

## **EXPERIENCE RATING: INSURANCE VERSUS EFFICIENCY\***

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Unemployment insurance (UI) distorts firms' layoff decisions by reducing the cost of laying off workers. To dampen this increase, it has been suggested that UI should be financed with an experience-rated tax. Despite the fact that increasing the level of experience rating can reduce unemployment, it can reduce the insurance coverage workers receive. With high experience rating, firms may reduce their severance payments by more than the UI benefit. We build a model where competitive firms offer contracts with severance payments to risk-averse workers. Frictions in the labor market lead to incomplete insurance. This article shows that less than full-experience rating enables the government to increase the insurance coverage workers receive. Welfare implications are also investigated.

### 1. INTRODUCTION

The primary objective of unemployment insurance (UI) is to provide coverage to workers in the presence of risky future employment opportunities. However, UI reduces the cost to firms of laying off workers, and consequently, firms increase the number of layoffs leading to more unemployment. One instrument to dampen or eliminate this perverse effect is using experience rating to finance unemployment insurance. Under an experience-rated system, firms pay a tax proportional to the total cost their layoff decisions impose on the UI program. Without experience rating, UI acts like a subsidy for firms who lay off workers. Experience rating increases the cost of laying off workers, and can counterbalance this negative distortion. With perfect experience rating when firms pay the full cost of their layoffs, Topel and Welch (1980) demonstrated that unemployment does not increase with the introduction of such a program. One important question that has been overlooked in the literature is how experience rating affects the government's ability to better insure workers against unemployment when firms privately offer some insurance. Privately provided insurance benefits, that is, severance payments, are reduced when there is public provision of UI. One of the two main objectives of this article is to assess how the level of experience rating can affect the ability

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of public UI to actually increase insurance coverage workers receive. In a world with frictions in the labor market, layoffs are already distorted. Can imperfect experience rating help undo such initial distortions? The answer will depend on whether the labor market is characterized by moral hazard or adverse selection.

Topel and Welch (1980) and Feldstein (1976) demonstrate that an efficient UI system has full-experience rating, since firms fully internalize all of the costs associated with their decisions. However, in practice, experience rating is not prevalent. Most countries use only payroll taxes to finance their UI programs. Those countries that do use experience rating, like the United States, do so only partially. So if experience rating is efficient, then why is it not a more prominent feature in unemployment insurance programs? Marceau (1993) and Burdett and Wright (1989) show that increasing the level of experience rating could lead to more unemployment. Under Cournot competition with free entry, or with variable firm size, increasing the degree of experience rating can increase unemployment by reducing the number of firms or by reducing firm size.

This article highlights other potentially undesirable effects of experience rating. When experience rating increases, private insurance in the form of severance payments may be reduced by more than the UI benefit, reducing coverage for unemployed workers. With risk-averse workers, such reductions in coverage have welfare implications. For such an effect to be present, we need to consider an economy with frictions. In the absence of frictions, full insurance will always arise, and the effect noted above would not be present. Looking at the impact of experience rating in the presence of frictions has been neglected in the literature. Frictions may lead to excessive layoffs, but also to too excessive retention. In the latter case, less than full-experience rating may be welfare improving by increasing layoffs.

We construct a model where workers are subject to permanent layoffs.<sup>2</sup> Although not all layoffs are permanent, permanent layoffs do constitute a significant portion of total layoffs.<sup>3</sup> Because workers are risk averse, firms can provide long-term insurance contracts to workers by using severance payments.<sup>4</sup> Without frictions, a firm's optimal contract fully insures workers, and layoffs are efficient without public intervention. An increase in unemployment benefits is followed by an equal reduction in private severance payments, regardless of the level of experience rating. Since less than full-experience rating increases layoffs, full-experience rating ensures efficient allocation. However, such results may not be obtained in the presence of frictions.

<sup>2</sup> With the exception of our section on adverse selection, most of the results in this article will hold when layoffs are temporary, as long as we restrict ourselves to UI systems, like in the United States, where benefits are only given to laid-off workers, and not to workers who are victims of reduced work hours. For a discussion of such alternate systems, see Burdett and Wright (1989).

<sup>3</sup> Oswald (1986) notes that from 1973 to 1976 in the United States, 40% of layoffs in the manufacturing sector were permanent, and Picot et al. (1998) found that the permanent layoff rate in Canada fluctuated from 8.7% to 7.3% between 1982 and 1993.

<sup>4</sup> The 2000 National Compensation Survey (BLS) show that 21% of all workers in the manufacturing sector receive severance payments. Moreover, according to Bureau of Labor Statistics ([www.bls.gov](http://www.bls.gov)), severance payments represent 0.1% of the total compensation for employees in private sector firms with less than 100 employees, and this number reaches 0.3% for private sector firms with more than 500 employees.

Many different environments lead to labor market frictions. For example, moral hazard or adverse selection in the labor market could affect contract offers. First, we consider a moral-hazard environment. Shapiro and Stiglitz (1984) show that when effort is unobservable, layoffs can discipline workers. Workers who shirk can be punished by being laid off and made to suffer the cost of being unemployed. Given an adequate wage and cost of being unemployed, workers will choose to provide the desired level of effort. Suffering a cost when laid off is essential in such a context. If a worker can costlessly find a new job with the same wage once laid off, shirking is the optimal decision. In this article, firms offer severance payments to workers in order to provide them with insurance against exogenous shocks. However, it is reasonable to believe that it could be difficult or impossible for a third party to assess the reason for separation. McLeod and Malcomson (1989) and Carmichael (1983) have illustrated that, because it is difficult for a third party to observe who initiated a job separation, contracts with severance payments must be supported by self-enforcing arrangements. For example, consider a firm that wishes to reduce its workforce. If its contracts only require that it pay severance in the event of a layoff, it would have an incentive to put pressure on employees to quit. Since this is not verifiable, any self-enforcing contract would require that severance be paid in the event of any separation. Consequently, firms will have to pay severance payments both to workers who are laid off for stochastic reasons and to those who are caught shirking. In this environment, full insurance will not be offered to workers, since it will provide no incentive for effort to be undertaken. As discussed in Mookherjee (1986), under such contracts the “non-indifference principle” applies, in the sense that laid-off workers would strictly prefer not to be laid off.

This yields two important results. First, even without UI, layoff decisions are distorted. Second, this distortion takes the form of excessive retention. Since firms are unable to provide full insurance, they may try to compensate workers by reducing the probability of layoffs. This leads to too few layoffs, which is in the same line as Acemoglu and Shimer (1999) or Mookherjee (1986). The level of insurance workers enjoy will vary with the level of experience rating. With full-experience rating, layoffs are not distorted by the provision of UI, and consequently the incentive constraint is independent of the generosity of the benefits. However, with less than-full experience rating, firms will increase their layoffs when UI benefits increase. As a consequence the optimal contract will stipulate a larger difference between wages and severance payments. This implies that less than full-experience rating *decreases* the total insurance, both private and public, which the worker receives. Lower experience rating could increase layoff efficiency, but harms workers in terms of the level of insurance they receive.

We contrast these findings with those from a second environment in which there is adverse selection in the labor market. We assume that workers have an unobserved ability and that firms cannot commit to retain low-ability workers. If firms have no prior information about a worker’s ability on the job, and if they cannot contract on this nonverifiable ability, they only have the option of hiring workers as wage workers, whom they may possibly wish to lay off in the future. Once working, firms and workers learn workers’ abilities. At some point, firms

must decide whether to retain or to lay off each worker on the basis of their observed ability. When a worker is laid off, other firms make inferences about the average ability of both fired and retained workers. Laid-off workers are inferred to have low ability and therefore receive low wage offers. Gibbons and Katz (1991) shows that postdisplacement wage offers are lower for workers displaced by layoffs than for those displaced by plant closings; this suggests that important information is contained in the layoff decisions of firms. Since laid-off workers are only able to generate low future wage offers, the “non-indifference principle” applies unless firms provide adequate severance payments. For further discussion, see Rogerson and Wright (1988) or Greenwald (1986). On the other hand, retained workers are inferred to have a higher ability, and are made wage offers to attract them away from their current employers. This implies that firms have to make initial wage offers to workers that are large enough to ensure loyalty.

In a similar framework, Waldman (1984) shows that when a worker’s ability is the private information of his present employer, but other firms are able to observe promotions, firms will tend to promote too few workers. The reason is that promoted workers have to be paid according to their inferred average ability, whereas firms make promotion decisions according to the marginal ability of the worker. In this environment, we find that firms lay off too many workers relative to the efficient allocation. Laing (1994) has also examined the impact of asymmetric information on firms’ layoff decisions. He has also shown that there are too many layoffs and that seniority rules may be able to eliminate this distortion. Seniority rules eliminate some firm discretion in making layoffs, and make it more difficult for firms to infer the ability of workers after observing a layoff decision. We assume perfect discretion when it comes to making layoffs.

Firms do not offer full insurance because high wages are required to retain workers. This results in too many layoffs, and anything less than full-experience rating will just exacerbate the problem. However, the impact of experience rating on severance payments will be positive. With less than full-experience rating, firms do not internalize the full cost of their layoffs, increasing their frequency. With more layoffs, the return to keeping a worker is higher, and, consequently, increasing UI benefits relaxes the constraint on wages. Therefore, private severance payments will decrease by less than the increase in UI benefits, *increasing* the level of insurance.

In the next section, we present the basic model, and then describe the sequence of events governing firm decisions. In Section 3, we characterize the equilibrium in each environment and the impact of government intervention. Finally, we briefly discuss an efficient UI system and provide some concluding remarks. All proofs are in the appendix.

## 2. THE MODEL

This one-period economy is composed of a large number ( $N$ ) of identical risk-averse workers. Their twice continuously differentiable, concave utility function is given by  $U = U(W + R)$ , where  $W$  is outside income and  $R$  is home production.

This home production takes a value of zero if the worker is employed and a positive value of  $r$  if the worker is unemployed. Each worker supplies one unit of effort inelastically to the firm that offers the highest wage.

A large number of identical, perfectly competitive firms each have one job opening. Firms take output prices, which are normalized to one, as given, and are risk neutral. It is assumed that firms have full discretion over their layoff decisions. A worker's productivity depends on a matching variable  $\Theta \in \{0, \theta\}$ , and their employer's investment in capital  $k$ . All firms know the distribution of this matching variable: It takes the value of either  $\theta$  or of zero. We assume that  $E(\Theta) > r$ , implying that some matched workers are more productive at home than at work, but on average matched workers are more productive at work. The firm can improve a worker's productivity by investing in capital. This investment can be interpreted in a very general fashion, as physical capital, managerial human capital, or even investment in a better screening process for hiring. Essentially, this could represent any capital investment that is in place before the worker is hired. The cost of such investment is given by  $c(k)$ , where  $c'(k) > 0$  and  $c''(k) > 0$ . This investment will affect the worker's productivity. The cost of such investment is sunk, and the investment is fully observable by workers. Firms have the opportunity to lay off workers with whom they are badly matched or those who do not exert the required effort. To ensure some positive amount of unemployment, we assume that the firm can only hire at time zero; so workers who are laid off will be unable to find another job.<sup>5</sup> We use a very simple discrete matching technology. A worker's productivity will take the value  $\theta$ , with probability  $q(k)$ , and zero, with probability  $1 - q(k)$ , where  $q'(k) > 0$  and  $q''(k) < 0$ .<sup>6</sup> The advantage of such technology is that layoff decisions are simple; in equilibrium, a worker will be laid off if the match is of value zero and kept when the match is of value  $\theta$ . An inefficient contract will have an impact on layoffs by affecting  $k$  and therefore the probability of a good match.

In this environment, many different types of contracts are possible. Since the goal of this article is not to describe all possible contracts, but rather to look at the impact of the UI system on the substitutability between public and private unemployment benefits, we restrict the type of contracts available in some fairly natural ways to ensure that severance payments arise in equilibrium. First, we assume that firms are able to commit to future wages and severance payments, thus implying they are enforceable contract terms. However, firms cannot commit to layoff decisions at the time of contracting, implying that in equilibrium workers will believe that firms will layoff workers according to profit-maximizing behavior at the time of the layoffs, and not according to any announcements made at the time of contracting. In other words, layoff decisions are time consistent. Moreover, ability, effort, matching productivity, and investments in capital are all assumed to be nonverifiable by a third party, and therefore they cannot be contracted upon.

<sup>5</sup> This assumption can be relaxed. As long as there exists some friction that implies that workers who are laid off do not find a new job instantly, unemployment will still exist.

<sup>6</sup> It is intuitive to interpret  $k$  as an investment prior to hiring to ensure a good match, like a good screening process.

In this model, contracting will not necessarily lead to efficient outcomes. As a consequence, these frictions may motivate government intervention. We consider two different questions related to government intervention. First, if a government wishes to provide some public UI, how can it finance the UI program without introducing further distortions into the firm's contracting and layoff decisions? Second, how does government intervention affect the equilibrium contract offered by the firm, especially the level of insurance provided by the combination of public UI and private severance payments? We only consider government intervention in the provision of UI. The benefit paid to unemployed workers is denoted  $b$ . Further, we assume that the government finances this program by taxing firms. Let  $T$  be the total tax imposed on firms, which is composed of two parts. The first part is a payroll tax  $\tau$ , whereas the second is an experience-rated tax, where firms pay a proportion  $e$  of the total cost they impose on the UI system due to their layoff decisions.<sup>7</sup> Since each firm has only one position, the total tax paid by the firm will be  $\tau$  if the worker hired is retained and  $eb$  if the worker is laid off. The government's total revenue is given by  $T = q\tau + (1 - q)eb$ , where  $q$  is the equilibrium aggregate proportion of workers who are not laid off, and the total spending is given by  $(1 - q)b$ . Given that all firms are identical, the government budget constraint is given by  $(1 - q)(1 - e)b = q\tau$ . Note that under a full-experience rating system ( $e = 1$ ), a payroll tax equal to zero would balance the budget.

The sequence of events is as follows. First, firms choose their level of investment in capital  $k$  and offer a contract  $\{w, s, k\}$ , where  $w$  is the wage and  $s$  is the severance payment offered to a worker if she is laid off. We restrict our attention to contracts where  $w > s$ . Then, workers choose to work or to shirk for the firm that offers the best contract. Next, firms observe the match values of their workers. Firms then choose whether or not to lay off their workers, and pay severance payments or wages depending on their choice. Finally, production takes place, and all payments are made.

Firms compete to attract workers by offering contracts  $\{w, s, k\}$  that maximize the expected utility of workers subject to their zero-profit condition.<sup>8</sup> With this simple layoff decision, the expected utility is given by  $q(k)U(w) + [1 - q(k)]U(s + r + b)$ . The zero-profit condition is given by  $E[\pi] = q(k)[\theta - w - \tau] - [1 - q(k)](s + eb) - c(k) = 0$ . We look at equilibrium contracts in two different contractual environments. In particular, moral hazard and adverse selection each impose additional restrictions on the contracts that firms will choose to offer in equilibrium. We denote such constraints as  $g(w, s, k) = 0$  for the moment, and specify the particular form for each case later. These constraints are affected by the UI system. Varying the level of experience rating may tighten or relax these constraints, implying different results depending on the nature of these constraints.

<sup>7</sup> In practice, experience-rated taxes are implemented at the industry level to provide insurance against any idiosyncratic shocks.

<sup>8</sup> Contracts without severance payments,  $s = 0$  or even  $s < 0$ , may be possible, in particular if  $r$  is large. We assume that  $r$  is sufficiently small so that in equilibrium  $s > 0$ .

The choice of capital investment  $k$  and the contract offered to workers solves the following problem:

$$\max_{w,s,k} q(k)U(w) + [1 - q(k)]U(r + s + b)$$

subject to:  $q(k)[\theta - w - \tau] - [1 - q(k)](s + eb) - c(k) = 0$  and  $g(w, s, k) = 0$

In other words, firms maximize worker's expected utility subject to a zero-profit constraint, and the constraint on wages and severance payments given by the particular labor market environment.

### 3. EQUILIBRIUM

3.1. *Labor Market without Frictions.* To understand how different labor contracting environments influence equilibrium contracts and how that interacts with the UI program, we compare it to the contract offered in a frictionless environment. To do so, we solve for the equilibrium contract when the  $g(w, s, k) = 0$  constraint is not binding.

LEMMA 1. *When the constraint  $g(w, s, k) = 0$  is not binding, the equilibrium contract fully insures workers against unemployment by setting  $w = s + r + b$ .*

Because workers are risk averse, firms equalize the utility of workers across employment states, which implies that  $w = s + r + b$ . This result is well known in the literature.

PROPOSITION 1. *In a frictionless world:*

- (i) *Given any value of  $e$  (and the corresponding  $\tau$ ), workers are fully insured for any level of  $b < w - r$ .*
- (ii) *With full-experience rating, ( $e = 1$  and  $\tau = 0$ ), the investment in capital chosen by firms is such that the net production surplus (which is given by  $q(k)\theta + [1 - q(k)]r - c(k)$ ) is maximized. With less than full-experience rating ( $e < 1$  and  $\tau > 0$ ), firms choose inefficiently low investments in capital, leading to a higher probability of layoffs compared to the capital level, which maximizes the net production surplus.*
- (iii) *Finally, for any UI system with less than full-experience rating, the provision of an unemployment benefit  $b > 0$  reduces workers' ex ante expected utility, whereas a similar system with full-experience rating with (unemployment benefit  $0 < b < w - r$ ) leaves the workers with the same ex ante expected utility.*

Result (ii) is consistent with Topel and Welch (1980). Since in their paper workers were basically risk neutral, production surplus is an appropriate measure of welfare. The introduction of publically provided UI allows firms to reduce their severance payments, and consequently, to reduce the private cost of laying off a

worker. This reduces the firm's incentive to invest in increasing the probability of a good match. With full-experience rating, firms internalize the full cost of their layoffs, and consequently choose the capital investment that maximizes the net surplus given by  $q(k)\theta + [1 - q(k)]r - c(k)$ . Investment in capital is such that  $q'(k)(\theta - r) = c'(k)$ , the marginal increase in the probability of a good match multiplied by the marginal gain from a good match equals the marginal cost of the capital investment. However in the present article, workers are risk averse. Since all firms make zero profit in equilibrium and workers are ex ante identical using ex ante expected utility is a more appropriate measure of welfare. Without frictions in the labor market, firms fully insure workers. Since wages are set through a zero-profit condition, wages will be maximized when the production surplus is maximized. So, not surprisingly (ii) and (iii) lead to identical results.

Part (i) of the proposition is more relevant to the focus of this article. The impact of experience rating on layoff decisions has been well studied. However as mentioned before, the impact of experience rating on the private provision of insurance has received little attention. In a world without frictions, severance payments are a perfect substitute for public UI programs in terms of insurance, since firms fully insure workers anyway.

**3.2. Moral Hazard.** To introduce moral hazard, we assume that after accepting a contract from a firm, but before the match value has been revealed, a worker can make a nonverifiable investment in some specific human capital. If the worker does not make the investment the match is of value zero with probability one; if the worker invests the match value will be  $\theta$  with probability  $q(k)$ .<sup>9</sup> This investment costs  $\alpha$ ; for simplicity, we assume that this cost enters the worker's utility function linearly,  $U = U(W + R) - \alpha$ . Because of the nonverifiability of the investment, wages cannot be contingent on this investment, but workers who do not invest may be laid off. In equilibrium, the firm will choose  $w > s$ , and will lay off all workers with low match values (zero), and will retain all workers with good match values ( $\theta$ ). A worker chooses to make the investment (or effort) if  $q(k)U(w) + [1 - q(k)]U(s + r + b) - \alpha \geq U(s + r + b)$ . The problem faced by firms is the same as defined in Section 2 where the function  $g(w, s, k) = 0$  is the incentive constraint given above.

**LEMMA 2.** *With moral hazard, the equilibrium contract offers imperfect insurance,  $w > s + r + b$ .*

This result is not surprising; to satisfy the incentive constraint, firms must create a gap between the wages offered and the unemployment package, so workers find

<sup>9</sup>This way of introducing moral hazard departs from the standard shirking model, where a worker has the choice between working hard (investing  $\alpha$ ) and shirking. If she works hard, she can stay with the firm and her payoff is  $U(w) - \alpha$ . On the other hand, if she chooses to shirk, then she faces the probability  $q(k)$  of being caught where  $q'(k) > 0$ . If caught, her payoff is  $U(s + r + b)$ , but if she is not, her payoff is  $U(w)$ . Her expected utility from shirking is therefore  $(1 - q(k))U(w) + q(k)U(s + r + b)$ . In this interpretation, the nonshirking constraint is identical to that used in this model. The problem of using the standard approach is that in equilibrium there are no layoffs, so it is hard to talk about UI.



it preferable to make the investment (or to provide effort). Since workers are not fully insured, unemployment insurance may be justified if it improves insurance to workers by increasing the welfare of laid-off workers. However, this has obvious consequences for the firm's ability to extract effort.

PROPOSITION 2. *With the presence of moral hazard:*

- (i) *Under full-experience rating ( $e = 1$ ), an increase in  $b$  is counteracted by an equal reduction in  $s$ . With less than full-experience rating ( $e < 1$ ), an increase in  $b$  is compensated by a larger reduction in the severance payment.*
- (ii) *With full-experience rating ( $e = 1$ ), the investment in capital chosen by a firm is such that the net production surplus (which is given by  $q(k)\theta + [1 - q(k)]r - c(k)$ ) is not maximized. More specifically, firms overinvest compared to the investment that would maximize surplus.*
- (iii) *Finally, for any UI system with less than full-experience rating, the provision of an unemployment benefit  $b > 0$  reduces workers' ex ante expected utilities, whereas a similar system with full-experience rating (with unemployment benefit  $0 < b < w - r$ ) leaves the workers with the same ex ante expected utility.*

The first result of Proposition 2 is important: It describes what happens to private severance payments when the government provides UI benefits at different levels of experience rating. When  $e = 1$ , a firm who lays off a worker pays the full cost of the layoff, so the UI benefit and the severance payment are perfect substitutes. Consequently, the firm's layoff decisions are not affected by changes in benefits,  $b$ . However, when  $e < 1$ , since firms do not internalize the full cost of their layoffs, an increase in  $b$  is associated with an increase in layoffs (which implies a decrease in  $k$ ). More layoffs imply that the incentive constraint becomes harder to satisfy, because those workers who choose to invest receive the wage  $w$  with a lower probability. Consequently, the difference between  $w$  and  $s + r + b$  must increase. This implies that private severance payments decrease by more than the increase in  $b$ . Therefore, workers receive less insurance.

The second part of Proposition 2 considers the level of capital investment with full-experience rating compared to the level that maximized the production surplus. Capital investment is lower than optimal, implying that the level of unemployment is too high. The intuition is as follows. Because workers are not fully insured, the probability of being laid off affects the expected utility of a worker. By reducing the probability of layoffs with a larger investment in  $k$ , firms can attract workers at a lower cost. The intuition of such a result is along the same lines as Acemoglu and Shimer (1999). The added contribution is that for the UI system to increase production surplus, there has to be imperfect experience rating. Less than full-experience rating could positively affect production surplus. Low levels of experience rating increase layoffs, and by doing so, can relax incentive constraints.

The first two parts of the proposition state that with less than full-experience rating, UI crowds out private severance by more, leaving the worker less insured.

On the other hand, such a system provides better incentives in terms of maximizing the surplus. One may think that the second argument is a justification for less than full experience. However, the reduction in insurance harms workers. The last part of the Proposition 2 concludes that the cost due to the reduction in the insurance coverage outweighs the benefit of higher production surplus. Consequently, full-experience rating system maximizes the workers' ex ante expected utility, leaving no valid reason for the use of a less than full-experience UI system.

*3.3. Asymmetric Information.* The next model is one where firms have private information about the quality of their own workers. Waldman (1984) demonstrated that firms who have private information about the quality of their workers will distort their promotion behavior in equilibrium. When promotion is observable, outside firms make inferences about the ability of promoted workers and may try to bid them away. Promotions are based on the marginal ability of workers, but because the wages required to retain promoted workers are based on their inferred average ability, firms will tend to promote too few workers. Gibbons and Katz (1991) applied the same intuition to layoff choices.

We introduce this type of inefficiency in a very simple way. Instead of  $\theta$  being a firm-specific match value, we now interpret it as a general skill ability. This is essentially a lemons problem: A firm can invest  $k$  units of effort to find out which workers from the pool of applicants are good, that is, have ability  $\theta$ . A larger investment yields a higher probability  $q(k)$  of finding a good worker. Once hired, the worker's true ability is revealed to both the worker and the firm.<sup>10</sup> With probability  $q(k)$ , the worker has a high ability level of  $\theta$ , and with probability  $1 - q(k)$ , the worker has a low ability level of zero. The cost of effort  $k$  is  $c(k)$ , and the previous assumptions on this function apply.

Because of the interaction between the worker's general skill and the firm's competitive behavior, we need to introduce some firm-specific human capital. The productivity of the worker at the original firm is given by the ability of the worker multiplied by  $(1 + f)$ , which represents some learning by doing or specific human capital. Such an assumption is common in this literature; see Waldman (1984) or Scoones and Bernhardt (1998).

If a worker's ability is revealed to be zero, then the firm will lay off the worker as long as  $w \geq s$ , and this worker will join the pool of unemployed workers. On the other hand, if the worker's ability is  $\theta$ , the firm will keep the worker. When a firm decides to keep a worker, it is essentially advertising that the worker has high ability. We assume that new firms with the same production function and with an open position can try to attract these high-ability workers. The after-tax productivity of a worker at a new firm is given by  $\theta - \tau$ , which is the wage offered by those firms. Consequently, if the original firm wants to retain the worker, they need to match this wage offer, imposing the constraint  $w \geq \theta - \tau$ .<sup>11</sup> Here again,

<sup>10</sup> We assume that workers do not know their ability level prior to the match to eliminate the possibility of screening contracts.

<sup>11</sup> It is assumed here that a worker can freely move to another firm. Moreover, if severance payments are negative, workers could optimally decide to stay even if the alternate wage offer is better. However, such types of contracts will provide bad insurance, and if workers are sufficiently risk averse, it will not be optimal for the firm to offer it because of the large risk premium it must include.

the problem faced by firms is the same as in Subsection 3.1, where the function  $g(w, s, k) = 0$  is simply  $w = \theta - \tau$ .

LEMMA 3. *Under asymmetric information, the equilibrium contract does not fully insure workers against unemployment, implying  $w > s + r + b$ .*

It is impossible for the firm to fully insure workers with severance payments and simultaneously satisfy the zero-profit condition because of the high wages they need to offer to workers they choose to retain.

PROPOSITION 3. *With asymmetric information:*

- (i) *Under full-experience rating ( $e = 1$ ), an increase in  $b$  is counteracted by an equal reduction in  $s$ . With less than full-experience rating ( $e < 1$ ), an increase in  $b$  is compensated by a smaller reduction in the severance payment.*
- (ii) *With full-experience rating ( $e = 1$ ), the investment in capital chosen by firms is such that the net production surplus (which is given by  $q(k)\theta + [1 - q(k)]r - c(k)$ ) is not maximized. More specifically, firms underinvest compared to the investment that would maximize this surplus.*
- (iii) *Finally, for any UI system with less than full-experience rating, the provision of an unemployment benefit  $b > 0$  reduces workers' ex ante expected utility, whereas a similar system with full-experience rating (with unemployment benefit  $0 < b < w - r$ ) leaves the workers with the same ex ante expected utility.*

With full-experience rating, a firm that lays off a worker pays the full cost of the layoff, so the UI benefit and the severance payment are perfect substitutes. Consequently, the firm's layoff decision is not affected by an increase in  $b$ . This result is the same as in the moral-hazard case. The reason is that in both cases, incentive constraints are not affected by changes in the UI benefit  $b$  when  $e = 1$ .

However, when  $e < 1$ , an increase in  $b$  is associated with a smaller decrease in the private severance payment,  $s$ . By keeping a worker, a firm sends a signal to outside firms that the worker is of high ability, and consequently, the wage offered to these workers needs to be sufficiently high to prevent them from being hired away by other firms. The profits a firm will enjoy from keeping a worker depends on specific human capital. When  $f$  is small, firms do not generate enough profit to be able to fully insure workers, because of the zero-profit condition. To understand what is happening to  $s$  when  $b$  increases, imagine that  $b$  increases by \$1. If firms reduce their severance payments by \$1, workers will now be receiving the same severance package, but because  $e < 1$  the zero-profit condition will no longer bind. This result comes from the fact that the cost of a layoff is  $s + eb$ . Because workers are risk averse and not fully insured, firms will attract workers by increasing the severance package. To do so, firms reduce the severance payment by less than \$1. Increasing the UI benefit in this environment relaxes the zero-profit constraints, leading to a higher level of insurance for workers. This is exactly the opposite of the moral-hazard case.

For the second part of Proposition 3, consider the case where  $\tau = 0$  and  $e = 1$ . In such a case, there will be too many layoffs due to the small investment in capital. Because wages are high relative to the severance payment package, firms extract a lower surplus from workers they retain. Consequently, firms have less incentive to undertake effort to keep workers, implying that the investment in  $k$  is lower, and the probability of layoff is higher. This implies that full-experience rating is desirable since it does not contribute to further layoffs.

Similar to the previous section, insurance and surplus maximization move in opposite direction when you introduce UI with less than full-experience rating. The conclusion is also the same as for the case of moral hazard; full-experience rating actually maximizes the ex ante expected utility for the same reason as before.

#### 4. CONCLUSION

In this article, the response of private insurance to changes in the level of experience rating within an UI system is analyzed under different types of market structure. At first glance, it looked like such a consideration could provide an argument against the use of high levels of experience rating. In an environment with moral hazard, a less than fully experience-rated UI system can increase production surplus. On the other hand, less than full experience rating can improve the insurance coverage workers receive when asymmetric information is present. However, a proper investigation reveals that full experience rating is more suited to maximizing workers' ex ante expected utility. The question as to why such low levels of experience rating are used worldwide remains unanswered. However, one thing this article does suggest is that partial experience rating, like the one used in the United States, will have varying consequences for the number of layoffs and the degree of worker insurance across industries, depending on the nature of contractual frictions that are present.

#### APPENDIX

A.1. *Proof of Lemma 1.* The first-order conditions of the firm's problem can be rewritten as follows:

$$(A.1) \quad U'(w) - \lambda = 0$$

$$(A.2) \quad U'(r + s + b) - \lambda = 0$$

$$(A.3) \quad q'(k)[U(w) - U(s + r + b)] + \lambda[q'(k)(\theta - w - \tau + s + eb) - c'(k)] = 0$$

$$(A.4) \quad q(k)[\theta - w - \tau] - [1 - q(k)](s + eb) - c(k) = 0$$

Equations (A.1) and (A.2) represent the trade-off between  $w$  and  $s$ , whereas Equation (A.3) dictates the choice of  $k$ , where  $\lambda$  is the Lagrange multiplier on the

zero-profit constraint. Finally, Equation (A.4) is just the zero-profit condition. We can see that from (A.1) and (A.2) that  $w = r + s + b$ . This implies that  $k$  is given by  $q'(k)[\theta - r - \tau - (1 - e)b] = c'(k)$ . ■

### A.2. Proof of Proposition 1.

- (i) Since  $w = s + r + b$ , workers are fully insured for all levels of  $e$ . Note that if  $b > w - r$  worker would be better off by being laid off. We abstract from such cases.
- (ii) First note that the production surplus is given by  $q(k)\theta + [1 - q(k)]r - c(k)$ , which is maximized when  $q'(k)(\theta - r) = c'(k)$ . Under full experience rating,  $\tau = 0$  and  $e = 1$ , so (A.3) simply becomes  $q'(k)(\theta - r) = c'(k)$ . When  $e < 1$  and  $\tau > 0$ , (A.3) becomes  $q'(k)[\theta - r - \tau - (1 - e)b] = c'(k)$ , given that  $q''(k) < 0$  and  $c''(k) > 0$ , it implies that  $k$  is smaller than the investment that maximized the production surplus. Consequently, the probability of a bad match is too high.
- (iii) Given that  $w = r + s + b$  the ex ante expected utility is simply given by  $U(w)$ , so the contract that maximizes  $w$  also maximizes  $U(w)$ . Because of the zero-profit condition, we know that the wage is given by  $q(k)[\theta - w - \tau] - [1 - q(k)](w - r - b + eb) = c(k)$ , or equivalently  $w = q(k)[\theta - \tau] + [1 - q(k)][r + (1 - e)b] - c(k)$ . The government budget constraint says that  $q(k)\tau = (1 - e)[1 - q(k)]b$ , so  $w = q(k)\theta + [1 - q(k)]r - c(k)$ , which take its highest value for  $e = 1$ . ■

A.3. Proof of Lemma 2. The first-order conditions of the firm's problem can be rewritten in the following way:

$$(A.5) \quad (1 + \mu)U'(w) - \lambda = 0$$

$$(A.6) \quad [(1 - q(k) + q(k)\mu)U'(r + s + b) - [1 - q(k)]\lambda = 0$$

$$(A.7) \quad q'(k)(1 + \mu)[U(w) - U(r + s + b)] \\ + \lambda[q'(k)(\theta - w - \tau + s + eb) - c'(k)] = 0$$

$$(A.8) \quad q(k)[\theta - w - \tau] - [1 - q(k)](s + eb) - c(k) = 0$$

$$(A.9.) \quad q(k)[U(w) - U(r + s + b)] - \alpha = 0$$

Equations (A.5) and (A.6) represent the trade-off between  $w$  and  $s$ , whereas Equation (A.7) dictates the choice of  $k$ ,  $\lambda$  is the Lagrange multiplier on the zero-profit constraint, and  $\mu$  is the Lagrange multiplier on the incentive constraint. Finally, Equations (A.8) and (A.9) are the zero-profit condition and the incentive constraint. Using Equations (A.5) and (A.6), we get the following equation:  $(1 + \mu)(1 - q(k))U'(w) = [(1 - q(k) + q(k)\mu)U'(r + s + b)]$ . It is easy to see that  $(1 + \mu)(1 - q(k)) > [1 - q(k) + q(k)\mu]$ , and given the concavity of the utility function,  $w > r + s + b$ . ■

#### A.4. Proof of Proposition 2.

- (i) To solve for  $\frac{\partial s}{\partial b}$ . Let  $J$  be the  $5 \times 5$  Jacobian matrix of the derivatives of (A.5) to (A.9) with respect to  $w, s, k, \lambda$ , and  $\mu$ . Let  $J_b$  be the  $5 \times 5$  matrix, where we replace in the Jacobian matrix the column of derivatives of the first-order condition with respect to  $s$  with the derivative of the first-order condition (A.5) to (A.9) with respect to  $b$ . Using Cramer's rule,  $\frac{\partial s}{\partial b} = \frac{|J_b|}{|J|}$ . Using the envelope theorem, we get that  $|J| = X$ , where  $X$  is the sum of 20 terms (available upon request). If the second-order condition is satisfied, the bordered Hessian needs to have the same sign as  $(-1)^5$ —so it is negative. Since  $|J|$  is the second derivative of the Lagrangian function, which implies that for the second-order condition to be satisfied, the fifth of principal minor needs have the same sign as  $(-1)^{5+1}$ . The fifth principal minor is just  $|J|$ , so  $X > 0$ . On the other hand,  $|J_b| = Y + eZ$ , where  $Z$  is the sum of four positive terms (available upon request). Moreover, if  $e = 1$ , then  $X = -(Y + Z)$ . This implies that if  $e = 1$ , then  $\frac{\partial s}{\partial b} = -1$ . When  $e < 1$ , then  $\frac{\partial s}{\partial b} = \frac{Y + eZ}{X}$ . Because  $Z > 0$ , when  $e < 1$ ,  $Y + eZ < Y + Z = -X$ , so  $\frac{\partial s}{\partial b} = \frac{Y + eZ}{X} < -1$ .
- (ii) The investment that maximized the production surplus  $k^*$  is given by  $q'(k^*)[\theta - r] = c'(k^*)$ . Let us evaluate the first-order condition of (A.7) with respect to  $k$ , at the first-best outcome  $k^*$ . As long as the second-order condition is satisfied, if the first-order condition evaluated at  $k^*$  is positive it implies that the equilibrium  $k$  is larger than the optimal value, whereas if the first-order condition is negative, it implies that the equilibrium  $k$  is lower. The first-order condition of (A.7) evaluated at  $k^*$  is given by

$$q'(k^*)(1 + \mu)[U(w) - U(s + r + b)] \\ + U'(w)(1 + \mu)[q'(k^*)(\theta - w - \tau + s + eb) - c'(k^*)]$$

If we use the first-order condition for the first-best problem  $c'(k^*) = q'(k^*)[\theta - r]$ , we get

$$q'(k^*)(1 + \mu)[U(w) - U(s + r + b)] \\ + U'(w)q'(k^*)(1 + \mu)[(\theta - w - \tau + s + eb) - (\theta - r)]$$

The sign of this expression evaluated at  $e = 1$  and  $\tau = 0$  is the same as the following expression:

$$[U(w) - U(s + r + b)] - U'(w)[w - (s + b + r)]$$

By concavity, this expression is strictly positive, so firms overinvest compare to the investment that maximize the production surplus.

- (iii) Taking the derivative of the Lagrangian function with respect to  $b$  tells us how an increase in  $b$  affect a worker's expected utility under the optimal contract. Using the envelope theorem, such a derivative is given by  $[(1 - q(k)) + \mu q(k)]U'(r + s + b) - \lambda[1 - q(k)]e$ . Using first-order condition

(A.6) the expression becomes  $(1 - e)[(1 - q(k)) + \mu q(k)]U'(r + s + b)$ . For any  $e < 1$ , an increase in  $b$  translates itself to a decrease in workers' expected utility, whereas if  $e = 1$  the expected utility at the optimum is unaffected by  $b$ . ■

A.5. *Proof of Lemma 3.* The first-order conditions of the firm's problem can be rewritten as follows:

$$(A.10) \quad q(k)U'(w) + \mu - \lambda q(k) = 0$$

$$(A.11) \quad U'(r + s + b) - \lambda = 0$$

$$(A.12) \quad q'(k)[U(w) - U(s + r + b)] \\ + \lambda[q'(k)(\theta(1 + f) - w - \tau + s + eb) - c'(k)] = 0$$

$$(A.13) \quad q(k)[\theta(1 + f) - w - \tau] - [1 - q(k)](s + eb) - c(k) = 0$$

$$(A.14) \quad w - \theta + \tau \geq 0 \quad [w - \theta + \tau]\mu = 0$$

Equations (A.10) and (A.11) represent the trade-off between  $w$  and  $s$ , whereas Equation (A.12) dictates the choice of  $k$ ,  $\lambda$  is the Lagrange multiplier on the zero-profit constraint, and  $\mu$  is the Lagrange multiplier on the wage constraint. Finally, Equations (A.13) and (A.14) are the zero-profit condition and the wage constraint. Using Equations (A.10) and (A.11), we get the following equation  $U'(w) + \frac{\mu}{q(k)} = U'(r + s + b)$ . The concavity of the utility function implies that  $w > r + s + b$ . Note that if  $f$  was large enough, such that the first-best contract (the one which solves (A.10) to (A.13)) would give a  $w > \theta - \tau$ , then the last constraint would not be binding, and the first-best contract would be the equilibrium. Since we want to concentrate on second-best world, we will assume that  $f$  is small enough so (A.14) binds. ■

A.6. *Proof of Proposition 3.*

- (i) We will solve for  $\frac{\partial s}{\partial b}$ . We simplify the first-order condition by substituting  $w = \theta - \tau$  in the first four equations:

$$(A.15) \quad q(k)U'(\theta - \tau) + \mu - \lambda q(k) = 0$$

$$(A.16) \quad U'(r + s + b) - \lambda = 0$$

$$(A.17) \quad q'(k)[U(\theta - \tau) - U(s + r + b)] \\ + \lambda[q'(k)(\theta f + s + eb) - c'(k)] = 0$$

$$(A.18) \quad q(k)[\theta f] - [1 - q(k)](s + eb) - c(k) = 0$$

Let  $J$  be the  $4 \times 4$  Jacobian matrix of the derivatives of the above first-order conditions with respect to  $s, k, \lambda,$  and  $\mu,$  and  $J_b$  be the  $4 \times 4$  matrix substituting the column of derivatives with respect to  $s$  with the derivatives with respect to  $b.$  Using Cramer's rule,  $\frac{\partial s}{\partial b} = \frac{|J_b|}{|J|}.$  Using the envelope theorem,  $|J| = -[1 - q(k)]X - U''(s + b + r)[q'(k)(\theta f + s + eb) - c'(k)] > 0,$  where  $X < 0$  is the derivative of (A.12) with respect to  $k.$  On the other hand,  $|J_b| = e[1 - q(k)]X + U''(s + b + r)[q'(k)(\theta f + s + eb) - c'(k)] < 0.$  This implies that if  $e = 1,$  then  $\frac{\partial s}{\partial b} = -1.$  When  $e < 1,$  then  $\frac{\partial s}{\partial b} = \frac{e[1 - q(k)]X + U''(s + b + r)[q'(k)(\theta f + s + eb) - c'(k)]}{-[1 - q(k)]X - U''(s + b + r)[q'(k)(\theta f + s + eb) - c'(k)]}.$  It is easy to show that  $e[1 - q(k)]X + U''(s + b + r)[q'(k)(\theta f + s + eb) - c'(k)] < [1 - q(k)]X + U''(s + b + r)[q'(k)(\theta f + s + eb) - c'(k)],$  so  $\frac{\partial s}{\partial b} > -1.$

- (ii) The first-best investment in  $k^*$  is given by  $q'(k^*)[\theta(1 + f) - r] = c'(k^*).$  Let us evaluate the first-order condition of (A.17) with respect to  $k,$  at the first-best outcome. As long as the second-order condition is satisfied, if the first-order condition evaluated at  $k^*$  is positive it implies that the equilibrium  $k$  is larger than the optimal value, whereas if the first-order condition is negative it implies that the equilibrium  $k$  is lower. The first-order conditions (A.17) and (A.16) evaluated at  $k^*$  are given by

$$\begin{aligned} & q'(k^*)[U(w) - U(s + r + b)] \\ & + U'(s + r + b)[q'(k^*)(\theta f + s + eb) - c'(k^*)] \end{aligned}$$

If we use the first-order condition for the first-best problem,  $c'(k^*) = q'(k^*)[\theta(1 + f) - r],$  we get

$$\begin{aligned} & q'(k^*)[U(w) - U(s + r + b)] \\ & + U'(s + r + b)q'(k^*)[(\theta f + s + eb) - \theta(1 + f) + r] \end{aligned}$$

The sign of this expression evaluated at  $e = 1$  and  $\tau = 0$  is the same as the following expression:

$$[U(w) - U(s + r + b)] - U'(s + r + b)[w - (s + b + r)]$$

By concavity, this expression is strictly negative, so the second-best investment  $k$  is lower than the optimum.

- (iii) Taking the derivative of the Lagrangian function with respect to  $b$  tells us how an increase in  $b$  affect a worker's expected utility under the optimal contract. Using the envelope theorem, such a derivative is given by  $[1 - q(k)]U'(r + s + b) - \lambda[1 - q(k)]e.$  Using first-order condition (A.11) the expression becomes  $(1 - e)[1 - q(k)]U'(r + s + b).$  For any  $e < 1,$  an increase in  $b$  translates itself to a decrease in workers' expected utility, whereas if  $e = 1,$  the expected utility at the optimum is unaffected by  $b.$  ■



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