Unemployment Insurance and Workers' Mobility

by

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This paper analyses the effects of unemployment insurance (UI) in a model with two sectors where one sector is more risky than the other, in the sense that the probability of becoming unemployed is higher. With risk-averse agents it is the case that, over a range of values of UI, increasing UI increases workers' mobility from the safe to the risky sector, thereby increasing both unemployment and income. (JEL: H 53, J 31, J 60)

1 Introduction

This paper analyses the *mobility effect* of unemployment insurance (UI): a rise in UI makes workers more willing to move from a job in the safe sector to one in the risky sector. The following two points are made. First, I show that there exists a benchmark unemployment benefit level such that if the benefit is below that value, then a rise in benefits increases both aggregate income and welfare by raising workers' mobility between sectors. Second, I show that such a rise in unemployment benefits reduces equilibrium wage differentials between sectors and increases the number of unemployed agents.

The theoretical literature on the relation between unemployment benefits and workers' mobility, which is discussed below, has focussed on the effects of unemployment benefits on workers' mobility between employment and unemployment. Roughly speaking, the results can be summarised as follows: unemployment benefits reduce workers' incentives to find, accept, and stay in a job. On the basis of this, it is often recommended that unemployment benefits in Europe should be reduced in order to increase labour-market activity.

Without denying the moral-hazard problems associated with unemployment benefits, my paper highlights a different effect. It focuses on the effects of unemployment benefits on job-to-job mobility. As argued by SINN [1995], unemployment benefits

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can be seen as an insurance device that increases risktaking by agents. In the model here, UI increases the mobility of workers in the safe sector of the economy to the risky sector, where the probability of becoming unemployed is higher. The second point of my paper is the following. Since higher UI induces more workers in safe jobs to move to risky ones, the equilibrium wage premium in the risky sector is reduced. Further, as more agents move to the risky sector, more will fail and become unemployed. These predicted effects of UI are supported by evidence from the literature on compensating wage differentials.

In my paper the rise in unemployment is not necessarily associated with a fall in aggregate income. The intuition is that risk-averse agents do not move to the risky sector even though that would increase expected and aggregate income. Insuring risk-averse agents by raising unemployment benefits makes them more mobile and hence increases both aggregate income and unemployment. This effect of UI on the allocation of workers over the risky and safe sectors in the economy has been ignored in the current debate on whether European countries should reduce their unemployment benefits to enhance labour-market activity.

Although the model below has an abstract formulation of the safe and risky sectors, a natural interpretation of the risky sector is an R&D-intensive sector of the economy. In this sector firms experiment with new technologies, some of which will be successful while others will fail. Consequently, in the R&D-intensive sector the turnover of firms and hence jobs is higher than in other sectors of the economy, where firms work with more predictable standard technologies. In the same line, the risky sector can be interpreted as consisting of small firms, and the safe sector as larger ones. It is a stylised fact (see for instance DAVIS, HALTIWANGER, AND SCHUH [1996]) that the job survival rate increases with firm size.

My paper is related to several parts of the literature on unemployment benefits. First, there are the search and efficiency wage models. In SHAPIRO AND STIGLITZ'S [1984] efficiency wage model firms cannot perfectly observe employees' effort levels. To motivate employees to work, firms pay a wage premium and fire workers on the spot once they are found shirking. A rise in the unemployment benefit level reduces the penalty associated with being fired. Consequently, firms have to offer a higher wage in order to prevent the employee from shirking. This higher wage reduces firms' demand for labour and hence raises unemployment.

The job search literature (see for instance LAYARD, NICKELL, AND JACKMAN [1991, chapter 5]) also predicts a positive relation between unemployment benefit levels and unemployment. In this case, a rise in the replacement ratio makes unemployed agents better off. Therefore they have less incentive to become employed. Thus they search longer before accepting a job, thereby increasing unemployment.

The work here differs from these models in the following respects. First, the model here considers the effects of UI on workers' mobility between jobs, not mobility between employment and unemployment. Second, the search literature assumes that on-the-job search is more costly than searching while one is unemployed, and this is why some job offers are refused by unemployed agents. However, as noted by LAYARD, NICKELL, AND JACKMAN [1991, p. 235], in general on-the-job and off-the-job search seem to be equally costly. This is the assumption I work with below. Finally, as argued by ATKINSON AND MICKLEWRIGHT [1991] and BULL [1985], the predictions of the search and efficiency wage models are not robust to the introduction of institutional detail. UI schemes typically found in OECD countries have the feature that "benefit is refused where a person has entered unemployment ... as a result of industrial misconduct" ATKINSON AND MICKLEWRIGHT [1991, p. 1689]. This implies that a rise in the unemployment benefit level does not necessarily cause a rise in wages in the efficiency wage model, since a shirking worker who is fired will not receive unemployment benefits.

Second, the literature on dual labour markets stresses the effects of unemployment benefits on the allocation of labour over different sectors. In particular, ATKINSON [1995] and [1999] has a model with a dual labour market that combines an efficiency wage model with the observation above that misconduct forfeits a worker's right to unemployment benefits. In his model, a rise in unemployment benefits moves employment from the *secondary sector* to the *primary sector*, in Atkinson's terminology. The primary sector has an efficiency wage structure and hence pays premium wages and features (wait) unemployment. The secondary sector has a perfectly competitive structure. In equilibrium agents are indifferent between applying for (and immediately getting) a job in the secondary sector with a low wage and entering wait unemployment for a high-wage job in the primary sector. In this setup, a rise in unemployment benefits makes it more attractive for workers to apply for primary-sector jobs. This effect of UI is similar to the one in this paper, where a rise in unemployment benefits makes it more attractive to move to the risky sector. Yet there are some differences, which it will be instructive to spell out. First, Atkinson assumes that workers in the secondary sector cannot apply for jobs in the primary sector. This is important, because if they could do so, there would be no (wait) unemployment in the first place and hence no rationale to give UI. In my model, in contrast, all agents, whether employed or not, have the same probability of being matched with a job in the high-wage (risky) sector. In my model, a rise in unemployment benefits increases the number of workers that move to the risky sector. Hence more of them fail, and unemployment unambiguously goes up. In Atkinson's model, a rise in unemployment benefits leads to a reduction in the secondary sector and an increase in the primary sector. The effect on unemployment is ambiguous. Second, in my model workers are risk-averse and hence do not maximize expected (and aggregate) income. Therefore, raising unemployment benefits can raise aggregate income. In contrast, in Atkinson's model workers are risk-neutral.

Third, there is the wage bargaining literature on the relation between unemployment benefits and unemployment. In these models, unemployment benefits improve workers' outside options, thereby raising the wage rate and reducing firms' profits. Therefore a smaller number of vacancies is created, which increases unemployment. Although, for ease of exposition, this effect is not modelled below, the analysis suggests the following qualification. In the risky sector, a rise in UI causes the wage premium to fall. Thus, unless the effect on workers' bargaining power is very strong, the rise in UI causes wages to fall in the risky sector. Further, since a rise in UI increases the labour supply in the risky sector, firms get matched with a worker sooner. Both effects cause more vacancies to be created in the risky sector. Although the vacancies in the risky sector are created at the expense of vacancies in the safe sector, with risk-averse agents this may increase aggregate income.

Finally, the following results in this paper are reminiscent of results in ACEMOGLU AND SHIMER [1999]. The production- (and welfare-)maximizing unemployment benefit level is zero with risk-neutral workers and strictly positive with risk-averse workers. Further, with risk-averse workers, starting at a zero unemployment benefit level, raising the benefit level raises both aggregate output and unemployment. The mechanism that creates this effect differs between the two papers. Whereas this paper stresses that an increase in unemployment benefits raises workers' mobility between sectors, in ACEMOGLU AND SHIMER's [1999] paper it reduces mobility from unemployment to employment. In their paper, this reduced mobility is, in fact, productive. Because of a positive search externality, agents tend to accept jobs too quickly.

The rest of this paper is organised as follows. Section 1 introduces the model, and section 2 solves for the benchmark case of the production optimum. Section 3 derives the private outcome. Section 4 shows the reallocation effect of UI. Section 5 discusses a number of points left out of the main analysis. Finally, section 6 concludes the paper. Proofs can be found in the Appendix.

2 The Model

Consider an economy with two sectors, 1 and 2, where sector 2 is more risky than 1, in the sense that the probability of becoming unemployed is higher in 2, as discussed below. The set of symmetric agents is the interval [0,1], and each agent is either employed in sector 1 or sector 2 or unemployed. Agents are matched to jobs with the following simple matching technology.

Each agent, whether unemployed or not, has the same exogenous[1] Poisson arrival rate $m_I dt$ of being matched with a job in sector i $(= 1, 2)$, and accepts it either immediately or not at all. This captures the idea that search intensity is independent of the agent's employment status, which follows from the observation above that on-the-job search is not more expensive than searching while unemployed. I will simply assume that searching for a job is costless. The assumption that the matching rates are identical for employed and unemployed agents is made for analytical convenience.

[1] Assuming the matching probabilities are exogenous avoids the following search externalities. On the one hand, if the matching technology is such that job searchers in sector 1 congest the search process of the unemployed, there is a negative search externality. This works in the direction of agents in sector 1 searching too much in the private outcome as compared to the social optimum. If, on the other hand, the matching technology features increasing returns to the number of searchers, there is a positive thin–thick market externality. In this case agents in sector 1 tend to search too little. Assuming matching probabilities are exogenous avoids search externalities and can be viewed as a neutral case.

What is important (and different from papers like ACEMOGLU AND SHIMER [1999] and ATKINSON [1995] and [1999]) is that the matching rate is strictly positive for employed agents. This positive matching rate allows for on-the-job search and the (job-to-job) mobility effect that this paper emphasizes.

An unemployed worker always accepts a job offer, since in the market equilibrium below, the wages in both sectors are higher than the unemployment benefit level, and the agent's chances of being matched with another (better) job do not depend on his employment status. If the agent accepts a job in sector 1, the match will be successful with probability 1. However, a job in sector 2 can fail, upon acceptance only, with probability φ. In this sense sector 2 is more risky than sector 1. In both sectors, agents face the same exogenous separation rate δdt.[2]

The fact that a match in sector 2 can fail upon acceptance is relevant for a worker in sector 1 who is matched with a job in 2. If the worker accepts the job, but the match fails, the worker becomes unemployed and cannot return to his old job in sector 1. Thus the cost for an agent in sector 1 of accepting a job in 2 is the discounted value of staying in sector 1. This cost is sunk before the agent knows whether the match in sector 2 will fail or not.

To find the equations of motion between the sectors and unemployment, let $n_i(t)$ denote the number of agents in sector i $(= 1, 2)$ at time t, and $u(t)$ the number of unemployed agents at time t. Of the $m_2 n_1(t)$ agents in sector 1 that are matched with a job in 2 at time t, let $S(t)$ denote the number that accept the job in 2. This variable $S(t)$ measures the mobility of agents from sector 1 to 2 and is the main variable of this paper. In the market equilibrium below it is the case that the wage in sector 2 is higher than in sector 1; hence no agent successfully matched with a job in sector 2 will move to sector 1.

For a given time path $S(t) \in [0, m_2 n_1(t)]$ the variables $n_1(t)$, $n_2(t)$, and $u(t)$ evolve over time as follows, with $\dot{n}_i(t) = dn_i(t)/dt$:

$$\dot{n}_1(t) = m_1 u(t) - \delta n_1(t) - S(t), \tag{1}$$

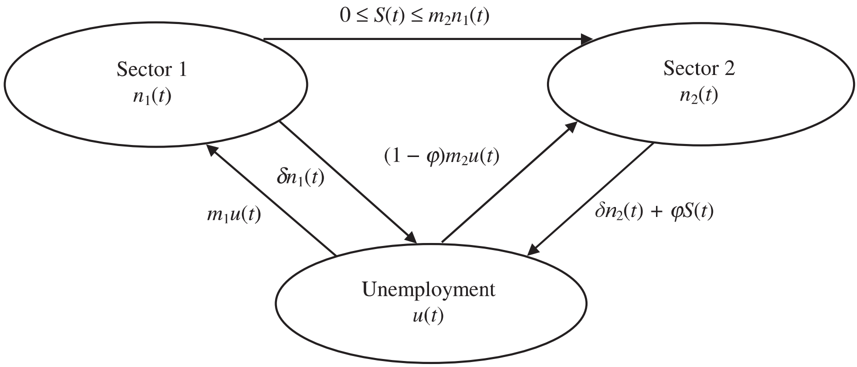
$$\dot{n}_2(t) = (1-\varphi) m_2 u(t) + (1-\varphi) S(t) - \delta n_2(t), \tag{2}$$

$$n_1(t) + n_2(t) + u(t) = 1. \tag{3}$$

Figure 1 illustrates the flows in the labour market. At time t there are $m_1 u(t)$ unemployed agents who are matched with a job in sector 1, which they accept. $\delta n_1(t)$ agents in sector 1 are separated from their job and become unemployed. Of the $m_2 n_1(t)$ agents in 1 that have been matched with a job in 2, $S(t)$ agents accept it. Of these agents, $\varphi S(t)$ fail and become unemployed; the other $(1-\varphi)S(t)$ are

[2] Another way of making sector 2 more risky than 1 is the following. Assume that $\varphi = 0$ and that the exogenous separation rate in sector 2 exceeds the rate in sector 1 ($\delta_2 > \delta_1$). Although one can check that with this formulation the results are the same as the ones found above, this assumption leads to the following technical complication. If $\delta_2 > \delta_1$, it may be privately (and potentially socially) optimal to move from sector 2 to 1, which can never happen in the model above. Hence at each instant one has to consider two cases, one where agents flow from 1 to 2, and another where they flow from 2 to 1. Assuming $\varphi > 0$ and $\delta_1 = \delta_2 = \delta$ avoids this technical complication.

Figure 1
Flows between Sectors and Unemployment



successfully matched with a job in 2. Further, $(1-\varphi)m_2u(t)$ unemployed agents are successfully matched with a job in 2 as well. And $\delta n_2(t)$ agents in sector 2 are separated from their job. Finally, the total number of agents adds up to 1.

Below I will focus on the steady state, which for given constant time path $S(t) = S$ is defined as $\dot{n}_1(t) = \dot{n}_2(t) = 0$. The following three equations give the steady-state values of n_1, n_2, and u:

$$n_1 = \frac{\delta m_1 - S(\delta + (1-\varphi)(m_1+m_2))}{\delta(\delta + m_1 + (1-\varphi)m_2)}, \tag{4}$$

$$n_2 = (1-\varphi)\frac{\delta m_2 + S(\delta + m_1 + m_2)}{\delta(\delta + m_1 + (1-\varphi)m_2)}, \tag{5}$$

$$u = \frac{\delta + S\varphi}{\delta + m_1 + (1-\varphi)m_2}. \tag{6}$$

The last equation implies the next result.

LEMMA 1 *If more agents (S) move from sector 1 to 2, unemployment (u) goes up.*

The intuition for this result is clear. As more agents take the risk of moving from sector 1 to 2, more agents fail and become unemployed.

The production technology in the model is as follows. A successful match in sector i produces one unit of intermediate good i. Hence the total production in sector i at time t equals $x_i(t) = n_i(t)$ with $i = 1, 2$. The two intermediate goods are used to produce final output with production function $y = y(x_1, x_2)$. This production function features constant returns to scale, is twice continuously differentiable, and satisfies $y(0, 0) = 0$, $y_i > 0$, $y_{ii} < 0$, and $y_{ij} \geq 0$ with $y_i = \partial y(x_1, x_2)/\partial x_i,\ i, j = 1, 2$ and $i \neq j$. It is routine to verify the following result.

LEMMA 2 *The marginal rate of technical substitution, y_2/y_1, is a continuous, increasing function of the relative amount of inputs x_1/x_2 (only).*

Since y_2/y_1 is a function of x_1/x_2 only, to simplify notation I write $y_2/y_1(x_1/x_2)$ instead of $y_2(x_1, x_2)/y_1(x_1, x_2)$ for the marginal rate of technical substitution.

3 Production Optimum

This section derives the production optimum. How many agents should move from sector 1 to 2 in order to maximise the discounted sum of final output? This outcome should be viewed as a benchmark case, and it is used to show how a rise in unemployment benefits can raise aggregate income.

The production optimum is defined as the solution to the following dynamic optimisation problem. Choose the control variable $S(t)$ and state variables $n_1(t)$, $n_2(t)$, and $u(t)$ to maximise $\int_0^\infty e^{-\rho t} y(n_1(t), n_2(t))dt$ subject to the equations of motion (1)–(3), where ρ is the agents' discount factor.

By Pontryagin's maximum principle, there exist Lagrange multipliers $\lambda_1(t)$, $\lambda_2(t)$, and $\lambda_u(t)$ such that the optimal $S^*(t)$, $n_1^*(t)$, $n_2^*(t)$, and $u^*(t)$ solve

$$\max \int_0^\infty e^{-\rho t}\big\{y(n_1(t), n_2(t)) - \lambda_1(t)\big[\dot{n}_1(t) - m_1 u(t) + \delta n_1(t) + S(t)\big] \\ -\lambda_2(t)\big[\dot{n}_2(t) - (1-\varphi)(m_2 u(t) + S(t)) + \delta n_2(t)\big] - \lambda_u(t)[u(t) + n_1(t) + n_2(t) - 1]\big\}dt.$$

Dropping the time index where that does not cause confusion, the following conditions need to be satisfied:

$$S^* = \arg\max_{0\le S\le m_2 n_1}[-\lambda_1 + (1-\varphi)\lambda_2]S, \tag{7}$$

$$e^{-\rho t}\big\{y_1\big(n_1^*, n_2^*\big) - \delta\lambda_1 - \lambda_u\big\} = \rho e^{-\rho t}\lambda_1 - e^{-\rho t}\dot{\lambda}_1, \tag{8}$$

$$e^{-\rho t}\big\{y_2\big(n_1^*, n_2^*\big) - \delta\lambda_2 - \lambda_u\big\} = \rho e^{-\rho t}\lambda_2 - e^{-\rho t}\dot{\lambda}_2, \tag{9}$$

$$\lambda_1 m_1 + \lambda_2(1-\varphi)m_2 = \lambda_u. \tag{10}$$

Here I focus on the steady-state solution defined by $S^*(t) = S^*$, $\dot{n}_1(t) = \dot{n}_2(t) = 0$, and $\dot{\lambda}_1(t) = \dot{\lambda}_2(t) = 0$ for each t. The interpretation of these equations is the following. The first equation compares the shadow value of a worker in sector 1, λ_1, with the shadow value of a worker in sector 2 times the probability of success in sector 2, $(1-\varphi)\lambda_2$. If the former exceeds the latter, it is optimal to keep all workers in sector 1 ($S^* = 0$), and in the opposite case all workers who are matched with a job in 2 should move from 1 to 2 ($S^* = m_2 n_1$). An interior solution for S is found only if $\lambda_1 = (1-\varphi)\lambda_2$: in expected terms the shadow values are equal. Equations (8) and (9) can, in steady state, be written as $\lambda_i = (y_i - \lambda_u)/(\rho + \delta)$. The shadow value of a worker in sector i equals the discounted value of his marginal product in that sector minus the opportunity cost of being employed (i.e., the shadow value of being unemployed). Because matches dissolve with probability δ each time period, the discount factor ρ is raised by this probability of dissolution. Finally, the shadow value of being unemployed equals the probability of a match in sector 1 times the value of such a match plus the probability of a successful match in sector 2 times the value of a match in 2.

The rather general production function $y(x_1, x_2)$ introduced above allows for two types of corner solutions. To simplify the statements of results below and facilitate the flow of argument, I rule out these corner solutions by assumption.

One type of corner solution is where sector 2 is so unproductive that production and welfare are maximized if no worker moves from sector 1 to 2. Clearly, in this case there is no role for UI to encourage workers in the safe sector to accept jobs in the risky sector. To rule out this corner solution, I assume that with $S = 0$ (no one moves from 1 to 2) the marginal product in the risky sector exceeds that in the safe sector to the extent that moving a worker from 1 to 2 raises aggregate income. It follows from equations (4) and (5) that with $S = 0$ we find that $x_1/x_2 = n_1/n_2 = m_1/[(1-\varphi)m_2]$. Hence to avoid this corner solution, the marginal rate of technical substitution y_2/y_1 evaluated at $x_1/x_2 = m_1/[(1-\varphi)m_2]$ should exceed a critical value. The following reasoning shows that the relevant critical value equals $[\rho + \delta + (1-\varphi)(m_1 + m_2)]/[(1-\varphi)(\rho + \delta + m_1 + m_2)]$. This critical value that avoids corner solutions is derived for the case where the social planner is indifferent between having a worker in sector 1 and moving him to sector 2. In terms of equation (7), it must be the case that $\lambda_1 = (1-\varphi)\lambda_2$. Substituting this into equations (8) and (9) and further using equation (10), we see that the marginal rate of technical substitution should in steady state be compared with the following ratio of shadow values:

$$[(\rho + \delta)\lambda_2 + (1-\varphi)(m_1 + m_2)\lambda_2]/[(1-\varphi)(\rho + \delta + m_1 + m_2)\lambda_2].$$

Cancelling the shadow value λ_2 yields the critical value.

The other corner solution that I want to avoid is the case where sector 2 is so productive that in the market outcome every agent always wants to move from sector 1 to sector 2 once he gets the chance. In this case, again, there is no role for UI to encourage workers to accept a job in the risky sector. A sufficient condition to rule out this corner solution is that a social planner is never willing to allow all agents to move from sector 1 to sector 2. In other words, if all agents were to move from sector 1 to 2 who are matched with a job (i.e., $S = m_2 n_1$), then the marginal rate of technical substitution falls short of the critical value derived above. Deriving the ratio n_1/n_2 from equations (4) and (5) with $S = m_2 n_1$ and substituting it into the marginal rate of technical substitution yields part (ii) of the assumption below.

ASSUMPTION 1

(i) $$\frac{\rho + \delta + (1-\varphi)(m_1 + m_2)}{(1-\varphi)(\rho + \delta + m_1 + m_2)} < \frac{y_2}{y_1}\left(\frac{m_1}{(1-\varphi)m_2}\right) \text{ and}$$

(ii) $$\frac{\rho + \delta + (1-\varphi)(m_1 + m_2)}{(1-\varphi)(\rho + \delta + m_1 + m_2)} > \frac{y_2}{y_1}\left(\frac{\delta m_1 - [m_2 n_1](\delta + (1-\varphi)(m_1 + m_2))}{(1-\varphi)(\delta m_2 + [m_2 n_1](\delta + m_1 + m_2))}\right).$$

Note for use below that the critical value

$$[\rho + \delta + (1-\varphi)(m_1 + m_2)]/[(1-\varphi)(\rho + \delta + m_1 + m_2)]$$

is bigger than 1. Assumption 1 implies the following result.

PROPOSITION 1 *The unique steady-state production optimum features* $0 < S^* < m_2 n_1$ *agents in sector 1 accepting a job they have been matched with in sector 2, where* S^* *is defined by*

$$(11)\quad \frac{y_2}{y_1}\left(\frac{\delta m_1 - S^*(\delta + (1-\varphi)(m_1+m_2))}{(1-\varphi)(\delta m_2 + S^*(\delta + m_1 + m_2))}\right) = \frac{\rho + \delta + (1-\varphi)(m_1+m_2)}{(1-\varphi)(\rho + \delta + m_1 + m_2)} > 1.$$

As one would expect, due to the probability of failure $\varphi > 0$ in sector 2, in the production optimum the marginal productivity in sector 2 exceeds the marginal productivity in sector 1. That is, $y_2/y_1 > 1$. The risk of failure prevents the equalization of marginal products across the two sectors. Further, because of Assumption 1, in the production optimum, some but not all agents that are matched with a job in sector 2 accept it. The next section compares S^* with the private outcome.

4 Private Outcome

To find the private outcome, I need to derive the equilibrium conditions for the labour market and the intermediate- and final-good markets. I assume that the (intermediate and final) goods produced have to be used (or consumed) immediately; otherwise they perish. Further, there is no capital market, so agents cannot borrow or save.

I assume that the intermediate- and final-good markets are perfectly competitive. Therefore, the price of one unit of final output y equals its marginal cost; that is, $p_y = \min_{x_1,x_2}\{p_1 x_1 + p_2 x_2 | y(x_1, x_2) \geq 1\}$. Let $(x_1^\#, x_2^\#)$ denote a solution to this problem. This cost minimisation problem for final output producers implies $p_1/p_2 = y_1/y_2$. Normalising prices in such a way that $p_i = y_i$ $(i = 1, 2)$, one gets by Euler's law (see for instance VARIAN [1984, p. 330]) $p_y = y_1 x_1^\# + y_2 x_2^\# = 1$ (numeraire) because $y(.,.)$ is homogenous of degree 1 in (x_1, x_2).

I make the following assumptions, to be discussed below, about wages, unemployment benefits, and agents' preferences. Wages are determined by bargaining between the matched worker and firm. In order to focus on the mobility effect, I assume that workers have all the bargaining power. Hence in each sector they capture the whole surplus of the match. As mentioned above, a successful match in sector i $(= 1, 2)$ produces one unit of output per unit of time, which is sold at a price p_i. Therefore the wage in sector i equals $w_i = p_i$ per unit of time. Allowing for Nash bargaining where both the worker and the firm capture part of the surplus complicates the mathematics substantially with risk-averse agents. It is, however, straightforward to see that it is still the case in that situation that a rise in unemployment benefits improves the attractiveness of the risky sector in comparison with the safe sector, which is the important ingredient for the mobility effect. The mobility effect of unemployment benefits would disappear in the case where firms have all the bargaining power and workers receive only their outside option. In the latter case, wages in both sectors are such that the worker is indifferent between working in either sector and being unemployed. It follows that there is no longer an equilibrium mechanism that determines uniquely the number of agents moving from sector 1 to 2 (in fact, some agents may even decide to move the other way). In other words, it is important for the mobility effect of UI that workers have some bargaining power; it is mathematically convenient to assume they have all the bargaining power.

An unemployed agent receives unemployment benefit $b \geq 0$. I assume that unemployment benefits are completely financed by taxes τ on wages and benefits, that is, $\tau w_1 n_1 + \tau w_2 n_2 = (1 - \tau)ub$ in each period. Finally, agents' utility of consuming y units of final output equals $v(y) = y^\gamma$ with $0 < \gamma \leq 1$. If $\gamma = 1$, agents are risk-neutral, and if $\gamma < 1$ they are risk-averse.

The derivation of agents' mobility decisions in the private outcome is similar to the derivation of the production optimum and can be found in the Appendix. An important variable in this derivation is the replacement rate R, which is defined here in terms of the wage in sector 1: $R = b/w_1$. Let σ^R denote the optimal private mobility strategy as a function of the replacement ratio R. In particular, σ^R denotes the probability that a worker in sector 1 accepts a job in sector 2 (conditional on being matched with such a sector 2 job). If σ^R agents in sector 1 accept the job offer from sector 2, then $S^R = \sigma^R m_2 n_1^R$ agents move from sector 1 to 2 in steady state, where n_1^R follows from (4) with $S = S^R$. The next result derives some properties of S^R for the case where $R = 0$ and compares the private mobility outcome $S^{R=0}$ with the production optimum S^*.

PROPOSITION 2 (NO UI) *If there is no UI in the private outcome ($R = b = 0$), then (I) the private outcome coincides with the production optimum ($S^0 = S^*$) if and only if agents are risk-neutral ($\gamma = 1$); (II) if agents are sufficiently risk-averse, then no agent in sector 1 accepts a job in sector 2 ($S^0 = 0$); (III) as agents become less risk-averse, more agents in sector 1 accept jobs in sector 2.*

The proposition shows that the private outcome without UI coincides with the benchmark of the production optimum if and only if agents are risk-neutral. This is for two reasons. First, risk-neutral agents' utility depends on expected values, and at a macro level, where the production optimum is determined, these expected values are realised with probability 1 due to the law of large numbers. Second, there are no externalities. In particular, due to the simple matching structure there are no search externalities, as mentioned in note 1.

However, if agents are risk-averse, the private outcome with no UI features lower labour mobility between sectors 1 and 2 than in the production optimum. And the more risk-averse agents are, the lower their mobility between the sectors. Moreover, if agents are very risk-averse (γ close to 0), there will be no job-to-job mobility at all in the private outcome.

The reason why with risk-averse agents the private outcome does not coincide with the production optimum is the assumption that there is no UI ($R = b = 0$). The next section shows that if private mobility falls short of the production optimum mobility, then a rise in unemployment benefits increases both unemployment and aggregate discounted income.

5 Unemployment Insurance

The next result first derives the benchmark replacement ratio R^* where the private outcome coincides with the production optimum. Then it derives the effects of a rise in the replacement ratio R on the wage differential, unemployment, and aggregate discounted income.

PROPOSITION 3 *(I) For each degree of risk aversion ($\gamma \in \langle 0, 1\rangle$) there exists a unique benchmark value of the replacement ratio R^* strictly between 0 and 1 such that the private outcome coincides with the production optimum ($S^{R^*} = S^*$); (II) as long as some but not all agents in sector 1 matched with a job in 2 accept this new job (i.e., $0 < \sigma^R < 1$), the wage differential w_2/w_1 is decreasing in the replacement rate R; (III) for each replacement rate R below the benchmark value R^* with $\sigma^R > 0$, it is the case that a reduction in the replacement rate reduces the steady state unemployment level; however, this reduction in R also reduces the discounted streams of total income, $Y = p_1n_1 + p_2n_2$, and final output.*

The second result of this proposition says that a fall in the replacement ratio reduces the number of people moving from sector 1 to 2 at each time t. This reduces the relative number of employed agents in sector 2 and hence increases the wage differential in steady state. Such a reduction in R also reduces unemployment. Since less agents take the risk of moving from sector 1 to 2, less agents fail and become unemployed.

The prediction (under (III) in the proposition) that a rise in the replacement ratio increases unemployment is in line with the predictions from the SHAPIRO–STIGLITZ [1984] efficiency wage model and the search literature, as discussed in the Introduction and section 3. However, the implications for aggregate income of the model above and these two types of models differ sharply. Whereas in search and efficiency wage models a fall in the replacement ratio and unemployment increases aggregate output,[3] the third result of Proposition 3 shows that this fall in unemployment reduces output if the replacement ratio R is smaller than its benchmark value R^*.

It is an empirical question which of the three relations between the level of benefits and the unemployment level is most relevant: the efficiency wage mechanism, the search and matching effect, or the mobility effect. Unfortunately, it is not possible to test the mobility argument directly, since I am not aware of empirical results on the relation between UI and workers' mobility between jobs in different sectors of the economy.

There is, however, indirect evidence in favour of the mobility mechanism from the literature on compensating wage differentials. The idea is that more risky jobs pay an equilibrium wage premium to compensate workers for the higher unemployment risk. TOPEL [1984, p. 501] finds that "the availability of UI increases unemployment,

[3] Exceptions are search models with a positive search externality where unemployment benefits encourage private agents to search longer than they otherwise would.

while simultaneously reducing the magnitude of compensating wage differentials." This finding is not readily explained in either a search framework or an efficiency wage model. But it is precisely the prediction of Proposition 3. As UI increases, more agents take the risk to move from sector 1 to 2, thereby reducing the wage differential and increasing unemployment.

Some people may argue that this role of UI is contradicted by evidence from the U.S. labour market, where high labour mobility between sectors goes together with low unemployment benefits. However, the model suggests two reasons why the insurance role of unemployment benefits may be less pronounced in the U.S. than in Europe to induce mobility between sectors. First, there are institutional differences between the U.S. and Europe that make a direct comparison of labour-market performance hazardous. Think for instance of the different attitudes[4] towards unemployment in Europe and the U.S. In Europe unemployment is seen as a failure, thereby making people more risk-averse in moving from the safe to the risky sector. In the U.S., however, unemployment is seen more as bad luck than as a signal of one's ability. This makes people behave in a more risk-neutral way, thereby increasing mobility by Proposition 2 (III). Second, as NICKELL [1997, p. 59] notes, "workers do appear to circulate faster through the existing jobs in North America." This can, for instance, be caused by the fact that it is easier for firms in the U.S. to fire employees. These higher separation rates lead *ceteris paribus* to more vacancies and hence higher hiring rates per unit of time. This higher turnover of jobs can lead to an implicit insurance effect, for the following two reasons. First, if the job destruction rate δ increases, jobs in sector 1 are not so safe anymore, and the relative job insecurity of sector 2 (as compared to 1) goes down. Second, if more people are hired every period (because of the higher turnover), becoming unemployed is not so bad anymore, because the expected unemployment spell is short. Both effects work in the direction of making sector 2 relatively more attractive. This leads to higher mobility between the sectors, for given UI.

Summarizing, the idea of reducing unemployment benefits in Europe to increase labour-market mobility may be misguided. It may well be that a reduction in unemployment benefits in Europe reduces the mobility of employed workers between sectors, thereby further reducing labour-market activity.

6 Discussion

This section discusses some issues that were left out of the formalisation above. First, I discuss two normative issues: the effects of UI on welfare and income inequality. Then I discuss how the results above may change if agents have access to a capital

[4] This difference is reminiscent of the different attitudes towards bankruptcy in the U.S. and Europe. In Europe bankruptcy is interpreted as a signal of bad management, making it hard for people that have gone bankrupt to start a new firm. This makes European firm owners far more careful than their U.S. counterparts, and induces them to stay in "safer" industries.

market and if unemployment benefits are related to previous wages, as they are in many countries.

Until now the analysis has been positive in nature. What can be said about the normative implications of a rise in unemployment benefits? I will argue that the analysis above implies that a rise in unemployment benefits raises welfare if the replacement rate is below the benchmark value R^* in Proposition 3.

In discussing welfare effects, I assume that agents evaluate welfare from behind a veil of ignorance, that is, before they know their future time path of unemployment and employment periods. In other words, distributional and political-economy aspects are not taken into account here. How do agents value a rise in unemployment benefits from behind a veil of ignorance? Without going into the details of how the veil is removed, it is not unreasonable to suppose that an agent's expected (from behind the veil) discounted income equals his aggregate discounted income.

Then risk-averse agents' expected welfare is determined by two components. On the one hand, their expected discounted income contributes positively to welfare. On the other hand, the variance of their income over their (infinite) lifetime contributes negatively to welfare. For a replacement rate below the benchmark value R^* in Proposition 3, a rise in UI increases welfare, since it increases agents' expected income and, by insuring agents against unemployment, reduces the variance of their income over their lifetime. So as long as private mobility falls short of the mobility in the production optimum, a rise in unemployment benefits is unambiguously favoured by all agents.

Next, consider the implications for income inequality of the mobility effect highlighted above. Assume that there are two types of agents in the economy, type A and type B. Further, suppose that type A agents are more mobile than type B agents and that A's mobility decisions are less affected by UI or other provisions of the welfare state than B's decisions. One can think here of the following examples. Type A agents are less risk-averse than type B agents. Or, if changing jobs has a geographical dimension, so that it involves changing houses, type A agents may be able to buy a new house or rent a house on the private market, whereas type B agents may have to queue for council houses. This also makes type B agents less mobile than type A agents, and at the same time it makes the mobility of B agents more dependent on the welfare state than the mobility of A agents. In this situation, a reduction in unemployment benefits (or other reductions in the welfare state) reduces the mobility of B agents far more than that of A agents. Hence the expected discounted income of B agents falls by more than that of A agents. Since A agents are more mobile to begin with, this reduction in the welfare state leads to bigger measured lifetime income inequality between A and B agents. This implication of the mobility effect may contribute to an explanation for the observations by ATKINSON [1997] and LEVY AND MURNANE [1992]. These authors argue that in the past two decades the U.S. and the U.K. have cut back the welfare state dramatically, and following that, both countries have shown a marked rise in measured income dispersion.

The analysis above leaves out capital markets and assumes that unemployment benefits do not depend on past wages of workers. First, consider the consequences of introducing capital markets. Such markets introduce the possibilities of agents saving or insuring themselves privately against the risk of unemployment. If agents can save to insure themselves, the strength of UI's mobility effect may be mitigated. But it will not disappear, because, as argued by BARR [1992] and GRUBER [1997], such private provisions for unemployment are likely to be inadequate in the real world. GRUBER [1997, p. 192] analyses the consumption-smoothing benefits of UI and notes that "individuals can save for unemployment, but this is less efficient than pooling unemployment risk through insurance, since those who do not end up losing their jobs are inefficiently reducing today's consumption. Furthermore, there are potential capital market constraints faced by the worker trying to smooth his consumption across unemployment spells." Although consumption smoothing has not been considered explicitly here, one can see that it will have similar effects to risk aversion. If it is not possible to smooth consumption over unemployment spells without insurance, agents will tend to stay in the safe sector and not move to the risky one in order to smooth consumption. So consumption smoothing gives a reason why the mobility effect of UI does not disappear with the introduction of (imperfect) capital markets.

Finally, in most OECD countries the unemployment benefit level that an unemployed worker receives depends on his wage history. Above I have assumed that the unemployment benefit b is the same for all workers irrespective of the sector they came from. I will argue that the mobility effect can be seen as another rationale (in addition to consumption smoothing, for example) for fixing the replacement rate rather than the unemployment benefit level. Risk-averse workers dislike the positive probability of becoming unemployed in either sector. However, with a fixed replacement rate, the wage premium paid in sector 2 implies that becoming unemployed in sector 2 is more attractive than becoming unemployed in sector 1.[5] This effect of fixing the replacement rate makes it more attractive to move to sector 2 than in a system with a fixed unemployment benefit level (for given amount of UI expenditure) and hence enhances workers' mobility between the sectors.

7 Conclusion

This paper has analysed the effects of UI on workers' mobility decisions between sectors. If one of the sectors in the economy – for example, an R&D-intensive sector – is more risky than others, then UI has the following mobility effect. If agents are risk-averse, then there is a nonempty interval of UI levels such that a rise in unemployment benefits increases agents' mobility and aggregate income in the

[5] The cause of unemployment that I have in mind here is the exogenous separation rate δ. In most OECD countries unemployment benefits depend on a worker's average wage in the previous years, not only on the last wage received before becoming unemployed. This makes it unrealistic to assume that a worker who becomes unemployed due the failure probability φ will receive the higher unemployment benefit level based on the wage in the risky sector.

private outcome. Because of higher UI, more agents move from the safe to the risky sector, thereby reducing the wage premium in the risky sector. Further, as more agents move to the risky sector, more fail and become unemployed. Some evidence has been quoted that seems to support these findings.

As stressed by ATKINSON AND MICKLEWRIGHT [1991], in reality UI is not a one-dimensional variable. Besides the level of UI, there are issues like eligibility for and duration of unemployment benefits. What matters in the model here is how people value becoming unemployed, because that influences the risks they are willing to take in moving between sectors. So the combination of unemployment benefit levels and eligibility for and duration of benefits should be such as to encourage workers to take mobility risks that increase expected income.

Summarising, this paper has highlighted some positive effects of UI that are often ignored. Of course, this is not the whole picture. These positive effects should be weighed against the negative effects of unemployment benefits, such as, reducing unemployed agents' efforts to search for a job. Yet it is not clear *a priori* that a fall in UI will increase labour-market activity in Europe. It may increase agents' mobility from unemployment to employment, but at the expense of a reduction in their mobility between sectors. In order to weigh the benefits and costs of UI, it needs to be established how strong the mobility effect, emphasised here, actually is. Unfortunately, I am not aware of any empirical studies analysing the effects of UI on workers' mobility between jobs in different sectors of the economy.

Appendix

A.1 Proof of Proposition 1

With $\dot{\lambda}_1(t) = \dot{\lambda}_2(t) = 0$, equations (8) and (9) can be rearranged so that equation (9) divided by (8) yields

$$\text{(A1)} \qquad \frac{y_2}{y_1} = \frac{(\rho+\delta)\lambda_2 + \lambda_u}{(\rho+\delta)\lambda_1 + \lambda_u} = \frac{(\rho+\delta+(1-\varphi)m_2)\lambda_2 + \lambda_1 m_1}{(\rho+\delta+m_1)\lambda_1 + (1-\varphi)\lambda_2 m_2},$$

where the last equality follows from the value for λ_u found in (10). Writing the relation between λ_1 and $(1-\varphi)\lambda_2$ as $\lambda_1 = (1-\varphi)\lambda_2\psi$, equation (7) implies the following three cases: (i) $\psi > 1 \Rightarrow S^* = 0$; (ii) $\psi < 1 \Rightarrow S^* = m_2 n_1$, and (iii) $\psi = 1 \Rightarrow 0 \leq S^* \leq m_2 n_1$.

Substituting $\lambda_1 = (1-\varphi)\lambda_2\psi$ in equation (12), one gets

$$\text{(A2)} \qquad \frac{y_2}{y_1} = \frac{\rho+\delta+(1-\varphi)(m_2+\psi m_1)}{(1-\varphi)(\psi(\rho+\delta+m_1)+m_2)}.$$

Note that the right-hand side of (A2) is decreasing in ψ. Using the steady-state expressions for n_1 and n_2 in (4) and (5), and using the result that y_2/y_1 is a function of $x_1/x_2 = n_1/n_2$, one gets a contradiction of the inequalities in Assumption 1 for cases (i) and (ii). In case (iii) it follows from (A2) with $\psi = 1$ that S^* must satisfy equation (11). Since y_2/y_1 is continuously increasing in n_1/n_2 by Lemma 2,

y_2/y_1 is continuously decreasing in S. Hence Assumption 1 implies that there is a unique solution S^* to (11) with $0 < S^* < m_2 n_1$. *Q.E.D.*

A.2 Proof of Proposition 2

Let V_i denote the discounted value for an agent currently in sector i ($i = 1, 2$), and V_u the discounted value for a currently unemployed agent. Let σ denote the probability with which an agent in sector 1, conditional on being matched with a job in 2, accepts this job. Then it is routine to verify that the privately optimal value of σ solves the following Bellman equations:

$$\rho V_1 = \max_{0 \leq \sigma \leq 1} \{ \nu((1-\tau)w_1) + \delta(V_u - V_1) + m_2\sigma[\varphi(V_u - V_1) + (1-\varphi)(V_2 - V_1)] \}, \tag{A3}$$

$$\rho V_2 = \nu((1-\tau)w_2) + \delta(V_u - V_2), \tag{A4}$$

$$\rho V_u = \nu((1-\tau)b) + m_1(V_1 - V_u) + m_2(1-\varphi)(V_2 - V_u). \tag{A5}$$

Consider the first equation. If the agent decides to move with positive probability ($\sigma > 0$) to sector 2, conditional on being matched with a job, then with probability φ the match fails and he ends up unemployed. With probability $1 - \varphi$ the match is successful and the agent receives discounted utility V_2 instead of V_1. The agent chooses $\sigma \in [0, 1]$ to maximise the discounted utility of being in sector 1.

I focus on the symmetric steady-state equilibrium where all agents choose the same value of σ for each time period t. Let $S = \sigma m_2 n_1$ denote the steady-state number of agents that move between sector 1 and 2 in the private outcome. Since I focus on the case where a rise in UI can raise private mobility, I consider the case where $\sigma < 1$. It follows from equation (A3) that for $\sigma < 1$ to be optimal it must be the case that $\varphi V_u + (1-\varphi)V_2 \leq V_1$ and the optimal strategy $\sigma < 1$ satisfies

$$\begin{aligned} \sigma \geq 0 \quad &\text{if and only if} \quad \varphi V_u + (1-\varphi)V_2 \leq V_1; \\ \sigma = 0 \quad &\text{if} \quad \varphi V_u + (1-\varphi)V_2 < V_1. \end{aligned} \tag{A6}$$

In other words, in the private optimum it must be the case that $\sigma[\varphi(V_u - V_1) + (1 - \varphi)(V_2 - V_1)] = 0$. Substituting this in the Bellman equations (A3)–(A5) above, one finds the following equations:

$$V_1 = \frac{\nu((1-\tau)w_1)}{\rho + \delta} + \frac{\delta}{\rho + \delta} V_u, \tag{A7}$$

$$V_2 = \frac{\nu((1-\tau)w_2)}{\rho + \delta} + \frac{\delta}{\rho + \delta} V_u, \tag{A8}$$

$$\rho V_u = \frac{(\rho+\delta)\nu((1-\tau)b) + m_1\nu((1-\tau)w_1) + m_2(1-\varphi)\nu((1-\tau)w_2)}{\rho + \delta + m_1 + (1-\varphi)m_2}. \tag{A9}$$

Using equations (A7) and (A8), the condition $\varphi V_u + (1-\varphi)V_2 \leq V_1$ is satisfied if and only if

$$\nu((1-\tau)w_1) \geq (1-\varphi)\nu((1-\tau)w_2) + \varphi\rho V_u. \tag{A10}$$

Finally, substituting the value for V_u in (A9) into equation (A10) yields, after rearranging,

$$\text{(A11)} \quad \left(\frac{w_2}{w_1}\right)^{\gamma} \leq \frac{\rho+\delta+(1-\varphi)(m_1+m_2)}{(1-\varphi)(\rho+\delta+m_1+m_2)} - \frac{\varphi(\rho+\delta)}{(1-\varphi)(\rho+\delta+m_1+m_2)} R^{\gamma},$$

where $R = b/w_1$ denotes the replacement ratio.

To find the private outcome, (A11) and (A6) have to be combined with the equation determining the steady-state wage ratio $w_2/w_1 = p_2/p_1 = y_2/y_1$ as a function of the number of agents in sector 1 that accept a job in 2. So if, in steady state, (A11) holds with strict inequality for each positive number of agents moving from 1 to 2, the optimal strategy is $\sigma^R = 0$ and hence $S^R = 0$. If (A11) holds with equality for a strictly positive number of agents $S^R \in \langle 0, m_2 n_1^R \rangle$ moving from 1 to 2 in steady state, the optimal private strategy supporting S^R is determined as $\sigma^R = S^R/(m_2 n_1^R)$.

Summarising,

$$\text{(A12)} \quad \begin{aligned} S^R = 0 \iff & \left[\frac{y_2}{y_1}\left(\frac{m_1}{(1-\varphi)m_2}\right)\right]^{\gamma} \\ & \leq \frac{\rho+\delta+(1-\varphi)(m_1+m_2)}{(1-\varphi)(\rho+\delta+m_1+m_2)} - \frac{\varphi(\rho+\delta)}{(1-\varphi)(\rho+\delta+m_1+m_2)} R^{\gamma}, \\ S^R > 0 \iff & \left[\frac{y_2}{y_1}\left(\frac{\delta m_1 - S^R(\delta+(1-\varphi)(m_1+m_2))}{(1-\varphi)(\delta m_2 + S^R(\delta+m_1+m_2))}\right)\right]^{\gamma} \\ & = \frac{\rho+\delta+(1-\varphi)(m_1+m_2)}{(1-\varphi)(\rho+\delta+m_1+m_2)} - \frac{\varphi(\rho+\delta)}{(1-\varphi)(\rho+\delta+m_1+m_2)} R^{\gamma}. \end{aligned}$$

Hence the steady-state private outcome S^0 is determined by this equation and $\sigma^0 = S^0/(m_2 n_1^0)$, where n_1^0 follows from (4) with $S = S^0$. There are two cases to consider:

$$\text{(i)} \quad \left[\frac{y_2}{y_1}\left(\frac{m_1}{(1-\varphi)m_2}\right)\right]^{\gamma} > \frac{\rho+\delta+(1-\varphi)(m_1+m_2)}{(1-\varphi)(\rho+\delta+m_1+m_2)},$$

$$\text{(ii)} \quad \left[\frac{y_2}{y_1}\left(\frac{m_1}{(1-\varphi)m_2}\right)\right]^{\gamma} \leq \frac{\rho+\delta+(1-\varphi)(m_1+m_2)}{(1-\varphi)(\rho+\delta+m_1+m_2)}.$$

In case (ii), with $R = 0$, equation (A12) can only hold with $S^0 = 0$. In case (i), using the fact that y_2/y_1 is continuously decreasing in S and Assumption 1, there is a unique $S^0 \in \langle 0, m_2 n_1^0 \rangle$ such that (A12) holds.

(I): follows from the comparison of (A12) with (11) for the case $\gamma = 1$ and $R = 0$.

(II): More formally, the claim can be stated as that there exists $\underline{\gamma} > 0$ such that $S^0 = 0$ for each $\gamma \in \langle 0, \underline{\gamma}]$. Since $y_2/y_1[m_1/((1-\varphi)m_2)] > 1$ by Assumption 1, it follows that for γ close enough to 0 case (ii) holds, since the right-hand side of (ii) is bigger than 1.

(III): The proposition claims that S^0 is increasing in γ for each $\gamma \in \langle \underline{\gamma}, 1 \rangle$. Consider equation (A12) holding with equality at $S^0 > 0$ and $R = 0$. By reducing $\gamma \in \langle \underline{\gamma}, 1 \rangle$, the left-hand side decreases. Hence S must fall to restore the equality, because y_2/y_1 is increasing in n_1/n_2 and therefore decreasing in S. *Q.E.D.*

A.3 Proof of Proposition 3

(I) Choose R^* equal to

$$R^* = \frac{(1-\varphi)(\rho+\delta+m_1+m_2)}{\varphi(\rho+\delta)} \cdot \left\{ \frac{y_2}{y_1}\left(\frac{\delta m_1 - S^*(\delta+(1-\varphi)(m_1+m_2))}{(1-\varphi)(\delta m_2 + S^*(\delta+m_1+m_2))}\right) - \left[\frac{y_2}{y_1}\left(\frac{\delta m_1 - S^*(\delta+(1-\varphi)(m_1+m_2))}{(1-\varphi)(\delta m_2 + S^*(\delta+m_1+m_2))}\right)\right]^\gamma \right\},$$

where S^* solves equation (11). Substituting this value for R^* into (A12) leads it to hold with equality at $S^* > 0$. Since (A11) then holds with equality, equation (A6) implies that it is optimal for agents to accept a job in sector 2, conditional on being matched with it, with probability $\sigma^* = S^*/(m_2 n_1^*)$, where n_1^* follows from (4) with $S = S^*$.

Note that for $\gamma = 1$, it is the case that $R^* = 0$ as in Proposition 2 (II). For $\gamma < 1$, it is the case that $R^* > 0$, because equation (11) implies

$$\frac{y_2}{y_1}\left(\frac{\delta m_1 - S^*(\delta+(1-\varphi)(m_1+m_2))}{(1-\varphi)(\delta m_2 + S^*(\delta+m_1+m_2))}\right) > 1.$$

Finally, note that $0 < \gamma \leq 1$ implies $R^* < 1$, for the following reason. First, R^* is decreasing in γ, because

$$\frac{y_2}{y_1}\left(\frac{\delta m_1 - S^*(\delta+(1-\varphi)(m_1+m_2))}{(1-\varphi)(\delta m_2 + S^*(\delta+m_1+m_2))}\right) > 1$$

by equation (11). Hence R^* is strictly smaller than the value that follows for $\gamma = 0$. For $\gamma = 0$, it follows from equation (11) that

$$R^* = \frac{(1-\varphi)(\rho+\delta+m_1+m_2)}{\varphi(\rho+\delta)}\left\{\frac{\rho+\delta+(1-\varphi)(m_1+m_2)}{(1-\varphi)(\rho+\delta+m_1+m_2)} - 1\right\} = 1.$$

Hence $0 < \gamma \leq 1$ implies $R^* < 1$.

(II): A reduction in R increases the right-hand side of (A12). In order to restore equality, the number $S^R > 0$ of people moving between sectors 1 and 2 needs to be reduced, thereby increasing the wage differential w_2/w_1 on the left-hand side.

(III): Since a reduction in R reduces S^R, Lemma 1 implies that steady-state unemployment is reduced. Further, since $Y = p_1 n_1 + p_2 n_2 = y_1 n_1 + y_2 n_2 = y(n_1, n_2)$, by definition of the production optimum such a reduction in S^R reduces the discounted stream of final output y and total income Y. *Q.E.D.*

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