technology: we consider professional, scientific and technological services, as well as the production and dissemination of knowledge as more talent-sensitive sectors than manufacturing, and accordingly we expect them to employ a larger fraction of workers in jurisdictions with more generous UI systems.

We analyze the relationship between sectoral employment and UI generosity using alternatively two panel data sets: yearly country-level data for 17 developed countries in 1995-2013, and yearly state-level data for the U.S. in 1990-2013. We measure the ratio of employees in the sector of interest to total employment (excluding self-employed workers) drawing country-level data from the OECD database, and U.S. state-level data from the Bureau of Labor Statistics (BLS).

In both data sets, the measure of the generosity of public UI is the income “replacement rate”, i.e. the ratio of unemployment benefits to the average salary, and varies both across countries (or states) and over time. The country-level replacement rate is the ratio of the UI benefits received by a worker in the first two years of unemployment to the worker’s last gross wage in the corresponding country, so as to capture both the level and the duration of unemployment benefits. These data are based on Aleksynska and Schindler (2011), as extended by Ellul, Pagano and Schivardi (2016) from 2005 to 2013. The replacement rate averages 0.35 for the whole sample, but features significant differences across countries: in France, the Netherlands, Norway, Portugal and Spain, its average exceeds 0.40; in contrast, in the Czech Republic, Greece, Israel and the U.K. it is below 0.20. Moreover, in some countries UI replacement rates vary significantly over time – within the same country: this is the case of Denmark, Italy, Norway and Portugal. In other countries they are quite stable: for example, in the Czech Republic it did not change throughout the whole period, and in Austria, Belgium, Spain and the UK it changed little over time.

The estimates of panel regressions based on country-level data are shown in Table 1, separately for two relatively talent-intensive sectors in columns 1 and 2 (professional, scientific and technological services, and information and communication, respectively), and for manufacturing in column 3. All regressions include country fixed effects to control for unobserved heterogeneity due to time-invariant differences in countries’ industrial specialization, and calendar year effects to absorb common trends in the relative employment shares of these three sectors, arising for instance

from global changes in technology or in product variety. Standard errors are reported in parenthesis below the respective coefficients.

**Table 1. Country-Level Sectoral Employment Regressions  
(OECD Yearly Data, 1995-2013)**

Dep. var.: % Employees	Professional, Scientific & Technological Services (1)	Information & Communication (2)	Manufacturing (3)
Replacement Rate (UI)	0.013** (0.005)	0.005** (0.002)	-0.044*** (0.008)
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adjusted $R^2$	0.975	0.923	0.972
N. obs.	314	314	295

The results show that the fraction of employees in the two more talent-intensive sectors is positively and significantly correlated with the replacement rate, while the corresponding fraction in manufacturing is negatively and significantly correlated with it. To have an idea of the economic significance of the estimates, consider that increasing the replacement rate from its average level in the Czech Republic (0.06, the lowest in the sample) to that of Portugal (0.65, the highest in the sample) is associated with an increase of 0.8 percentage points in the fraction of employees in professional, scientific and technological services, and a decrease in the fraction of manufacturing employment of 2.6 percentage points, to be respectively compared with overall sample means of 12 and 18 percent for these two sectors.

We apply this approach also to U.S. data, exploiting variation in state-level replacement rates. These are defined as the product of the maximal UI benefits and the respective maximal duration, measured in 2002 constant dollars using the Consumer Price Index (as done by Agrawal and Matsa, 2013), standardized by the average wage in the relevant sector, state and year. The data for UI benefits and duration are drawn

from the “Significant Provision of State UI Laws” of the U.S. Department of Labor, and the data for average wage by sector, state and year are based on BLS data. The replacement rate averages 0.22 for the whole sample, but differs substantially across states: its mean ranges from 0.42 in Massachusetts, 0.32 in Rhode Island, and 0.30 in Pennsylvania, to 0.14 in Alabama, Arizona and District of Columbia. Moreover, in some states – such as Minnesota and Pennsylvania – it varies appreciably over time.

Also for U.S. state-level data, we estimate panel regressions – shown in Table 2 – for two relatively talent-intensive sectors and for the manufacturing sector. The former sectors differ from those in Table 1, because BLS statistics define sectors differently from the OECD: for the U.S. we consider health and education services (columns 1 and 2) and professional and business services (columns 3 and 4) as more talent-intensive than manufacturing (column 5 and 6).

**Table 2. State-Level Sectoral Employment Regressions**  
(U.S. Yearly Data, 1990-2013)

Dep. var.: % Employees	Health & Education Services		Professional & Business Services		Manufacturing	
	(1)	(2)	(3)	(4)	(5)	(6)
Replacement Rate (UI)	0.071*** (0.002)	0.012*** (0.002)	0.621*** (0.005)	0.017 (0.005)	-0.144*** (0.002)	-0.018*** (0.002)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes
Adjusted $R^2$	0.927	0.971	0.973	0.987	0.916	0.952
N. obs.	1,152	1,152	1,224	1,224	1,104	1,104

The regressions in the odd columns include only country fixed effects, while those in even columns include also calendar year effects. The results are broadly in line with those of Table 1 based on country-level data: the coefficient of the replacement rate is estimated to be positive for the two more talent-sensitive sectors, and negative for manufacturing. All estimates are significantly different from zero, except for the

coefficient in column (4), which refers to professional and business services in the specification that includes year effects.

The regressions shown in Tables 1 and 2 are based on aggregate data. An additional piece of evidence can be gleaned from firm-level data on R&D investment by U.S. companies: recall that, according to our model, higher UI replacement rates may induce firms to become more talent-sensitive by investing in R&D. Evidence on this point is provided by Ellul, Wang and Zhang (2016), who find that firms in states with more generous UI insurance tend to feature greater risk-taking behavior along various dimensions, including R&D investment. In Table 12 of their study, they regress the ratio of R&D investment to total assets on the replacement rate in the state where the company is headquartered, and on lagged company level controls (total assets, leverage, ROA, market-to-book ratio, asset tangibility and sales growth), and find that the coefficient of the replacement rate is positive and significant. While their R&D evidence is based on a subsample of firms for which they observe managerial compensation data, the same result is obtained using a comprehensive sample of 139,210 firm-year observations between 1992 and 2013, drawn from Compustat.<sup>8</sup>

On the whole, the evidence presented in this section is broadly consistent with the prediction that the generosity of UI is positively correlated with the development of talent-sensitive industries. It is a task for future research to investigate whether this prediction is also upheld in the context of quasi-natural experiments associated with reforms of the social security system.

## 10 Conclusions

Talent discovery is crucial in human capital-intensive industries (such as high-tech, professional services and health), as it allows for efficient matching of workers to tasks, translating into higher production and wages. However, it also generates risks for workers who are uncertain about their own skills, as after some work experience they may turn out to be either more or less talented than expected, and if insufficiently talented they may be laid off.

When the labor market is non-competitive, firms can insure their employees

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<sup>8</sup>We are very grateful to Kuo Zhang for kindly agreeing to re-estimate the R&D regressions on this larger sample.

against the resulting human capital risk, compensating them with severance pay in case of layoff. However, labor market competition prevents firms from insuring workers against layoff risk, as it comes at the expense of more talented workers: the cross-subsidy given to low-performing employees would induce high-performing ones to switch to a competitor, leaving their initial employer only with overpaid and un-talented employees. Absent any insurance, risk-averse workers will select themselves into less talent-sensitive occupations, which discover less precise information about their skills and thus generate less or no layoff risk.

The core policy implication of our model is that in competitive labor markets, public UI induces workers to seek employment in more talent-sensitive industries, irrespective of their risk aversion, as they prefer to test their own skills in jobs that reveal sharper information about their talent. This allows for more efficient job-talent matches, hence higher average wages, than in the absence of such intervention. The resulting increase in layoff risk (and consequently in the unemployment rate) generates no welfare losses because of the safety net provided by UI. The higher layoff risk reflects the more frequent firings of workers upon bad performance: the availability of unemployment benefits increases workers' reservation wage, so that firms are less likely to break even, and more demanding in their criterion to retain employees.

We also show that UI dominates another possible policy intervention, namely employment protection legislation (EPL) that constrains firms' ability to lay off workers. In fact, if the labor market is competitive and workers are protected by limited liability, EPL will prevent highly talent-sensitive firms to break even, and therefore will distort employment towards firms with less talent-sensitive technologies and therefore with lower expected productivity. Hence, in order to foster the discovery and efficient allocation of talent, policy should prefer insurance of employees against layoffs over norms that penalize layoffs. Another interesting policy implication of the analysis is that UI encourages workers to acquire education, irrespective of their degree of risk-aversion, which in turn further enhances talent discovery.

Admittedly, these strong results would be to some extent mitigated or modified in a richer model that were to allow for the potential efficiency costs of UI. For instance, if workers' labor supply were modelled as resulting from a leisure-consumption trade-off, the payroll taxes required to fund unemployment benefits would distort labor supply.

Moreover, in the model we rule out the workers' ability to insure themselves via financial markets, for instance by borrowing after being laid off: we do so to focus on firms and on the social security system as the only possible sources of insurance against workers' human capital risk. This assumption is not unrealistic, as workers are often credit constrained (Jacobson, LaLonde and Sullivan, 1993). However, clearly self-insurance of workers via precautionary saving would reduce the benefits from the presence of UI.

Finally, our analysis abstracts from general equilibrium effects of the allocation of workers across industries, such as its effect on the relative prices of goods produced by industries featuring different talent sensitivity – an assumption that is appropriate in a small open economy where the relative prices of tradeable are dictated by the international market. For instance, the model predicts that upon the introduction of UI all workers will switch to the most talent-sensitive industries. If instead the relative price of these industries' output were determined endogenously in the economy, it would decline in response to the increase in their output of these industries, and this would limit the extent of the reallocation process. However, the result that more labor would be employed in talent-sensitive industries would still hold true qualitatively.

## Appendix: Proofs

### Proof of Lemma 1

**Proof.** Since  $\theta_H \geq p$ , by condition (2) we have  $1 - \theta_H < \frac{\bar{y} - w_0}{c}$ . Therefore, if at  $t = 1$  the project yields a positive surplus, the employee is retained and the project continued. If instead the project delivers a loss in  $t = 1$ , the belief that the worker is good is updated to  $\theta_L \leq p$ . We need to distinguish two possible cases for the conditional expected revenue:

- 1)  $1 - \theta_L < \frac{\bar{y} - w_0}{c}$ : the worker is retained for any realization of  $y_1$ , as she is expected to produce a positive surplus;
- 2)  $1 - \theta_L \geq \frac{\bar{y} - w_0}{c}$ : the worker is laid off, as she is expected to generate a loss for any wage higher than (or equal to)  $w_0$ .

Whether a firm ends up in case 1 or 2 depends on the talent-sensitivity of its production technology  $\lambda$ . By continuity of  $\theta_L$ ,  $\exists \hat{\lambda} : \bar{y} - (1 - \theta_L)c = w_0$  given by

$$\hat{\lambda} \equiv \frac{\bar{y} - (1 - p)c - w_0}{pc}. \quad (15)$$

If the project's informativeness is  $\hat{\lambda}$ , the firm is indifferent between laying off and keeping a worker who failed in the previous period as in expectation it will always break even. If  $\lambda < \hat{\lambda}$ , the firm's optimally keeps all its employees (case 1). If  $\lambda \geq \hat{\lambda}$ , instead, the firm lays off workers who generate a loss at  $t = 1$ , and retain those who generate a positive surplus (case 2), as the former would not make it break even. ■

### Proof of Proposition 1

**Proof.** We prove this proposition in two steps: we show that

- 1) if all firms offer contracts with severance pay, workers choose to work for firms with  $\lambda \geq \hat{\lambda}$ .
  - 2) given 1), workers choose to work for the most talent-sensitive firm on the market.
- 1) Any firm with  $\lambda < \hat{\lambda}$  pays all workers a constant wage across the two periods, irrespective of their performance, and therefore provides the same unconditional ex-

pected utility for both periods:

$$\mathbb{E}_0 \left[ U(\lambda < \widehat{\lambda}) \right] = 2u[\bar{y} - (1 - p)c].$$

Instead, firms with  $\lambda \geq \widehat{\lambda}$  offer different wages across the two periods and fire workers who had a bad performance at  $t = 1$ . Hence they provide the following unconditional expected utility:

$$\mathbb{E}_0 \left[ U(\lambda \geq \widehat{\lambda}) \right] = u[\bar{y} - (1 - p)c] + u[p(\bar{y} - (1 - \theta_H)c)].$$

Since  $u(w)$  is an increasing function, and  $\bar{y} - (1 - p)c < p[\bar{y} - (1 - \theta_H)c]$  for any  $\lambda \geq \widehat{\lambda}$ , any worker prefers to work for firms with  $\lambda \geq \widehat{\lambda}$ .

2) To show that workers prefer the firm with the highest  $\lambda$  among those with  $\lambda \geq \widehat{\lambda}$ , notice that  $w_1$  is independent of  $\lambda$ , while  $w_2 = p(\bar{y} - (1 - \theta_H)c)$  is increasing in  $\lambda$ :

$$\frac{\partial w_2}{\partial \lambda} = \frac{\partial w_2}{\partial \theta_H} \cdot \frac{\partial \theta_H}{\partial \lambda} = p(1 - p)c > 0.$$

Hence, they will pick the most talent-sensitive firm in the market. ■

## Proof of Proposition 2

**Proof.** Let  $\Delta U_S$  denote the expected benefit from choosing the safe job rather than the risky one, so that

$$\begin{aligned} \Delta U_S &= pu[\bar{y} - (1 - \theta_H^S)c] + (1 - p)u[\bar{y} - (1 - \theta_L^S)c] - \{pu[\bar{y} - (1 - \theta_H^R)c] + (1 - p)u(w_0)\} \\ &= pu[\bar{y} - (1 - \theta_H^S)c] + (1 - p)u[\bar{y} - (1 - \theta_L^S)c] - pu[\bar{y} - (1 - \theta_H^R)c], \end{aligned} \quad (16)$$

where in the second step we have used the assumption  $u(w_0) = 0$ . To simplify notation, let us define:

$$y_{2H}^S \equiv \bar{y} - (1 - \theta_H^S)c, \quad y_{2L}^S \equiv \bar{y} - (1 - \theta_L^S)c, \quad y_{2H}^R \equiv \bar{y} - (1 - \theta_H^R)c, \quad (17)$$



which allows us to rewrite (16) as follows:

$$\Delta U_S = (1 - p)u(y_{2L}^S) - p[u(y_{2H}^R) - u(y_{2H}^S)]. \quad (18)$$

Consider any two expected revenues  $x_1$  and  $x_2$  such that  $x_1 \in (w_0, y_{2H}^S)$  and  $x_2 \in (y_{2H}^S, y_{2H}^R)$ . By the mean value theorem, we can write (18) as

$$\Delta U_S = (1 - p)u'(x_1)(y_{2L}^S - w_0) - pu'(x_2)(y_{2H}^R - y_{2H}^S), \quad (19)$$

where by concavity of the utility function  $u'(x_1) > u'(x_2)$  since  $y_{2L}^S < y_{2H}^S < y_{2H}^R$ . Using (17) in equation (19) yields

$$\Delta U_S = (1 - p)[u'(x_1)y_{2L}^S - u'(x_2)(\lambda_R - \lambda_S)pc]. \quad (20)$$

By adding and subtracting  $(1 - p)u'(x_2)(y_{2L}^S - w_0)$  on the right-hand side of (20), dividing and multiplying it by  $u'(x_2)$  and simplifying, we obtain:

$$\Delta U_S = (1 - p)u'(x_2) [\rho(y_{2L}^S - w_0) + \bar{y} - c + (1 - \lambda_R)pc - w_0], \quad (21)$$

where  $\rho \equiv \frac{u'(x_1) - u'(x_2)}{u'(x_2)}$  is a measure of worker's risk aversion: for fixed values of  $x_1$  and  $x_2$ , the greater the curvature of the utility function, the larger the numerator and the smaller the denominator. By the continuity of  $\Delta U_S$  in  $\rho$ , there exists a critical risk aversion level:

$$\hat{\rho} \equiv \frac{[1 - (1 - \lambda_R)p]c - \bar{y} + w_0}{y_{2L}^S - w_0} \geq 0 \quad (22)$$

such that, for any  $\rho \geq \hat{\rho}$ , workers will prefer the safe job, and for any  $\rho < \hat{\rho}$  they will prefer the risky one. Clearly, the threshold risk aversion  $\hat{\rho}$  is increasing in  $\lambda_R$ : indeed, it equals 0 for  $\lambda_R = \hat{\lambda}$  and  $(c - \bar{y})/y_{2L}^S > 0$  for  $\lambda_R = 1$ . ■

### Proof of Proposition 3

**Proof.** (i) In firms with  $\lambda < \hat{\lambda}$ , the unconditional expected wage at  $t = 2$  equals the worker's expected productivity:

$$\mathbb{E}_0(y_2) = p[\bar{y} - (1 - \theta_H)c] + (1 - p)[\bar{y} - (1 - \theta_L)c]. \quad (23)$$

Upon substituting for  $\theta_H$  and  $\theta_L$ , this expression becomes

$$\begin{aligned}\mathbb{E}_0(y_2) &= p[\bar{y} - (1-p)(1-\lambda)c] + (1-p)\{\bar{y} - [1 - (1-\lambda)p]c\} \\ &= \bar{y} - (1-p)c = \mathbb{E}_0(y_1) \quad \forall \lambda < \hat{\lambda},\end{aligned}$$

which is independent of  $\lambda$ . Instead, the unconditional variance of the wage is increasing in  $\lambda$ :

$$\sigma^2 = p\{y_{2H} - [\bar{y} - (1-p)c]\}^2 + (1-p)\{y_{2L} - [\bar{y} - (1-p)c]\}^2 = p(1-p)\lambda^2 c^2.$$

hence, the wage paid by firms with informativeness  $\lambda < \hat{\lambda}$  is a mean-preserving spread of the distribution of the wage that would be paid by a firm with  $\lambda = 0$ , which does not update its beliefs. Thus, a risk-averse worker will always choose the least informative project available.

(ii) In firms with  $\lambda \geq \hat{\lambda}$ , a worker that produces  $y_1 = \bar{y} - c$  at  $t = 2$  is laid off and gets zero utility. If instead  $y_1 = \bar{y}$  at  $t = 2$ , the worker's wage is increasing in  $\lambda$  (as shown in the proof of Proposition 1). Thus, all workers prefer to work for the firm featuring the highest  $\lambda$ . ■

## Proof of Lemma 2

**Proof.** First, we derive the new condition that defines the firms that lay off underperforming workers at  $t = 1$  under UI. As in the proof of Lemma 1, we distinguish two possible cases for the conditional expected revenue:

- 1)  $1 - \theta_L < \frac{\bar{y} - w_0 - b}{c}$ : the worker is retained for any realization of  $y_1$ , as she is expected to produce a positive surplus;
- 2)  $1 - \theta_L \geq \frac{\bar{y} - w_0 - b}{c}$ : the worker is laid off, as she is expected to generate a loss for any wage higher than (or equal to)  $w_0 + b$ .

Whether a firm ends up in case 1 or 2 depends on the talent-sensitivity of its production technology  $\lambda$ . By continuity of  $\theta_L$ ,  $\exists \lambda^* : \bar{y} - (1 - \theta_L)c = w_0 + b$  given by

$$\lambda^* = \frac{\bar{y} - (1-p)c - (w_0 + b)}{pc}. \quad (24)$$

The government chooses the optimal tax rate  $\tau$  and transfer to unemployed workers  $b$  in order to maximize the social welfare function subject to the binding budget constraint and the non-negativity constraint for the tax rate  $\tau$ :

$$\max_{\{\tau, b\}} pu[y_{2H}^R(1 - \tau)] + (1 - p)u(b),$$

subject to

$$\begin{aligned} py_{2H}^R\tau &= (1 - p)b, \\ \tau &\in [0, 1], \end{aligned}$$

which is equivalent to:

$$\max_{\{\tau\}} pu[y_{2H}^R(1 - \tau)] + (1 - p)u\left(\frac{py_{2H}^R\tau}{1 - p}\right)$$

Working out the first-order condition for an interior solution to this problem delivers the optimal level of  $\tau$ :

$$\tau^* = 1 - p. \tag{25}$$

Substituting  $\tau^*$  in the budget constraint yields the optimal UI benefit:

$$b^* = py_{2H}^R, \tag{26}$$

so that employees in firms with  $\lambda_R \geq \lambda^*$  obtain full insurance. Replacing the unemployment benefit  $b$  with its optimal value  $b^*$  in (26) yields the value of  $\lambda^*$ . Since  $b^* > 0$ , it is immediate that  $\lambda^* < \hat{\lambda}$ . ■

## Proof of Proposition 4

**Proof.** In the presence of public UI, a worker employed by a firm featuring  $\lambda_R \geq \hat{\lambda}$  earns utility

$$u[\bar{y} - (1 - p)c] + u(py_{2H}^R) \tag{27}$$

whereas a worker employed by a firm exhibiting  $\lambda_S \in [0, \hat{\lambda})$  has unconditional expected utility

$$u[\bar{y} - (1 - p)c] + pu(y_{2H}^S) + (1 - p)u(y_{2L}^S). \tag{28}$$

We know that

$$y_{2H}^R > y_{2H}^S \geq y_{2L}^S \Rightarrow u(py_{2H}^R) > pu(y_{2H}^S) + (1-p)u(y_{2L}^S)$$

and this holds for every concave utility function and for every  $\lambda_R \geq \hat{\lambda} > \lambda_S$ .

Hence, any worker would choose the more talent-sensitive job over the less informative one. ■

### Proof of Lemma 3

**Proof.** If firms cannot fire workers in a competitive labor market, those featuring talent-sensitivity  $\lambda < \hat{\lambda}$  earn zero unconditional expected profit. On the other hand, if workers are not laid off after a bad outcome in  $t = 1$ , the unconditional expected profit for a firm with  $\lambda \geq \hat{\lambda}$  is:

$$\mathbb{E}_0(\pi) = (1-p)[\bar{y} - (1-\theta_L^R)c] \leq 0. \quad (29)$$

Note that firms with  $\lambda \geq \hat{\lambda}$  will not want to keep badly performing employees idle, as this would generate an expected loss equal to their reservation wage:

$$\mathbb{E}_0(\pi) = -w_0 < 0. \quad (30)$$

Hence, if highly talent-intensive firms do not fire workers after a bad outcome in  $t = 1$ , they would make losses. Anticipating this at  $t = 0$ , in an EPL regime such firms have no incentive to hire workers, and will be inactive. This is an equilibrium, since there are no profitable deviations from a situation in which all such firms are inactive: if any single one of them were to start production and enter the labor market, other firms would have an incentive to poach the employees tested by this firm: any other firm with  $\lambda \geq \hat{\lambda}$  has an incentive to free ride on the others, so that in equilibrium none of them would be active at  $t = 0$ . ■

### Proof of Proposition 5

**Proof.** (i) By Proposition 2, in a competitive labor market without government intervention, workers with risk-aversion  $\rho < \hat{\rho}$  choose to work for firms with  $\lambda \geq \hat{\lambda}$ .

By Lemma 3, when EPL is in place, these jobs are no longer available, so that the expected revenue and wages in the economy is lower than without EPL. If instead all workers have risk-aversion  $\rho \geq \hat{\rho}$ , then they will all work for firms with  $\lambda < \hat{\lambda}$  that feature no layoff risk, so that the introduction of EPL is inconsequential.

(ii) By Proposition 4, in a competitive labor market with public UI, all workers choose the most talent-sensitive (highest- $\lambda$ ) job available, which generates the highest feasible production while keeping risk-sharing efficient. By Lemma 3, when EPL is in place, only jobs in firms with  $\lambda_S < \hat{\lambda}$  are available, so that the expected revenue and wages in the economy is strictly lower than with public UI. Moreover, with EPL all workers will have to take jobs in firms with  $\lambda_S < \hat{\lambda}$ , which feature wage risk (unless  $\lambda_S = 0$ ), whereas in the presence of UI they would have chosen jobs in firms with  $\lambda_R \geq \hat{\lambda}$ , yet bear no layoff risk. Hence, EPL also implies less efficient risk sharing than UI. ■

## 10.1 Proof of Proposition 6

**Proof.** Let  $\Delta U_E$  denote the benefit for a risk-averse worker with  $\rho < \hat{\rho}$  from investing in costly education. Moreover, let  $y_{2H}(\lambda'')$  and  $y_{2H}(\lambda')$  denote the expected revenue respectively generated by workers with and without costly education, conditional on observing  $y_1 = \bar{y}$ . Since  $\lambda'' > \lambda'$ ,  $y_{2H}(\lambda'') > y_{2H}(\lambda')$ . We assume that  $\psi < \bar{\psi}$ , so that at least risk-neutral workers invest in costly education. This condition implies  $\psi < y_{2H}(\lambda'') - y_{2H}(\lambda') = (1-p)(\lambda'' - \lambda')c$ . The net utility gain from costly education is

$$\begin{aligned} \Delta U_E &= pu(y_{2H}(\lambda'') - \psi) + (1-p)u(w_0 - \psi) - pu(y_{2H}(\lambda')) - (1-p)u(w_0). \\ &= p[u(y_{2H}(\lambda'') - \psi) - u(y_{2H}(\lambda'))] - (1-p)[u(w_0) - u(w_0 - \psi)]. \end{aligned} \quad (31)$$

Consider any two expected revenues  $x_1$  and  $x_2$  such that  $x_1 \in (w_0 - \psi, w_0)$  and  $x_2 \in (y_{2H}(\lambda'), y_{2H}(\lambda'') - \psi)$ . By the mean value theorem, we can write (31) as

$$\Delta U_E = p[(1-p)(\lambda'' - \lambda')c - \psi]u'(x_2) - (1-p)u'(x_1)\psi.$$

where, by concavity of the utility function,  $u'(x_1) > u'(x_2)$  since  $w_0 < y_{2H}(\lambda') < y_{2H}(\lambda'') - \psi$ . Hence,  $\Delta U_E \geq 0$  if and only if

$$(1-p)u'(x_1)\psi \leq u'(x_2)p[(1-p)(\lambda'' - \lambda')c - \psi]. \quad (32)$$

By adding and subtracting  $(1-p)u'(x_2)\psi$  on its left-hand side, (32) can be rewritten as

$$\rho \leq \rho_E \equiv \frac{p(1-p)(\lambda'' - \lambda')c - \psi}{(1-p)\psi} = \frac{\bar{\psi} - \psi}{(1-p)\psi},$$

where  $\rho \equiv \frac{u'(x_1) - u'(x_2)}{u'(x_2)}$  is a measure of worker's risk aversion, as it denotes the slope of marginal utility: workers whose risk aversion is below the threshold  $\rho_E$  will invest in private education, while those with risk aversion above  $\rho_E$  will not. The threshold risk aversion  $\rho^E$  is decreasing in the cost  $\psi$  of additional education. It is immediate that costly education implies a net benefit  $\Delta U_E > 0$  in the presence of public UI, since effectively all workers behave as risk-neutral. ■

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