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Incentive Contracts and Efficient Unemployment Benefits*

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Abstract

Several European countries have reformed their labor market institutions. Incentive effects of unemployment benefits have been an important aspect of these reforms. We analyze this issue in a principal-agent model, focusing on unemployment levels and labor productivity. In our model, a higher level of unemployment benefits improves the workers' position in wage bargaining, leading to stronger effort incentives and higher output. However, it also reduces incentives for labor market participation. Accordingly, there is a trade-off. We analyze how changes in the economic environment such as globalization and better educated workers affect this trade-off.

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1 Introduction

This paper analyzes the effect of benefit payments on worker productivity and unemployment levels. We assume that relationships between firms and wealth-constrained workers suffer from moral hazard since effort on the job is non-contractible. Higher unemployment benefits improve the workers' bargaining position in contract negotiations. As a result, they receive a larger share of the surplus, which strengthens their effort incentives. On the other hand, there will be more workers leaving the labor force. The optimal level of unemployment benefits balances this trade-off.

In recent years, a number of countries have undergone substantial reforms of their labor market institutions. Often, this involved reductions in the level or duration of unemployment benefits. For example, in Germany unemployment benefits amounted to 67% of the last net income and were paid for up to 32 months. Thereafter, the unemployed received an unlimited assistance of 57% of their last net income.[1] In 2005 this was substantially changed with the so-called Hartz IV legislation. Now, unemployment benefits are usually paid for 12 months. Thereafter, the unemployed receive a fixed payment that does not depend on the previous wage and equals the payment to those people who have never worked.[2] Other countries have implemented similar reforms that reduced unemployment benefits (see Saint-Paul (2004), Nickell, Nunziata, and Ochel (2005)).

This raises two questions, both addressed in this paper. First, which factors determine the optimal level of unemployment benefits? Second, can changes in these factors contribute to our understanding why many countries have recently reduced these benefit payments? In our model higher unemployment benefits improve the workers' threat point in contract negotiations. This may result in higher effort and output (see Pitchford (1998); Demougin and Helm (2006)). Furthermore, we will show that globalisation, which we model as a better outside option of firms if contract negotiations with domestic workers fail, has weakened this effort-enhancing effect of unemployment benefits.

In particular, we consider an environment with a continuum of workers that differ in their skill level so that they are of different productivity. Workers are wealth-constrained and their effort is non-contractible, leading to moral hazard. They are randomly matched with firms and bargain with them about linear incentive contracts. Initially, we focus on the case of a sin-

[1] Without children the respective levels were 60% and 53%.

[2] See Jacobi and Kluve (2006) for a description and first assessment of the Hartz legislation.

gle representative firm. However, we also consider an extension where firms differ in their outside option.

A higher level of unemployment benefits improves the workers' threat point and, thereby, their bargaining power. As a consequence, the workers' share of the total surplus from an employment relationship rises.[3] Furthermore, the structure of the incentive contract changes. For inefficiently low effort levels, as the workers' bargaining power improves they are allocated a higher share of the surplus by raising the incentive component of the wage contract. This increases effort and, thereby, overall surplus. Once effort is first-best, further improvements in the workers' bargaining power are compensated by increasing the fixed payment to them.

Accordingly, up to a certain level higher unemployment benefits improve the overall surplus from an employment relationship. However, there is a trade-off since higher benefits reduce the number of firm/worker matches for which the joint surplus exceeds the sum of their outside options. Hence more workers become unemployed. The optimal level of unemployment benefits balances these two effects.

We also examine how this mechanism is affected by changes in the economic environment. In particular, if workers' skills improve, e.g. due to better education, benefit payments should be raised. The reason is that workers' effort on the job becomes more valuable the better their skills. Globalisation has an opposite effect. As firms' profit opportunities from moving their capital abroad improve, there will be less domestic employment. Accordingly, the effort-enhancing effect of unemployment benefits becomes less important.

Obviously, linear incentive contracts are just one out of several instruments that are used to incentivize workers. Other examples include promotions, subjective performance evalutions and deferred compensation (see Prendergast (1999)). Reflecting this variety in a single analytical model is not feasible. We have chosen to focus on linear incentive contracts because they straightforwardly capture the main idea which drives our results: that higher wages are often associated with higher effort incentives. Furthermore, linear incentive contracts appear as a suitable modelling device because they are used for different segments of the labor force.

Our paper contributes to the rich literature on the incentive effects of unemployment benefits (see Holmlund (1998) and Fredriksson and Holmlund (2006) for surveys). A part of this literature also finds that there may be

[3] See van der Horst (2003) for empirical evidence that an increase in the replacement rate (the proportion of in-work income that is maintained for somebody becoming unemployed) enables workers to negotiate a higher wage rate. Similarly, there exists evidence for a positive relationship between unemployment benefits and reemployment earnings (e.g., Burgess and Kingston (1976)).

a trade-off between productivity and unemployment levels. However, the mechanism by which this result occurs is a different one. While it is common to focus on moral hazard in the search effort of unemployed agents, we analyze effects of moral hazard during an employment relationship. In this respect, the two approaches complement each other.

Acemoglu and Shimer (1999) and Acemoglu and Shimer (2000) consider a search model with risk-averse workers. Unemployment insurance encourages workers to take the risk of applying for high wage jobs, and firms respond by creating more capital-intensive, high productivity jobs. Thereby, output is raised, but also the risk of becoming unemployed. Moreover, due to moral hazard workers may respond to higher benefit payments by reducing their search effort. Marimon and Zilibotti (1999) as well as Diamond (1981) also stress the role of unemployment benefits as a "search subsidy" that allows the unemployed to take the time necessary to find a suitable job.[4] Mortensen (1977) emphasizes the entitlement effect which arises since unemployed people are often not eligible to benefit payments (see also Fredriksson and Holmlund (2001)). Therefore, high unemployment benefits provide an additional incentive to seek employment so as to become entitled to them in the case of a future job loss.

Our paper is also related to the literature on efficiency wages since both focus on endogenous work effort. In the efficiency wage model, higher unemployment benefits reduce the costs of shirking and, therefore, effort incentives (Shapiro and Stiglitz (1984)). However, the opposite result arises when the regulator can pay lower unemployment benefits to agents that have been shirking, as compared to agents that have lost their job for other reasons. In this case, the spread between the utility from shirking and non-shirking increases, which strengthens effort incentives (Goerke (2000)).[5]

The remainder of the text is structured as follows. After introducing the basic model (section 2), we analyze contract negotiations for an individual firm/worker match (section 3). In section 4, we examine the effect of unemployment benefits on effort incentives and participation decisions. Section 5 determines the optimal level of social benefits. In section 6 we analyze the comparative statics for worker skills and firm mobility. Finally, in the concluding section 7 we present some empirical evidence for our analytical results and the underlying mechanism.

[4] Other important contributions that focus on moral hazard in search effort in their analysis of optimal employment insurance are Shavell (1979) and Hopenhayn and Nicolini (1997).

[5] Wang and Williamson (1996) also assume that the probability of remaining employed depends on a worker's effort.

2 The model

We consider an environment populated by a continuum of risk neutral firms and risk neutral workers of equal measure. Firms are identical. Workers differ in their respective skills, which are measured by the parameter $\gamma \in \mathbb{R}^+$ and distributed according to the density function $f(\gamma)$.[6] Workers and firms are randomly matched in pairs. After the matching, each firm observes the worker's skill and negotiates with him an employment contract. The value of a match with a γ worker undertaking effort $a \in \mathbb{R}^+$ is $\gamma v(a)$, where $v(a)$ is increasing concave and satisfies the Inada conditions. All workers have the same effort cost function $c(a)$, which is increasing and convex with $c'(0) = 0$.

Labor relationships suffer from a moral hazard problem with respect to the worker's effort. However, effort generates a contractible signal which the firm can use to align incentives. As is well known from the literature, due to the risk-neutrality we can restrict attention to a binary signal $m \in \{0, 1\}$, where $m = 1$ is the favorable signal (see Milgrom (1981)).[7] We denote with $p(a)$ the probability of observing the favorable signal given the worker's effort and assume $p'(a) > 0, p''(a) < 0$.[8] In addition, we assume that workers are financially constrained requiring wage payments to be non-negative.[9] Due to the structure of the problem, contracts will be binary; the worker always receives a fixed payment F and, in addition, a bonus b when $m = 1$, whereby payments must satisfy $F, F + b \geq 0$.

A priori, the optimal contract negotiated by a specific firm/worker pair will depend on the skill parameter γ characterizing that particular match. However, in order to keep notation to a minimum, we suppress this dependence on γ whenever possible without confusion. Consider now such a firm/worker match: If negotiations are successful and the worker undertakes effort a, it leads to the payoffs

$$U \equiv F + bp(a) - c(a), \tag{1}$$

$$\Pi \equiv \gamma v(a) - F - bp(a) \tag{2}$$

for the worker and the firm respectively. Alternatively, if negotiations fail, the parties receive their respective outside opportunities; the worker becomes

[6]The assumption of a productivity close to zero may seem rather strong. However, it reflects the widely expressed concern that a certain percentage of the potential workforce lacks even the most basic prerequisites for employment.

[7]Specifically, in a risk-neutral agency problem all relevant information from a mechanism design point of view can be summarized by a binary statistic (see, e.g., Kim (1997)).

[8]These conditions guarantee that the agent's problem is well behaved. They are equivalent to considering binary signals satisfying MLRC and CDFC within the class of differentiable signals with constant support.

[9]Otherwise the first-best is obtainable, as is well known from the literature.

unemployed, obtaining benefit payments $s \geq 0$, while the firm invests its capital elsewhere, receiving $r \geq 0$. We refer to contracts that lead to $U \geq s$ and $\Pi \geq r$ as "mutually beneficial".

Altogether, the game proceeds as follows. First, the regulator chooses unemployment benefits. Second, firms and workers are randomly matched in pairs. Third, each pair negotiates an incentive contract. If negotiations fail, the parties receive their respective outside opportunity. Otherwise, the worker undertakes effort, the signal is realized and payments are made. In the remaining, the game is solved by backwards induction.

3 Negotiations of incentive contracts

In this section, we consider a firm/worker match for which a mutually beneficial, incentive-compatible contract exists. At the last stage of the game, if negotiations were successful, the worker faces a contract $\{F, b\}$ and chooses effort to maximize his payoff. The shape of $p(a)$ and $c(a)$ imply a concave payoff function for the agent. Thus, effort follows from the first-order condition of (1):

$$bp'(a) = c'(a). \tag{3}$$

In the preceding stage of the game, parties negotiate the contract. For the moment, we abstract from the specific bargaining process, but assume that it leads to efficient outcomes subject to the incentive, wealth and participation constraints (examples for which this is the case are the alternating offer game, the egalitarian solution and the Nash bargaining solution).[10] Analytically, the set of efficient outcomes, hereafter the constrained Pareto frontier (CPF), is defined as the set of payoff pairs (Π, U) that arise if we maximize the firm's payoff, thereby varying the constraint on the worker's payoff $\overline{U}$:

$$\max_{a,F} \; \gamma v(a) - F - B(a), \quad \text{s.t.} \tag{I}$$

$$B(a) = \frac{c'(a)p(a)}{p'(a)}, \tag{IC}$$

$$F \geq 0, \tag{FC}$$

$$F + B(a) - c(a) \geq \overline{U}. \tag{PC}$$

Here, (IC) is the incentive-compatibility constraint that follows from (3), where $B(a) \equiv b(a)p(a)$. Accordingly, $B(a)$ is the expected bonus which the

[10] The latter will be analyzed in more detail below.

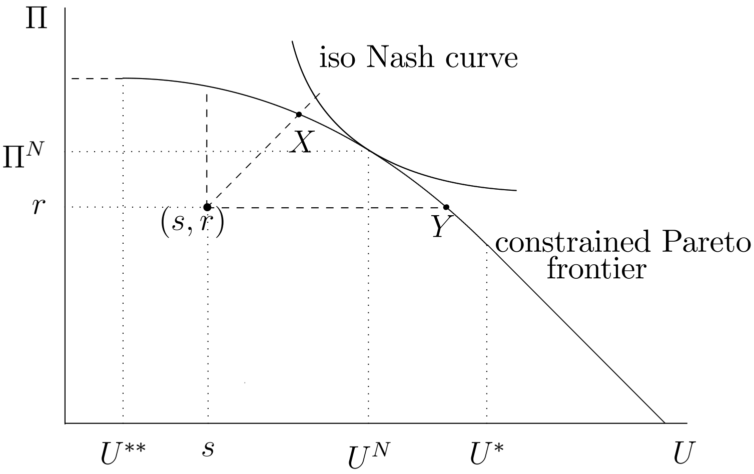

Figure 1: Contract Negotiations

firm has to pay in order to induce effort a. We assume that $B(a)$ is convex, which ensures that the first-order condition of the Langragian is sufficient. Condition (FC) is the worker's financial constraint, and (PC) is the constraint that assures participation of the worker.

Figure 1 depicts the CPF. First, consider the case $\overline{U} = 0$. From the curvature assumptions, $B(a) - c(a)$ is positive and increasing in effort. Hence, for any strictly positive effort the worker's participation constraint (PC) cannot bind, and the agent receives a strictly positive rent. Moreover, F enters negatively into the firm's profit function so that $F = 0$. Thus, the firm's profits can be written as

$$\Pi = \gamma v(a) - c(a) - [B(a) - c(a)], \tag{4}$$

where the term in square bracket is the agent's rent. Writing the profit this way emphasizes that the firm compensates the agent for his effort costs and, in addition, pays him a rent. Since the marginal rent is positive, the ensuing effort level, a^{**}, will be below the first-best effort, a^*, which solves $\max \Pi + U$, yielding

$$\gamma v'(a^*) - c'(a^*) = 0. \tag{5}$$

Second, raising the constraint on the worker's payoff, $\overline{U}$, does not affect the outcome of the contract until $\overline{U} = U^{**} \equiv B(a^{**}) - c(a^{**})$. Accordingly, the dashed segment of the curve in figure 1 does not belong to the CPF since such payoff profiles cannot arise from an incentive-compatible contract.

Third, when $\overline{U} \geq U^{**}$, further increases in $\overline{U}$ must be compensated by raising either b or F. Increasing b raises effort. Therefore, it is initially advantageous until effort reaches the first-best level a^*. This yields $U^* \equiv$

$B(a^*) - c(a^*)$. At that point any further increase in $\overline{U}$ is best compensated by lump sum transfers F so that the CPF has slope -1. We summarize these results in the following proposition (for a formal proof see Demougin and Helm (2006)).

Proposition 1 *The constrained Pareto frontier is strictly decreasing and concave. Specifically, for low values of U, the optimal contract has $F = 0$, the agent extracts rent and effort is constant at the second best effort level a^{**}. For intermediate values of U, $F = 0$, and effort is increasing in U. For high values of U, the optimal contract implements first-best effort a^* and has $F = U + c(a^*) - B(a^*)$.*

In order to analyze the effect of unemployment benefits on the negotiated contract, we have to make a concrete assumption with respect to the bargaining process. Specifically, we assume that the outcome of negotiations follows from maximizing the Nash product for equal bargaining power,

$$\mathcal{N} \equiv (U - s)(\Pi - r), \tag{6}$$

with respect to feasible contracts; i.e. contracts that satisfy the incentive, financial and participation constraint.[11] Given our focus in this section on firm/worker matches for which mutually beneficial contracts exist, this yields a solution along the CPF (see Demougin and Helm (2006)). Thus, the outcome of negotiations solves:[12]

$$U^N, \Pi^N = \arg\max_{U,\Pi} \mathcal{N} \quad \text{s.t.} \quad U, \Pi \in \text{CPF}.$$

As we are in the case where mutually beneficial contracts exist, the disagreement point (s, r) must lie (i) either on the dashed segment of the curve in figure 1, (ii) or on the CPF, (iii) or below the dashed segment or the CPF. In the first case, the bargaining outcome will be (U^{**}, Π^{**}) as it follows from the restriction on incentive-compatible contracts and the above discussion. In the second case, the parties simply implement the contract that yields the disagreement point.

The third case, where (s, r) lies strictly below the dashed segment or the CPF, is the most relevant. Here, the problem of maximizing the Nash

[11] Many of the following results are not restricted to this specific assumption about the bargaining process. For example, the egalitarian solution would be obtained by moving along an array that starts at (s, r) at a 45° angle to the CPF. Upon raising s, the egalitarian solution moves to the right along the CPF, as will be shown to be the case with the Nash bargaining solution.

[12] We use superscripts ^{N} to denote the Nash bargaining solution.

product given the feasibility constraint can be represented geometrically by the introduction of iso-Nash curves that are characterized by a constant $\mathcal{N}$ in (6). In the (U, Π) space, holding s and r constant, it is easily verified that the iso-Nash curves are decreasing convex with slope

$$\left.\frac{d\Pi}{dU}\right|_{\mathcal{N}=\text{constant}} = -\frac{\Pi - r}{U - s}. \tag{7}$$

Furthermore, the Nash product increases in the North-East direction.[13] Altogether, the (constrained) Nash bargaining solution, (U^N, Π^N), is characterized by a tangency of the iso-Nash curve with the CPF.

Lemma 1 *The Nash bargaining solution has the following properties:*

a) If $a^N = a^*$, *then* $\Pi - r = U - s$.

b) If $a^N < a^*$, *then* $U - s > \Pi - r > 0$ *or* $U - s \geq \Pi - r = 0$.

c) Moreover, $\gamma v'(a^N) - B'(a^N) \leq 0$.

The lemma has a straightforward intuition. The Nash product is maximized if the overall surplus is maximized and divided equally between the parties. In figure 1, the second objective is achieved if we are on the 45° line that starts at the parties' outside option (r, s), i.e. at point X. The first objective is achieved if effort is efficient. Geometrically, this is the case to the right of U^* along the flat part of the CPF where it has slope -1.

In the solution under (a), there is no conflict between the goals of maximizing the surplus and that of an equal division. This is the case if the parties' outside options are such that the 45° line intersects the CPF to the right of U^*. Analytically, statement (a) then follows from (7).

However, in some cases, attaining the first goal of maximizing the overall surplus would require paying out a large bonus to the worker in order to induce first-best effort. Attaining the second goal of dividing this surplus equally between the two parties would then necessitate a negative fixed payment so as to equalize the surplus between the two parties. The worker's financial constraint, $F \geq 0$, makes such a solution infeasible, thereby introducing a trade-off between both goals. At the optimum the parties set $F = 0$ and negotiate a reduction of the bonus, trading off the surplus loss against the benefits of a more equal surplus allocation. In the lemma, this is the first case under (b).

[13] See Muthoo (1999, 12) for a similar approach.

Geometrically, such a situation is depicted in figure 1, where the optimal solution lies in between the equal surplus allocation (point X) and the effort maximizing solution subject to participation (point Y) so that $U - s > \Pi - r > 0$. Analytically, this statement follows from the fact that for $a^N < a^*$ the slope of the CPF is $|\Pi_U| < 1$ and the slope of the iso-Nash curve as given by (7). The second case under (b) arises if the disagreement point lies (i) on the dashed segment of the curve so that the worker obtains $U^{**} > s$, or (ii) on the CPF so that $U - s = \Pi - r = 0$.

The last claim in lemma 1 states that the value for the firm of a marginal increase in effort is (weakly) lower than the additional expected bonus which it has to pay to the worker for raising his effort. Observe that $a^{**} \leq a^N \leq a^*$. Moreover, from (4) a^{**} is implicitly defined by

$$\gamma v'(a^{**}) - B'(a^{**}) = 0. \tag{8}$$

Thus, the statement follows by concavity of (4).

Finally, we obtain the following intuitive result.

Corollary 1 *More productive agents face higher powered incentives and exert higher effort.*

Proof. See Appendix. ■

4 Incentive effects of unemployment benefits

4.1 Effort incentives

We now analyze the effect of variations in the level of social benefits on effort. As in the previous section, we focus on firm/worker matches for which a mutually beneficial, incentive-compatible contract exists. This means that $(s, r) \in \Omega$, where Ω is the set of points on or below the curve in figure 1, including the dashed segment. Formally, $\Omega \equiv \{s, r \geq 0$ such that there exists a U^N, Π^N with $U^N \geq s$ and $\Pi^N \geq r\}$.

Consider a disagreement point as in figure 1 for which the Nash bargaining solution leads to an inefficient effort level. Raising s shifts the disagreement point to the right. Hence the tension between equal surplus distribution and effort efficiency – measured as the distance between points X and Y – is reduced. The Nash bargaining solution moves along the CPF to the right. Thus, the contracted effort level increases by Proposition 1.

Intuitively, as the worker's outside option s improves, his payoff U must increase. As long as effort is not Pareto efficient, this is best achieved by raising the bonus. As we keep increasing s, one of two things can happen. Either the disagreement point moves outside the set Ω, at which point contract negotiations would fail, or effort reaches the first-best level. In the figure, the latter occurs if the 45° line intersects the constrained Pareto frontier at U^*. This point is characterized by equal surplus division, efficient effort and $F = 0$, i.e.

$$B(a^*) - c(a^*) - s = \gamma v(a^*) - B(a^*) - r. \tag{9}$$

If s is above the level at which (9) holds, the parties can select $F \geq 0$ in order to achieve $U(a^*) - s = \Pi(a^*) - r$, thereby maximizing the Nash product. Accordingly, further increases in s are fully offset by a higher fixed payment F. By contrast, if s is below the level at which (9) holds, the worker's financial constraint, $F \geq 0$, makes the solution $U(a^*) - s = \Pi(a^*) - r$ unattainable. By lemma 1 effort is then inefficient. These results can be summarized as follows.

Proposition 2 *Define* $\hat{s} \equiv 2B(a^*) - c(a^*) - \gamma v(a^*) + r$. *Consider* $(s, r) \in int(\Omega)$.

a) If $s < \hat{s}$, *then* $a^N < a^*$ *and* $da^N/ds > 0$.

b) If $s \geq \hat{s}$, *then* $a^N = a^*$.

In the proposition, we limit the analysis to disagreement points in the interior of Ω. In this case, raising social benefits has a positive effect on the effort of inefficient workers. However, if a disagreement point lies exactly on the CPF, raising s implies that mutually beneficial contracts no longer exist.

4.2 Successful matches

We now extend the analysis by considering workers of different skill levels γ. Matches with different workers generate different constrained Pareto frontiers, hereafter CPF(γ). Intuitively, an increase in productivity shifts the constrained Pareto frontier outwards. Mathematically, raising γ means that for any given U, the firm obtains a higher payoff Π, since even without adjusting the contract profits would increase due to the productivity gain. This implies that the set of disagreement points for which mutually beneficial contracts exist, $\Omega(\gamma)$, also depends on the specific worker.

Consider an arbitrary disagreement point (s, r) and define the critical worker γ^c such that the boundary of $\Omega(\gamma^c)$ passes through that disagreement point.[14] Accordingly, mutually beneficial contracts exist only for workers with productivity $\gamma \geq \gamma^c$. In contrast, low skilled workers with $\gamma < \gamma^c$ become unemployed because for them no mutually beneficial and incentive-compatible contracts exist.

In order to analyze how policy variations in benefit payments s affect the unemployment level, we distinguish two cases. First, suppose that the disagreement point defining γ^c lies to the right of $U^{**}(\gamma^c)$, i.e. on CPF(γ^c). From figure 1, an increase in s shifts the disagreement point to the right, thereby raising γ^c. This unequivocally increases the unemployment level. However, from proposition 2 workers characterized by $\gamma > \gamma^c$, who exert inefficient effort, are now induced to raise effort. Thus, there is a trade-off between the unemployment level and effort efficiency.

Second, suppose that the disagreement point (s, r) lies on the dashed, flat part of the boundary of $\Omega(\gamma^c)$, i.e. to the left of $U^{**}(\gamma^c)$. Accordingly, small variations in s do not affect γ^c. As a result, increasing s leaves unemployment unchanged. Nevertheless, more productive workers $\gamma > \gamma^c$ are again induced to raise effort.

Proposition 3 *Consider a disagreement point (s, r) with associated γ^c.*

a) If $s < U^{**}(\gamma^c)$, then a marginal increase in s has no effect on γ^c and unemployment.

b) If $s \geq U^{**}(\gamma^c)$, then an increase in s raises γ^c and unemployment.

Accordingly, for low levels of unemployment benefits, i.e. $s < U^{**}(\gamma^c)$, raising s improves effort efficiency without increasing unemployment. In contrast, for $s \geq U^{**}(\gamma^c)$ there is a trade-off between effort efficiency and unemployment. In the following, we analyze the resulting regulator's problem of balancing this trade-off.

5 The optimal level of unemployment benefits

We now consider the problem of a benevolent regulator who chooses the level of unemployment benefits s in order to maximize social welfare. For each

[14] Observe that as γ converges to zero, $\Omega(\gamma)$ converges to the point of origin. In contrast, as γ becomes unbounded, $\Omega(\gamma)$ converges to the positive quadrant. Thus, by continuity there exists a critical worker γ^c such that the boundary of $\Omega(\gamma^c)$ passes through the disagreement point.

unemployed worker, s constitutes a cost for the state and simultaneously a benefit for that unemployed person. In the aggregate these two effects cancel out. Moreover, for parsimony we ignore the excess burdens associated with the financing of unemployment benefits, such as distortionary costs of taxation. As a result, the social welfare function is

$$W \equiv \int_{\gamma^c}^{\infty} [\gamma v(a_\gamma) - c(a_\gamma)] f(\gamma)\, d\gamma + \int_0^{\gamma^c} r f(\gamma)\, d\gamma, \qquad (10)$$

where a_γ is the effort of the worker with skill γ. The first term represents the welfare derived from domestic employment relationships, and the second term represents the value of the firms' outside opportunity for unsuccessful matches.

The regulator maximizes welfare, anticipating the outcome of contract negotiations as analyzed in the previous sections. The resulting first-order condition is

$$\int_{\gamma^c}^{\infty} [\gamma v'(a_\gamma) - c'(a_\gamma)] \frac{da_\gamma}{ds} f(\gamma)\, d\gamma - \frac{d\gamma^c}{ds} [\gamma^c v(a_{\gamma^c}) - c(a_{\gamma^c}) - r]\, f(\gamma^c) = 0. \qquad (11)$$

The first term reflects the positive effect of raising s as inefficient workers will increase their effort. The square bracket in the integral is positive for matches leading to inefficient effort and nil otherwise. Moreover, by proposition 2 $da_\gamma/ds > 0$ for matches with inefficient effort.

The second term reflects the negative effect of raising s as this increases unemployment. By proposition 3, $d\gamma^c/ds \geq 0$. Furthermore, observe that $\gamma^c v(a_{\gamma^c}) - c(a_{\gamma^c})$ measures the unused potential of workers just becoming unemployed due to the raise in s. That effect is only partially offset by the firms' outside opportunity r so that the second square bracket in (11) is also positive.[15] Altogether, the optimal level of unemployment benefits, s^*, balances both effects. In particular, it implies the following result.

Proposition 4 *The optimal level of unemployment benefits, s^*, is strictly positive.*

Proof. See appendix. ■

For graphical illustration, suppose that figure 1 depicts the CPF of the critical worker γ^c. With $s = 0$ the disagreement point would lie on the vertical axis and, therefore, on the dashed segment of the curve, which does not

[15] Since the disagreement point for the critical worker lies on the boundary of $\Omega(\gamma^c)$, we have $\gamma^c v(a_{\gamma^c}) - B(a_{\gamma^c}) - F - r = 0$. As $B(a_{\gamma^c}) + F > c(a_{\gamma^c})$ by the curvature assumptions and $F \geq 0$, the second term in square brackets is clearly positive.

belong to the CPF. From the previous results we know that a marginal increase in s does not affect the participation decision of worker γ^c but increases the effort of those workers $\gamma > \gamma^c$ that exert inefficient effort. Therefore, the regulator could increase effort efficiency without raising unemployment.

The first-order condition (11) also illustrates that the positive effect of unemployment benefits on welfare is actually driven by the moral hazard problem. If effort were contractible – or in the absence of the workers' financial constraints – the term da/ds would be zero so that we would get a boundary solution with $s = 0$. By contrast, if benefit payments had no negative effect on employment, s would be raised until all agents undertake efficient effort.

The optimal level of unemployment benefits, s^*, depends on the underlying parameters of the model. In the remaining, we examine how changes in the distribution of skill levels and in the firms' outside options affect s^*.

6 Comparative static analysis

6.1 Changes in workers' skill levels

In this section, we discuss improvements in the distribution of skills, which may arise from improvements in education or production technologies. In order to analyse this issue, we now assume that workers' skills are log-normally distributed, i.e.

$$f(\gamma; \mu, \sigma) = \frac{1}{\gamma\sigma\sqrt{2\pi}} e^{-\frac{(\ln\gamma-\mu)^2}{2\sigma^2}}, \tag{12}$$

where μ and σ are the mean and standard deviation of the logarithm of γ. This distribution is often used in the empirical literature on human capital (see Glomm and Ravikumar (1992); Heckman and Honore (1990)). We interpret an improvement in the skill distribution as an increase of its mean μ. Maximizing social welfare as given in (10) for this distribution yields the first-order condition:

$$\int_{\gamma^c}^{\infty} [\gamma v' - c'] \frac{da_\gamma}{ds} \frac{1}{\gamma} e^{-\frac{(\ln\gamma-\mu)^2}{2\sigma^2}} d\gamma - \frac{d\gamma^c}{ds} [\gamma^c v - c - r] \frac{1}{\gamma^c} e^{-\frac{(\ln\gamma^c-\mu)^2}{2\sigma^2}} = 0. \tag{13}$$

Applying the implicit function theorem with respect to μ, we obtain (see appendix)

$$\frac{ds}{d\mu} = \frac{\int_{\gamma^c}^{\infty} [\gamma v'(a_\gamma) - c'(a_\gamma)] \frac{da_\gamma}{ds} e^{-\frac{(\ln\gamma-\mu)^2}{2\sigma^2}} \frac{\ln\gamma - \ln\gamma^c}{\gamma\sigma^2} d\gamma}{-W_{ss}} > 0. \tag{14}$$

Note that each term under the integral in (14) is non-negative. Furthermore, at s^* the second-order condition implies $W_{ss} \equiv d^2W/ds^2 < 0$.

Proposition 5 *Suppose that workers skills are (μ, σ)-log-normally distributed. Then the optimal level of unemployment benefits increases in μ.*

Intuitively, the result obtains because with higher skilled workers the welfare loss associated with "inefficient effort" increases. Thus, the regulator becomes more willing to raise s although it increases unemployment.

6.2 Changes in firms' outside options

It is widely argued that in the course of globalisation firms' ability to relocate abroad has improved. In our model, we capture this by an improvement in firms' outside options. From the previous analysis, we know that this leads, ceteris paribus, to more unemployment and a lower effort level. We now examine the regulator's optimal response with respect to social benefits. Should the latter be raised to counterbalance the firms' improved bargaining power, or reduced to weaken incentives to move abroad?

In the above analysis, we considered a continuum of heterogenous workers while firms were assumed identical. In order to analyze globalisation, we now take the opposite approach. We fix workers' skills at a uniform level γ, but assume that there exists a continuum of firms differing in their outside option r. This approach reflects that some firms are less mobile than others. It also enables us to represent better outside options as a change in the distribution of r.

As before, workers and firms are randomly matched in pairs. Accordingly, for each individual firm/worker match, contract negotiations are exactly as described in section 3. However, all workers are now characterized by the same constrained Pareto frontier and by the same set Ω of disagreements points for which mutually beneficial contracts exist. Therefore, for a given level of social benefits s there now exists a critical firm r^c such that the disagreement point (s, r^c) lies on the boundary of Ω. Accordingly, contract negotiations lead to employment if and only if $r \leq r^c$.

By the same arguments that prove proposition 3, it can be readily shown that $dr^c/ds \leq 0$, with a strict inequality whenever $s \geq U^{**}$. Intuitively, increasing s implies that less firms will find a profitable domestic match. Similarly, by the same arguments that prove proposition 2, we obtain $da^N/dr < 0$ if $r \geq \hat{r} \equiv \gamma v(a^*) + c(a^*) - 2B(a^*) + s$ and $a^N = a^*$ if $r < \hat{r}$. From the definition of $\hat{r}$ and $\hat{s}$ it can be seen that effort efficiency depends on the relative level of the outside options. This ratio becomes more favorable for the worker as s increases or as r falls.

As in the previous section, we focus on a log-normal distribution of the random variable r with support $r \in [0; \infty]$.[16] If a worker γ is matched with a firm $r \leq r^c$, they will negotiate a mutually beneficial contract. Otherwise, the firm receives its outside option r, while the matched worker becomes unemployed and receives benefits s. Hence, given the extension to heterogenous firms social welfare becomes

$$\widehat{W} \equiv \int_0^{r^c} [\gamma v(a_r) - c(a_r)] \frac{1}{r\sigma\sqrt{2\pi}} e^{-\frac{(\ln r - \mu)^2}{2\sigma^2}} dr + \int_{r^c}^{\infty} r \frac{1}{r\sigma\sqrt{2\pi}} e^{-\frac{(\ln r - \mu)^2}{2\sigma^2}} dr. \quad (15)$$

where μ and σ are now the mean and standard deviation of the logarithm of r.

We interpret an improvement in the distribution of the firms' outside option as an increase of its mean μ. By implicit differentiation of the first-order condition of (15) we obtain at the optimum[17]

$$\frac{ds}{d\mu} = \frac{\int_0^{r^c} [\gamma v'(a_r) - c'(a_r)] \frac{da}{ds} \frac{1}{r} e^{-\frac{(\ln r - \mu)^2}{2\sigma^2}} \frac{\ln r - \ln r^c}{\sigma^2} dr}{-\widehat{W}_{ss}} < 0. \quad (16)$$

The sign follows because $\ln r - \ln r^c < 0$ for all $r \in [0; r^c)$ so that the last term under the integral is negative.

Proposition 6 *Suppose that firms' outside options are (μ, σ)-log-normally distributed. Then the optimal level of unemployment benefits decreases in μ.*

Intuitively, as the firms' outside options improve, there are less profitable firm/worker matches. Accordingly, the number of matches for which unemployment benefits s have a positive effect on effort has fallen. Hence, by reducing s the regulator can alleviate the unemployment problem, which has become more severe due to the firms' better outside options, at a lower cost in terms of efficiency losses.

7 Concluding Remarks

In this paper we have argued that non-contractible effort of financially constrained workers provides a rationale for unemployment benefits. The ensu-

[16] The following results can also be obtained for many other distributions such as the exponential.

[17] The calculation steps for deriving this expression are the same as in the previous section.

ing moral hazard problem implies that properly designed policies may improve workers' effort efficiency. In particular, unemployment benefits improve the bargaining position of workers, enabling them to negotiate higher expected wages. For some matches, this raises the agreed upon bonus, thereby strengthening the workers' incentives and improving efficiency. However, higher unemployment benefits also reduce the number of firm/worker matches for which mutually beneficial contracts exist. The optimal benefit level balances these two effects.

An overview of OECD data suggests that empirical observations are consistent with this trade-off. For the period 1995-2004, we find that in 81% of the OECD countries there is a positive relation between changes in the level of long-term unemployment and in the net replacement rate, which measures the proportion of in-work net income that is maintained for somebody becoming unemployed. Moreover, in 76% of the countries in which the net replacement rate has been increased (reduced), the growth of labor productivity has been above (below) average.[18] More systematic empirical studies have come to similar results. Specifically, there is substantial evidence that a rise in unemployment benefits tends to increase unemployment (e.g. Blanchard and Wolfers (2000); Lalive, Ours, and Zweimüller (2006)). Furthermore, Blanchard (2004) shows that in many European countries high benefit payments have led not only to high unemployment levels, but also to a relatively high productivity per hours worked. Using a quantitative model that is calibrated to capture the U.S. labor market for high school graduates, Acemoglu and Shimer (2000) also find a positive effect of unemployment benefits on productivity.

While these findings are consistent with the results from our model, there is less direct evidence regarding the specific mechanism which we have discussed in this paper. Van der Horst (2003) finds that an increase in the replacement rate allows workers to negotiate higher wages, but leads to more unemployment. Furthermore, there is an empirical literature which verifies the link between higher boni and effort (e.g. Prendergast (1999); Chiappori and Salanié (2003)). Nevertheless, several other determinants of unemployment levels and worker productivity exist (see, e.g., OECD (2007)). The

[18] Data on the net replacement rate (NRR) of unmarried persons without children during the first year of unemployment are from OECD: Benefits and Wages 2004. Data on long-term unempoyment as percentage of total unemployment are from OECD: OECD in Figures, 2005 and 2006-07 editions. Growth of labor productivity is measured as the quotient of the growth of gross value added and employment in the business sector (data extracted from OECD.stat). The sample consists of the OECD countries except Mexico, Czech Republic, Slovakia and Turkey due to incomplete data (the second figure also excludes Hungary).

relative importance of these factors is an empirical question which is beyond the scope of this paper.

Turning to our comparative static results, we found that the optimal level of unemployment benefits increases in the average skill level of workers, while it decreases with the firms' outside option. The first result appears consistent with the observation that states with high education levels often afford relatively generous unemployment benefits, as for example the Nordic countries. Furthermore, if globalisation has improved firms' outside options, we find that the second prediction is also compatible with casual observations. Particularly, the effect of globalisation is often emphasized as a reason for reducing the "welfare state".

There are several possible extensions of the paper. For example, we have only considered a uniform level of unemployment benefits. However, for efficiency reasons one would expect that benefits should be higher for more skilled workers. Intuitively, more skilled workers are less likely to become unemployed, while an increase in their effort due to an improved bargaining power is particularly beneficial. This would provide a justification for the dependence of benefit payments on previous earnings. Another extension would be to explicitly introduce capital into the model and discuss the implication of unemployment benefits on investment decisions and growth.

Appendix

Proof of corollary 1

From (5) and (8), first-best and second-best effort, a^* and a^{**}, are increasing in γ. For intermediate values of effort, $a^{**} < a^N < a^*$, note that $F = 0$ by proposition 1. Hence the constrained Nash bargaining solution follows from maximizing

$$\mathcal{N} = [B(a) - c(a) - s]\,[\gamma v(a) - B(a) - r]\,.$$

By implicit differentiation of the corresponding first-order condition,

$$\frac{da^N}{d\gamma} = -\frac{\mathcal{N}_{a\gamma}}{\mathcal{N}_{aa}} > 0$$

since $\mathcal{N}_{aa} < 0$ from the second-order condition and $\mathcal{N}_{a\gamma} > 0$. Finally, $b'(a) > 0$ from (3). □

Proof of proposition 4

By contradiction, suppose that $s^* = 0$. In figure 1, the threat point $(r, s = 0)$ would then lie on the vertical axis. By definition of the critical worker γ^c, the boundary of $\Omega(\gamma^c)$ passes through this threat point. Now consider a worker $\gamma^c + \varepsilon$, where ε is a small number. The threat point $(r, s = 0)$ lies in the interior of $\Omega(\gamma^c + \varepsilon)$. Therefore, Nash bargaining is characterized by the point of tangency between the CPF and the Iso-Nash curve. Moreover, if ε is sufficiently small the Nash bargaining solution will lie on the left, curved part of the CPF where effort is inefficient and $da/ds > 0$ by proposition 1. Accordingly, the first term in (11) is strictly positive at $s = 0$. Furthermore, by proposition 1, $U^{**}(\gamma^c) > 0$ so that $d\gamma^c/ds = 0$ by proposition 3. Therefore, the second term in (11) is equal to zero. In conclusion, the first-order condition cannot be satisfied at $s = 0$.

Finally, as s is increased, most of the matches fail and the first term in (11) converges to 0, while the second term is strictly positive. Accordingly, an interior solution with $s > 0$ exists by the intermediate value theorem. □

Calculation of equation (14)

Implicit differentiation of the first-order condition (13) yields

$$\begin{aligned}\frac{ds}{d\mu} &= \frac{\int_{\gamma^c}^{\infty} \left(\gamma v' - c'\right) \frac{da_\gamma}{ds} \frac{\ln\gamma - \mu}{\gamma\sigma^2} e^{-\frac{(\ln\gamma-\mu)^2}{2\sigma^2}} d\gamma - \frac{d\gamma^c}{ds}\left(\gamma^c v - c - r\right) \frac{\ln\gamma^c - \mu}{\gamma^c\sigma^2} e^{-\frac{(\ln\gamma^c-\mu)^2}{2\sigma^2}}}{-W_{ss}} \\ &= \frac{\int_{\gamma^c}^{\infty} \left(\gamma v' - c'\right) \frac{da_\gamma}{ds} \frac{\ln\gamma - \mu}{\gamma\sigma^2} e^{-\frac{(\ln\gamma-\mu)^2}{2\sigma^2}} d\gamma - \int_{\gamma^c}^{\infty} \left(\gamma v' - c'\right) \frac{da_\gamma}{ds} \frac{\ln\gamma^c - \mu}{\gamma\sigma^2} e^{-\frac{(\ln\gamma-\mu)^2}{2\sigma^2}} d\gamma}{-W_{ss}},\end{aligned}$$

where the second line follows by substitution from the first-order condition (13). Rearranging yields (14).

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