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Optimal Earnings-Related Unemployment Benefits*

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Abstract

Existing unemployment insurance systems in many OECD countries involve a ceiling on insurable earnings. The result is lower replacement rate for employees with relatively high earnings. This paper examines whether replacement rates should decrease as the level of earnings rises. The framework is a search equilibrium model where wages are determined by Nash bargaining between firms and workers, job search intensity is endogenous and workers are heterogeneous. The analysis suggests higher replacement rates for low-paid workers if taxes are uniform. The same result may hold when taxes are redistributive. Numerical simulations indicate that there are modest welfare gains associated with moving from an optimal uniform benefit system to an optimally differentiated one in both cases, i.e., uniform and redistributive taxation. The case for differentiation arises from the fact that it may have favourable effects on the tax base.

Keywords: Unemployment Insurance, Unemployment, Search.

JEL-Classification: D81, D83, J64, J65.

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1. Introduction

The process of industrialization created new kinds of risks such as mass unemployment and income uncertainty. The uncertain employment prospects together with risk averse individuals resulted in the provision of unemployment insurance (UI) in order to mitigate the risks.¹ While the earliest forms of UI were developed by trade unions in Great Britain in 1832, France was the first state providing this kind of social protection in 1905.

However, there are other reasons except demand for income security behind the public provisions of UI. Unemployment benefits enable the unemployed person to spend sufficient time to search for a job that matches his skill level, whereas lack of income can force the unemployed to take a job which does not match his skill. In this case the existence of UI increases labour market efficiency and reduces the cost of search for the unemployed. Moreover, improved matching of workers to vacant jobs may reduce the probability of future spells of unemployment. At the same time, employers are likely to find it easier to dismiss workers under a UI regime, since workers will tend to demand less compensation for losing jobs. It will allow employers to adopt methods of production with higher risk of redundancy. In addition, the willingness of workers to be mobile is likely to be greater under a UI regime.

However, UI may have adverse incentive effects. More generous UI benefits may increase unemployment by reducing search effort² and/or increasing wage pressure.³ On the other hand, the existence of insurance schemes increases the incentive for uninsured to find employment in order to become eligible for future benefits.⁴ But this entitlement effect may imply that the unqualified individuals accept the first offered job that does not match their skill.

From a social perspective, an effective system of income protection for the unemployed reduces divisions in society and provides some form of justice to people who lose their jobs through no fault of their own; from a macroeconomic perspective, it stabilises purchasing power and so the demand for goods and services.

Despite these facts protection against the financial risk of unemployment developed later than provision for other circumstances⁵ (industrial accident, old age pension, health, and family

¹ Agell (2000).

² See Baily (1978), Flemming (1978), Shavell and Weiss (1979).

³ Johnson and Layard (1986).

⁴ Mortensen (1977).

⁵ Alber (1981), Alber and Flora (1981), Flora (1987) and Tsukada (2002).

allowance). However, UI is now not only an integral part of the social welfare system, it is also one of the most important institutions of social insurance in most advanced economies.

Over the past couple of decades, a considerable amount of work has been devoted to the economic analysis of the impact of unemployment benefits on unemployment. Since the emergence of job-search theory⁶, economists have got an effective analytical tool for labour market analysis. This has resulted in a large amount of theoretical and empirical research. Today, although the theory of job search⁷ is a young actor on the stage of labour market analysis, it plays a major part in the economics of labour. It may be one of the reasons that labour economics and the institutions and rules that govern labour markets have moved from the periphery to the centre of economic discourse.⁸

Another reason behind the considerable attention in research about UI benefit systems, and the most important reason in my opinion, is the rise in unemployment in the most OECD countries during the 1970s, 1980s, and 1990s and its persistence in most countries. In the European union there are about 27 million people unemployed or would be willing to sign up for a job if labour market prospects improved. Furthermore, half of the unemployed has been out of work for more than one year.⁹

Various aspects have been explored e.g. the relationship between benefit levels and the duration of unemployment, the impact of benefit duration on unemployment duration, and the linkages between UI through job search and labour supply.¹⁰ Put differently, there has been a considerable attention to explore rational individual behaviour during unemployment. However, there are still areas that have not been developed. Despite the voluminous literature on this topic, there is in fact relatively little attention paid to the relationship between the structure of UI benefit system and unemployment. The following analysis is a first step towards a theoretical evaluation of this aspect.

⁶ A rigorous and detailed analysis of the impact of UI on individual job search behaviour under imperfect information was first provided by Dale Mortensen (1977).

⁷ Another key feature of the theory is that it tries to describe the behaviour of unemployed individuals in a dynamic, ever changing and uncertain environment since the certain and static environments used by previous models could not represent many of life's real work experiences.

⁸ See Freeman (1998).

⁹ See Munzi and Salomäki (1999).

¹⁰ For a more detailed discussion of the development of UI in theory and practice see Holmlund (1998), Devine and Kiefer (1991) and Atkinson and Mickelwright (1991).

All OECD countries have schemes for the specific purpose of paying benefits to unemployed persons, and even though these schemes differ widely from one country to another, the benefit level in most countries has a maximum. Income support for workers is usually based on one of two principles (or both): insurance or assistance. Assistance payments, available to unemployed that are not qualified for insurance benefit, are usually not related to past contributions, though they may vary with age, marital status and number of children.

The insurance-type schemes are quite often unrelated to family circumstances and generally related to previous earnings in employment and based on one of two principles: either the amount of benefit is fixed on a flat-rate basis (Beveridgean); or it is proportional to the wage (Bismarckian).¹¹ While most countries in EU have wage-related UI benefit system, the UK has flat-rate benefit system since 1982. In practice, however, compensation schemes can involve both principles. At the same time, a ceiling imposed on benefits can substantially reduce the proportion of previous income received. This paper focuses on this aspect of earnings-related benefits schemes.

The aim of the paper is to analyse the optimal structure of replacement rates in a search equilibrium framework along the lines of Pissarides (2000). The model allows for endogenous search effort among unemployed workers. Wages are assumed to be endogenous as in Fredriksson and Holmlund (2001), but benefit payments are indefinite, which means that there is no risk of losing benefits for unemployed workers. There are two types of workers, where one type is more productive and therefore receives a higher wage. Furthermore, replacement rates are allowed to be different. We find that the optimal system is characterised by lower replacement rates for workers with higher wages if taxes are uniform. In the case of redistributive taxation, the same result may hold under certain condition.

The paper is organised as follows. Section 2 provides an overview of the system of unemployment insurance in the OECD countries. Section 3 is devoted to the presentation of the model. Section 4 derives some analytical results concerning the properties of the optimal replacement rates. In section 5 of the paper I present the numerical results concerning the optimal replacement rates and finally, section 6 concludes.

¹¹ OECD (1999).

2. Earnings-Related UI in Practice

Within the OECD the replacement rates for unemployed vary substantially. The designs of UI reflect national values and norms. Each country has built its own system with its own specific national features, and there is not any common form of UI system in OECD countries. The regulation of unemployment insurance is often very complicated. These facts make it difficult to rank the systems according to some criteria.

Generally, a minimum period of insured employment is required to qualify for UI benefits. This period ranges from 10.5 weeks in Canada to 108 weeks in Portugal. The initial rate of benefit ranges from 40 to 90 percent of previous earnings. The benefit rate is related to gross earnings with the exception of Germany, where the payment rates are expressed as a percentage of net income. UI benefits are taxed in most countries but not in Germany, Australia, Austria, Czech Republic, Japan, Korea, Portugal and the United Kingdom. Only in Belgium is UI unlimited in duration. Payment rates decrease over time in several countries, e.g. Belgium, Czech Republic, France, Hungary and Norway. The payment rates can depend on age, family situation, employment record and previous earnings.¹² However, despite the complexity and diversity of national unemployment insurance arrangements¹³ that results in a wide diversity in coverage and organisation of UI,¹⁴ there are some common characteristics shared across countries in OECD.

Unemployment insurance schemes are generally of a compulsory nature for the majority of countries, with Denmark and Sweden as exceptions. Furthermore, the state is involved in establishing the regulation of UI schemes, although government participation in financing insurance schemes differs a great deal from one country to another.

¹² OECD (1999).

¹³ Unemployment insurance differs, like social insurance, even between most advanced economies. Esping-Andersen (1990) discusses three different types of welfare capitalism in 18 advanced economies with three types of social policy regimes. Leibfried (1993) found a fourth type including Portugal, Spain and Greece. Historically, there are also differences between these countries about the establishment and development of the welfare state. While the German social insurance system had established by Chancellor Otto von Bismarck in the 1880s, the passage of the Social Security Act as a result of president Franklin D. Roosevelt's New Deal in 1935 launched the American federal welfare state. See Leman (1980) and Brooks (1893).

¹⁴ A comparison of different studies about net replacement rates of the unemployed in EU countries shows that there are three similar groups of countries with high, intermediate and low replacement rates. The high replacement rates are noticed in Denmark, Finland, France, Luxembourg, Netherlands, Portugal and Sweden, the intermediate one in Austria, Belgium, Germany, Spain and United Kingdom and the low one in Greece, Ireland and Italy. Note that these studies are about the "net" rate of unemployment benefits where taxes and family-related benefits are included. See Munzi and Salomäki (1999).

Finally, the general character of the UI schemes in most OECD countries is that they contain income-related benefits, i.e., the level of benefit paid is at least partially earnings-related in most OECD countries. The exceptions are Iceland, Ireland, Korea, Poland and the United Kingdom, where benefits are unrelated to previous income.¹⁵

Thus, either there is a ceiling on insurable earnings, as in most OECD countries, which fixes the insurance benefit at the same level for a large proportion of the unemployed; or the amount of benefit is fixed on a flat-rate basis. The latter point means that unemployment insurance rarely operates as a pure insurance scheme. There is some major deviation from the basic principles of insurance. One reason is presumably that there is a desire to introduce some redistribution within the group of insured individuals. Such redistribution, which depends on criteria other than the occurrence of the risk insured against, is typically to the advantages of the low paid workers. Of course, redistribution within insurance schemes differs substantially from one country to another and sometimes the differences are so great between countries that it is scarcely possible to classify them in the same group.

Table 1 shows that the existing UI in many OECD countries involves an upper limit or ceiling on insurable earnings. There is a fixed compensation rate up to a certain income level; above this level, the maximum, benefits are fixed. This means that the actual replacement rate is lower for employees with earnings exceeding the maximum level¹⁶; this rate can be much lower than the maximum rates.¹⁷ Put another way, the wage replacement rate decreases as the level of earnings rises. As a corollary some proportion of the unemployed receive the UI benefit at the same level.

This fact creates some interesting questions that appear to have received little or no attention in the economic literature. What is the optimal structure of replacement rates in a world with heterogeneous labour? Consider an economy with two types of workers, one more productive and therefore with higher wage. Should these two types have the same replacement rate or

¹⁵ There are some other common features in addition to these characteristics. One of the fundamental characteristics of social insurance, including unemployment insurance, is that it promotes solidarity principle, i.e., unlike private insurance, UI is a pooling of risks without differentiating contributions according to exposure to risk. Moreover, the state, employers and workers finance generally UI.

¹⁶ In Sweden, for example, 75 percent of all full-time employees had an income above the ceiling in 1996. See SOU (1996).

¹⁷ According to SOU (1996), employees with monthly earnings exceeding 25000 SEK in 1996 had a replacement rate lower than 50 percent of the lost income.

should one type have a higher benefit level? Is it possible to rationalise the empirical pattern we observe, i.e., a system where low-income workers have higher replacement rates? Can such a system be rationalised on efficiency grounds? Or do we need to invoke distribution arguments?

Table 1. UI Systems Around the World

	Replacement Rate (%)	Maximum Benefit
Australia	–	–
Austria	57	Yes
Belgium	60	Yes
Canada	55	Yes
Czech Republic	60	Yes
Denmark	90	Yes
Finland	90	Yes
France	75	Yes
Germany	60	Yes
Greece	40	Yes
Hungary	65	Yes
Iceland	Flat	Yes
Ireland	Flat	Yes
Italy	80	Yes
Japan	80	Yes
Korea	Flat	Yes
Luxembourg	80	Yes
Netherlands	70	Yes
New Zealand	–	–
Norway	62.4	Yes
Poland	Flat	Yes
Portugal	65	Yes
Spain	70	Yes
Sweden	80	Yes
Switzerland	70	Yes
United Kingdom	Flat	Yes
United States	50	Yes

Notes: Australia and New Zealand have an assistance type benefit with characteristics of both unemployment assistance and social assistance.

Source: OECD (1999).

3. The Framework of Analysis

3.1 The Labour Market

Consider an economy with two separate sectors, indexed $i = 1, 2$. One sector ($i = 1$) employs exclusively workers with relatively low productivity; the other sector ($i = 2$) employs workers with high productivity. There is no search on the job since we assume homogenous workers in each sector and therefore no wage differentials within sectors. The total number of workers is fixed and normalised to unity in each sector.

The number of jobs is variable and determined by zero-profit conditions. Firms produce according to a constant returns to scale technology. As usual, we simplify by focusing on “small” firms with only one job. At any point in time, a fraction $1 - u_i$ of the labour force in sector i is employed while the remaining fraction u_i is unemployed and searching for a job. There is a continuum of infinitely-lived individuals, and time is continuous.

Existing jobs are destroyed at the exogenous Poisson rate f_i . This creates an inflow into the unemployment pool that is equal to the outflow in equilibrium. There are frictions in the labour market that make it impossible for all unemployed workers to find jobs instantaneously.¹⁸

Unemployed workers are immediately eligible for UI benefits when they enter unemployment and benefit payment is indefinite. These assumptions are made for tractability. Benefits are provided by the government and are funded by taxing all workers’ incomes, both employed and unemployed.

Let s_i denote search intensity. Thus, the effective number of searchers in a sector is given by $S_i = s_i u_i$. The matching function, which captures the frictions in the market, relates the flow of new hires, H_i , to the number of effective searchers and the number of vacant jobs, v_i , i.e., $H_i = H(S_i, v_i)$. It is assumed increasing in both its arguments, continuously differentiable, concave, and homogenous of degree one.¹⁹

¹⁸ The sources of the frictions are costs and time delays, associated with imperfect information about the location of job and job characteristics, in the process of finding trading partners.

¹⁹ Empirical research suggests also a constant returns matching technology (see Petrongolo and Pissarides (2001)).

Let $\mathbf{q}_i \equiv v_i / S_i$ denote labour market tightness and $q(\mathbf{q}_i) = H_i(S_i, v_i) / v_i = H_i(1/\mathbf{q}_i, 1)$ denote the rate at which vacant jobs become filled, so $1/q(\mathbf{q}_i)$ is the expected time until a vacant job will be filled. Further, by the properties of matching technology, $q'(\mathbf{q}_i) < 0$: the tighter the labour market, the more difficult for a firm to fill a vacancy. Finally, the elasticity of $q(\mathbf{q}_i)$ is denoted by $\mathbf{s} \equiv -\mathbf{q}_i q'(\mathbf{q}_i) / q(\mathbf{q}_i)$, where $\mathbf{s} \in (0, 1)$.

Unemployed workers enter employment at the endogenous rate $s_i \mathbf{a}(\mathbf{q}_i) = s_i H_i(s_i u_i, v_i) / s_i u_i$ and $\mathbf{a}(\mathbf{q}_i) = H_i(s_i u_i, v_i) / s_i u_i = H_i(1, \mathbf{q}_i)$, where. Moreover, $\mathbf{a}'(\mathbf{q}_i) = (1 - \mathbf{s})q(\mathbf{q}_i) > 0$. Thus the more vacancies the easier for workers to find jobs and the more unemployed workers the easier for firms to fill their vacancies. In steady state the flow into unemployment equals the flow out of unemployment. Thus, flow equilibrium implies $s_i \mathbf{a}(\mathbf{q}_i) u_i = \mathbf{f}_i (1 - u_i)$ which can be rewritten as follows

$$u_i = \frac{\mathbf{f}_i}{\mathbf{f}_i + s_i \mathbf{a}(\mathbf{q}_i)} \quad i = 1, 2 \quad (1)$$

Equation (1) is one of the key equations of the model. It implies a negative relationship between search effort and unemployment rate. The other source of variation in unemployment is \mathbf{q}_i , which can be seen as a measure of labour market conditions.

3.2 The Behaviour of Workers

The two types of workers are matched in two separate labour markets. The employed workers can affect the equilibrium outcome because they bargain over the wage rate. The unemployed workers can influence the exit rate to employment and equilibrium unemployment through their search effort. Workers have utility functions that are strictly concave in wage income (w_i) and leisure. The instantaneous utility of unemployed workers is decreasing in search effort, since search reduces available leisure time. The utility function for the employed worker is $\mathbf{u}_i(w_i, h) = \mathbf{u}_i(w_i)$, where h , hours of work, is exogenously fixed. The unemployed workers utility is given by $\mathbf{u}_i = (\mathbf{B}_i, s_i)$, where \mathbf{B}_i is the benefit level. The worker's utility function is assumed to be logarithmic:

$$\mathbf{u}_i = \ln c_i + \mathbf{g} \ln \ell_i \quad i = 1, 2 \quad (2)$$

where c_i denotes consumption and ℓ_i leisure. Workers do not have access to a capital market, so consumption equals income at each instant. Let T denotes available time and \mathbf{t}_i the tax rate, thus, the consumption and leisure in the two states are given by $c_i = w_i(1 - \mathbf{t}_i)$ and $\ell_i = T - h$ if employed; $c_i = B_i(1 - \mathbf{t}_i)$ and $\ell_i = T - s_i$ if unemployed. Thus, the employed worker's time is divided between work and leisure, whereas the unemployed worker's time is divided between search and leisure. The utility function can be rewritten as: $\mathbf{u}_i^e = \ln w_i(1 - \mathbf{t}_i) + \mathbf{g} \ln(T - h)$ and $\mathbf{u}_i^u = \ln b_i w_i(1 - \mathbf{t}_i) + \mathbf{g} \ln(T - s_i)$, where superscripts e and u refer to employed and unemployed. We have assumed $B_i = b_i w_i$, where b_i is the replacement rate. Thus benefit levels are indexed to (average) wages within each sector.

The value functions can now be defined. Let E_i and U_i be the expected present values of employment and unemployment, respectively, and let r denote the subjective rate of time preference. Thus, the value functions can be written as follows:

$$rE_i = \mathbf{u}_i^e - \mathbf{f}_i(E_i - U_i) \quad (3)$$

$$rU_i = \mathbf{u}_i^u + s_i \mathbf{a}(\mathbf{q}_i)(E_i - U_i) \quad (4)$$

The unemployed worker chooses search effort to maximise the value of unemployment. The first-order condition takes the form:

$$\Psi \equiv -\frac{\mathbf{g}}{T - s_i} + \mathbf{a}(E_i - U_i) = 0 \quad (5)$$

where

$$E_i - U_i = \frac{\mathbf{u}_i^e - \mathbf{u}_i^u}{r + \mathbf{f}_i + s_i \mathbf{a}(\mathbf{q}_i)} = \frac{\ln w_i(1 - \mathbf{t}_i) + \mathbf{g} \ln(T - h) - \ln b_i w_i(1 - \mathbf{t}_i) - \mathbf{g} \ln(T - s_i)}{r + \mathbf{f}_i + s_i \mathbf{a}(\mathbf{q}_i)} \quad (6)$$

is the difference in present values between employment and unemployment. Equation (5) says that, in optimum, the marginal cost of increasing search activity is equal to its expected marginal gain. The first term in (5) captures the marginal cost, i.e., reduced available leisure time. Higher search effort increases the marginal cost of search by reducing the available leisure time. The second term captures the gain in utility, i.e. higher probability of a change of states, from unemployment to employment. Note also that the second-order condition holds, $\Psi_{s_i} < 0$. There is not any relationship between the wage and search effort; $\Psi_{w_i} = 0$, since $E_i - U_i$ is independent of the wage, an implication of the chosen functional form. Moreover, $E_i - U_i$ is independent of the tax rate. Finally, an increase in the replacement rate reduces s_i , since $E_i - U_i$ is decreasing in b_i .

3.3 Firm Behaviour and Wage Determination

The number of jobs is endogenous and determined by profit maximising firms. Labour productivity is denoted by y_i . The firm bears a fixed vacancy cost ky_i , with $k > 0$ equal across sectors. Workers arrive to vacant jobs according to a Poisson process at the rate $q(\mathbf{q}_i)$. Wages are chosen by a Nash-bargaining rule. Assuming a perfect capital market with fixed interest rate r , letting J_i denote the expected present value of an occupied job and V_i the expected present value of a vacant job, the flow values are as follows:

$$rV_i = -ky_i + q(\mathbf{q}_i)(J_i - V_i) \quad (7)$$

$$rJ_i = y_i - w_i - f_i(J_i - V_i) \quad (8)$$

Equation (7) says that the expected flow value of a vacancy is equal to the expected capital gain from finding a worker minus the vacancy cost. Likewise, equation (8) shows that the expected value of an occupied job is equal to the flow profit from a filled job minus the expected capital loss if the match is dissolved.

In the environment of this model with profit maximising firms in a competitive market, the free entry of new vacancies ensures that the supply of vacant jobs in equilibrium involves $V_i = 0$, i.e., profit maximisation implies that employers create jobs until the expected return of

a vacancy is equal to zero. Now, a zero-profit condition for firm entry can be derived from equations (7) and (8):

$$J_i = \frac{y_i - w_i}{r + \mathbf{f}_i} = \frac{ky_i}{q(\mathbf{q}_i)} \quad (9)$$

Equation (9) states that in equilibrium, market tightness is such that the expected cost of hiring a worker is equal to the expected profit from a new job. If w_i rises, the number of vacant jobs, and thus \mathbf{q}_i , falls. We can now derive the wage cost as a function of the productivity of labour, i.e.,

$$w_i = y_i \left[1 - (r + \mathbf{f}_i) \frac{k}{q(\mathbf{q}_i)} \right] \quad (10)$$

Equation (10) shows a negative relationship between the real producer wage and labour market tightness. The lower the tightness, the higher the wage cost for the firm and vice versa. Condition (10) can therefore represent a downward-sloping “labour demand curve” in a w_i, \mathbf{q}_i space. y_i is the marginal product of labour and $(r + \mathbf{f}_i)ky_i / q(\mathbf{q}_i)$ is the firm’s expected hiring cost. Equation (10) can also be thought as demand wage. The elasticity of the demand wage with respect to tightness is given as $d \ln w_i / d \ln \mathbf{q}_i = \mathbf{s} (1 - y_i / w_i) < 0$. Note that this elasticity approaches zero as $\mathbf{s} \rightarrow 0$, a special case that corresponds to an infinitely elastic labour demand schedule.

The Nash bargaining problem is

$$\max_{w_i} \Lambda_i(w_i) = [E_i(w_i) - U_i]^b [J_i(w_i) - V_i]^{1-b} \quad (11)$$

Equation (11) states that the surplus from a job match would be shared between the firm and the worker according to a fixed parameter, $\mathbf{b} \in (0,1)$. The surplus enjoyed by firms is J_i in equilibrium with $V_i = 0$, while worker’s surplus is $E_i - U_i$. The first-order conditions for maximisation of Nash product with respect to w_i have the following structure:

$$E_i - U_i = \frac{\mathbf{b}}{1 - \mathbf{b}} \frac{J_i}{w_i} \quad (12)$$

The worker's surplus is, according to (12), increasing in its bargaining power and decreasing in the firm's wage cost. Further, the first-order condition indicates that the value of a job match is positive in equilibrium, since both the worker's and the firm's surplus are positive according to equations (9) and (12), and equal to the expected cost of search and hiring. Thus, there exists a pure economic rent when a job becomes occupied and this rent is shared between the worker and the firm according to a Nash-bargaining rule.

Substituting (3), (4), (9), (10) and the employed and unemployed workers' utility functions into (12), we can derive a wage equation as a function of labour market tightness. The equation can be written as follows:

$$w_i = \frac{\mathbf{b} y_i \frac{k}{q(\mathbf{q}_i)} (r + \mathbf{f}_i + s_i \mathbf{a}(\mathbf{q}_i))}{A_i (1 - \mathbf{b})} \quad (13)$$

where $A_i = \mathbf{g} \ln \ell_i - \ln b_i - \mathbf{g} \ln(1 - s_i)$. Equation (13) states that a tighter labour market increases the wage rate through worker's bargaining power. A tighter labour market improves worker's position and their bargaining strength, which results in higher wage rate. As a result, this equation represents the upward-sloping "wage setting curve" in w_i, \mathbf{q}_i space.

3.4 Equilibrium

The general equilibrium of the model is given by the simultaneous satisfaction of the four equilibrium conditions (1), (5), (10) and (13), recognising (6). It can be shown that the equilibrium is unique. To determine tightness, use the free-entry condition (10) and the wage equation (13):

$$G \equiv 1 - (r + \mathbf{f}_i) \frac{k}{q(\mathbf{q}_i)} - \frac{\mathbf{b}}{1 - \mathbf{b}} \frac{k}{q(\mathbf{q}_i) A_i} (r + \mathbf{f}_i + s_i \mathbf{a}(\mathbf{q}_i)) = 0 \quad (14)$$

where $G_s = 0$, a property implied by optimal search behaviour. Given tightness, equation (5) determines search behaviour. With tightness and search determined, equation (1) gives unemployment. Finally, taxes can be determined once wages and unemployment are determined. The government's budget constraint takes the form:

$$t_1[(1-u_1)w_1 + u_1b_1w_1] + t_2[(1-u_2)w_2 + u_2b_2w_2] = u_1b_1w_1 + u_2b_2w_2$$

Note that $y_2 > y_1$ implies $w_2 > w_1$ for $b_1 = b_2$ and $f_1 = f_2$. Equation (14) implies that labour market tightness is independent of the tax rate and productivity in equilibrium. The same result can be shown for search effort, i.e., a change in labour productivity or tax rate does not affect search effort even though changes in productivity affect wages. It means also, by using (1), that equilibrium unemployment is independent of the level of productivity and the tax rate.

However, a higher replacement rate, b_i , reduces labour market tightness through a higher wage. To see this, differentiate (14) implicitly to get $G_{q_i} < 0$ and $G_{b_i} < 0$. A rise in the worker's bargaining power, b , has a similar effect for similar reasons. It is also obvious that an increase in the separation rate, f_i , or a higher vacancy cost, k , decreases tightness.

4. The Optimal Structure of Replacement Rates

Consider a social welfare function of utilitarian form, that is

$$W = \sum_i [(1-u_i)rE_i + u_i rU_i]$$

To compare different steady state without considering the adjustment process, let the discount rate approach zero, i.e. $r \rightarrow 0$, and substitute the value functions into the welfare function. We get an expression for social welfare that is simplified to a weighted average of workers' instantaneous utilities:

$$W = \sum_i W_i = \sum_i [(1-u_i)v_i^e + u_i v_i^u]$$

4.1 Paretoefficiency

Let us first examine a Pareto efficient UI policy by maximising the expected utility of agent 1, given the expected utility of agent 2. Rewrite the utilitarian welfare function:

$$\begin{aligned} W_i &\equiv (1-u_i)\ln w_i(1-t_i) + u_i \ln b_i w_i(1-t_i) + H_i \\ &= \ln w_i + \ln(1-t_i) + u_i \ln b_i + H_i \end{aligned} \quad (15)$$

where $H_i \equiv (1-u_i)g \ln(T-h) + u_i g \ln(T-s_i)$ captures the leisure components. The budget restriction is

$$\Omega \equiv \sum_{i=1,2} \{t_i [(1-u_i) + u_i b_i] w_i - u_i b_i w_i\} = 0 \quad (16)$$

Let L denote the value of the Lagrangian and \mathbf{m} the Lagrange multiplier on the utility constraint, and \mathbf{I} the Lagrange multiplier on the budget constraint. The Lagrangian for this problem is

$$L = W_1 + \mathbf{m}(W_2 - R) + \mathbf{I}\Omega \quad (17)$$

where R is a given “promised” welfare for high-skilled workers. Differentiating with respect to each of the choice variables gives us the first-order conditions:

$$\frac{dL}{db_1} = \frac{dW_1}{db_1} + \mathbf{I} \left(\frac{d\Omega}{db_1} \right) = 0 \quad (18)$$

$$\frac{dL}{db_2} = \mathbf{m} \frac{dW_2}{db_2} + \mathbf{I} \left(\frac{d\Omega}{db_2} \right) = 0 \quad (19)$$

$$\frac{dL}{dt_1} = \frac{dW_1}{dt_1} + \mathbf{I} \left(\frac{d\Omega}{dt_1} \right) = 0 \quad (20)$$

$$\frac{dL}{dt_2} = \mathbf{m} \frac{dW_2}{dt_2} + \mathbf{l} \left(\frac{d\Omega}{dt_2} \right) = 0 \quad (21)$$

$$\frac{dL}{d\mathbf{l}} = \Omega = 0 \quad (22)$$

$$\frac{dL}{d\mathbf{m}} = W_2 - R = 0 \quad (23)$$

where

$$\frac{dW_i}{db_i} = \frac{d \ln w_i}{db_i} + \frac{u_i}{b_i} - [\mathbf{g} \ln(T-h) - \ln b_i - \mathbf{g} \ln(T-s_i)] \frac{du_i}{db_i} - u_i \left(\frac{\mathbf{g}}{T-s_i} \right) \frac{ds_i}{db_i} \quad (24)$$

$$\frac{d\Omega}{db_i} = -w_i \left[(\mathbf{t}_i - \mathbf{t}_i b_i + b_i) \frac{du_i}{db_i} + u_i (1 - \mathbf{t}_i) \right] + [\mathbf{t}_i (1 - u_i + u_i b_i) - u_i b_i] \frac{dw_i}{db_i} \quad (25)$$

If $b_1 = b_2$, then $dW_1/db_1 = dW_2/db_2$, an implication of (10) and the fact that tightness, search and unemployment are independent of productivity. Note also that $\Phi \equiv W_2 - R = 0$ defines an implicit function $\Phi(b_2, \mathbf{t}_2, R) = 0$ with the partial derivatives $\Phi_1 = dW_2/db_2$, $\Phi_2 < 0$ and $\Phi_3 = -1$. Consider a case where each group finances its own UI, the case of “autarky”. This implies that $\mathbf{t}_i(1 - u_i + u_i b_i) = b_i u_i$, which means that the tax rates are independent of the wage rates. We obtain the following result:

Lemma 1. The optimal system involves identical replacement rates and thus identical taxes, if each group finances its own benefits.

Proof. Differentiate equation (15) with respect to b_i , recognising $\mathbf{t}_i(1 - u_i + u_i b_i) = b_i u_i$, we have the relevant first-order conditions:

$$\frac{dW_i}{db_i} = \left(\frac{1}{1 - \mathbf{t}_i} \right) \frac{d\mathbf{t}_i}{db_i} = \left(\frac{u_i}{1 - u_i + u_i b_i} \right) \left[1 + \left(\frac{1}{1 - u_i} \right) \frac{d \ln u_i}{d \ln b_i} \right] \quad (26)$$

Equation (26) says that, in optimum, the welfare cost of increasing tax rates is equal to the welfare gain from a rise in the replacement rate. The right hand side term in (26) captures the welfare cost implied by the associated tax increase, whereas the left hand side term captures the welfare gain from a rise in the replacement rate. Inspecting (26) and recognising (24) implies that $b_1 = b_2$ is optimal, since labour productivity does not enter the expression. Thus, we have $t_1 = t_2$ since $u_1 = u_2$ at $b_1 = b_2$. QED.

Let W_i^* denote the expected utility of a type i worker under autarky. Note that $W_2^* > W_1^*$ since high productivity workers enjoy higher consumption levels. We can establish the following result:

Proposition 1. (i) For $R = W_2^*$, benefit differentiation is not optimal. (ii) For $R < W_2^*$, benefit differentiation, i.e., $b_1 > b_2$, is optimal provided that a benefit rise reduces the wage bill.

Proof. Note that $dW_1/db_1 = dW_2/db_2$ at $b_1 = b_2 = b$ and suppose that (18) holds and consider the change in welfare arising from an increase in b_2 :

$$\begin{aligned}
\left(\frac{dL}{db_2}\right)_{b_1=b_2} &= \mathbf{l} \left[\frac{d\Omega}{db_2} - \mathbf{m} \frac{d\Omega}{db_1} \right] = \\
&\quad - \mathbf{l} \left[(\mathbf{t}_2 - \mathbf{t}_2 b + b) \frac{du}{db} + u(1 - \mathbf{t}_2) \right] w_2 \\
&\quad + \mathbf{l} \mathbf{m} \left[(\mathbf{t}_1 - \mathbf{t}_1 b + b) \frac{du}{db} + u(1 - \mathbf{t}_1) \right] w_1 \\
&\quad + \mathbf{l} [\mathbf{t}_2(1 - u + ub) - ub] \frac{dw_2}{db} \\
&\quad - \mathbf{l} \mathbf{m} [\mathbf{t}_1(1 - u + ub) - ub] \frac{dw_1}{db} \tag{27}
\end{aligned}$$

It follows from (19), (20), (21) and $u_1 = u_2 = u$ at $b_1 = b_2 = b$ that $\mathbf{m} = \frac{(1 - \mathbf{t}_2)w_2}{(1 - \mathbf{t}_1)w_1}$. This

implies:

$$\left(\frac{dL}{db_2}\right)_{b_1=b_2} = \mathbf{1}w_2(1-u)\left(\frac{\mathbf{t}_2 - \mathbf{t}_1}{1 - \mathbf{t}_1}\right)\left(\frac{d \ln[(1-u)w]}{db}\right) \quad (28)$$

where we have used the fact that $d \ln w_1 / db = d \ln w_2 / db = d \ln w / db$. From $\Phi(b_2, \mathbf{t}_2, R) = 0$ we have $\mathbf{t}_1 \leq \mathbf{t}_2$ as $R \leq W_2^*$. Hence $(dL/db_2)_{b_1=b_2} = 0$ for $R = W_2^*$. For $R < W_2^*$ we have $(dL/db_2)_{b_1=b_2} < 0$ if $d[\ln(1-u)w]/db < 0$. QED.

The result in (i) that benefit differentiation is not Paretoimproving is not surprising. Suppose an initial situation where the two groups are totally separate and each group finances its own UI. This results to same replacement rate. Suppose now these two groups put together their UI. Any distribution of replacement rate back and forth between the two groups make one group better off and the other worse off. Thus, the allocation cannot be Pareto efficient.

Corollary 1. Benefit differentiation with $b_1 > b_2$ is optimal if $R < W_2^*$ and the labour demand schedule is sufficiently wage inelastic. In particular, $\mathbf{s} \rightarrow 0$ is a sufficient condition for the optimality of $b_1 > b_2$ if $R < W_2^*$.

Proof. Define $Z \equiv (1-u)w$ and note that $d \ln Z / db = (d \ln Z / d \ln \mathbf{q})(d \ln \mathbf{q} / db)$, where $d \ln \mathbf{q} / db < 0$. Use the equilibrium conditions of the model to compute $d \ln Z / d \ln \mathbf{q}$:²⁰

$$\frac{d \ln Z}{d \ln \mathbf{q}} = \left[u \left(\frac{1-s}{s} \right) \left(1 - \mathbf{s} + \mathbf{s} \frac{y}{w} \right) + u(1 - \mathbf{s}) \right] + \left(1 - \frac{y}{w} \right) \quad (29)$$

where $d \ln Z / d \ln \mathbf{q} > 0$, and thus $d \ln Z / db < 0$, as $\mathbf{s} \rightarrow 0$. QED. Equation (29) states that there are two different mechanisms working in opposite directions. The bracketed expression captures the employment effect whereas the last term captures the wage effect. An increase in

²⁰ By using equations (1), (5), (10) and (13) we can write the wage bill as $Z(\mathbf{q}) = [1 - u(\mathbf{q}, s(\mathbf{q}))]$. The function $s(\mathbf{q})$ is obtained by combining the first-order condition for optimal search with the Nash bargaining rule.

the replacement rate reduces employment but it also increases the wage rate so that total effect on the tax base is generally ambiguous.

4.2 Utilitarian Objectives

4.2.1 Redistributive Taxation

Let us now assume a utilitarian objective function, $W \equiv W_1 + W_2$, which is equivalent to $m=1$. Maximise W with respect to the policy instruments, subject to (16). Let L denote the Lagrangian and I the multiplier associated with the budget constraint. The Lagrangian for this problem is

$$L = W_1 + W_2 + I\Omega \quad (30)$$

and the first-order conditions are as in (18)-(22), with $m=1$. It follows from the first-order conditions for t_1 and t_2 that the optimal tax rates imply equalisation of expected incomes:

$$(1 - t_1)[(1 - u_1)w_1 + u_1 b_1 w_1] = (1 - t_2)[(1 - u_2)w_2 + u_2 b_2 w_2] \quad (31)$$

Assume that the matching functions (job arrival functions), separation rates and vacancy costs are equal across the sectors. It follows that $b_1 = b_2$ implies $u_1 = u_2$. In this case, we have also $(1 - t_1)w_1 = (1 - t_2)w_2$, implying equalisation of expected utilities across the two groups. Is it then optimal to equalise replacement rates? Assume that (18) holds and evaluate dL/db_2 at $b_1 = b_2 = b$. At this point we have $dW_1/db_1 = dW_2/db_2$ and thus:

$$\begin{aligned} \left(\frac{dL}{db_2} \right)_{b_1=b_2} &= I \left[\frac{d\Omega}{db_2} - \frac{d\Omega}{db_1} \right] = \\ & - I \left[(t_2 - t_2 b + b) \frac{du}{db} + u(1 - t_2) \right] w_2 \end{aligned}$$

$$\begin{aligned}
& + \mathbf{I} \left[(\mathbf{t}_1 - \mathbf{t}_1 b + b) \frac{du}{db} + u(1 - \mathbf{t}_1) \right] w_1 \\
& + \mathbf{I} [\mathbf{t}_2(1 - u + ub) - ub] \frac{dw_2}{db} \\
& - \mathbf{I} [\mathbf{t}_1(1 - u + ub) - ub] \frac{dw_1}{db}
\end{aligned} \tag{32}$$

Proposition 2. The optimal structure of replacement rates involves $b_2 < b_1$ if wages are exogenous.

Proof. Use the condition $(1 - \mathbf{t}_1)w_1 = (1 - \mathbf{t}_2)w_2$ to substitute out \mathbf{t}_2 from (32). The resulting expression takes the form:

$$\left(\frac{dL}{db_2} \right)_{b_1=b_2} = -\mathbf{I}(w_2 - w_1) \left[\frac{du}{db} - (1 - u) \frac{d \ln w}{db} \right] \tag{33}$$

where we have used the fact that $d \ln w_1 / db = d \ln w_2 / db = d \ln w / db$. The second term in the square bracket disappears with exogenous wages and thus we always have $dL / db_2 < 0$ in this case (so $b_1 = b_2$ cannot be optimal). QED.

The sign is unclear in the general case. Note that expression (33) can also be written as

$$\left(\frac{dL}{db_2} \right)_{b_1=b_2} = \mathbf{I}(w_2 - w_1)(1 - u) \left[\frac{d \ln e}{db} + \frac{d \ln w}{db} \right] = \mathbf{I}(w_2 - w_1)(1 - u) \frac{d \ln Z}{db} \tag{34}$$

where $e = 1 - u$ is the employment rate and $Z = ew$ is the wage bill. Equation (34) implies that benefit differentiation is always optimal if labour demand elasticity is sufficiently low, i.e., $\mathbf{s} \rightarrow 0$.

4.2.2 Uniform Taxation

We have supposed so far that the government is free to choose separate tax rates for the two categories, t_1 for group 1 (low skilled) and t_2 for group 2 (high skilled). Now, we will look at a special case, i.e. we have a restriction on taxes: benefits are financed by a uniform proportional tax rate, t . The budget restriction is then

$$t[(1-u_1)w_1 + u_1b_1w_1 + (1-u_2)w_2 + u_2b_2w_2] - u_1b_1w_1 + u_2b_2w_2 = 0 \quad (35)$$

To characterise the optimal UI policy in this case, the maximisation problem is:

$$\max_{b_1, b_2, t} W = \sum_i \{ (1-u_i) [\ln w_i(1-t) + g \ln \ell_i] + u_i [\ln b_i w_i(1-t) + g \ln(1-s_i)] \}$$

The Lagrangian for this problem is

$$L = W_1 + W_2 + \mathbf{I} [t(1-u_1)w_1 + tu_1b_1w_1 + t(1-u_2)w_2 + tu_2b_2w_2 - b_1u_1w_1 - b_2u_2w_2] \quad (36)$$

Differentiating with respect to each of the choice variables gives us the first-order conditions:

$$\frac{dL}{db_1} = \frac{dW_1}{db_1} + \mathbf{I} w_1 \left[-(t - tb_1 + b_1) \frac{du_1}{db_1} - u_1(1-t) \right] + \mathbf{I} \left[-(tu_1 - t - tu_1b_1 + u_1b_1) \frac{dw_1}{db_1} \right] = 0 \quad (37)$$

$$\frac{dL}{db_2} = \frac{dW_2}{db_2} + \mathbf{I} w_2 \left[-(t - tb_2 + b_2) \frac{du_2}{db_2} - u_2(1-t) \right] + \mathbf{I} \left[-(tu_2 - t - tu_2b_2 + u_2b_2) \frac{dw_2}{db_2} \right] = 0 \quad (38)$$

$$\frac{dL}{dt} = \frac{dW_1}{dt} + \frac{dW_2}{dt} + \mathbf{I} [(1-u_1)w_1 + u_1b_1w_1 + (1-u_2)w_2 + u_2b_2w_2] = 0 \quad (39)$$

$$\frac{dL}{d\mathbf{I}} = [t(1-u_1)w_1 + tu_1b_1w_1 + t(1-u_2)w_2 + tu_2b_2w_2 - b_1u_1w_1 - b_2u_2w_2] = 0 \quad (40)$$

Should the two types have the same replacement rate or should one type have a higher benefit level? Assume $f_1 = f_2$, implying $w_2 > w_1$ for $y_2 > y_1$. The following proposition summarises the result:

Proposition 3. The optimal structure of replacement rates involves $b_2 < b_1$.

Proof. Assume that (37) holds and evaluate dL/db_2 at $b_1 = b_2 = b$ and obtain:

$$\begin{aligned} \left(\frac{dL}{db_2} \right)_{b_1=b_2} &= I \left[w_1 \left[(t - tb + b) \frac{du}{db} + u(1-t) \right] \right] - I \left[-(tu - t - tub + ub) \frac{dw_1}{db_1} \right] \\ &\quad - I \left\{ w_2 \left[(t - tb + b) \frac{du}{db} + u(1-t) \right] \right\} + I \left[-(tu - t - tub + ub) \frac{dw_2}{db_2} \right] \end{aligned} \quad (41)$$

where (40) implies $tu - t - tub + ub = 0$. Hence

$$\left(\frac{dL}{db_2} \right)_{b_1=b_2} = -I(w_2 - w_1) \left[(t - tb + b) \frac{du}{db} + u(1-t) \right] < 0 \quad (42)$$

QED.

This implies that b_2 is too high and should, therefore, be reduced. So, in optimum, a worker with higher wage should get a lower replacement rate, i.e., $b_2 < b_1$. The reason for this result is that skilled workers' unemployment is more costly for the government than unskilled workers' (see the government's budget constraint). A lower replacement rate leads to a lower unemployment rate, through higher search effort and higher tightness, and lower government expenditure. So, it is in government's interest that skilled workers are employed, since they contribute more to tax revenues.

5. Numerical Simulations

5.1 The Benchmark

To provide some information on plausible numbers and to examine whether replacement rates are increasing or decreasing in wages, the model is calibrated numerically. Another reason to do this is to resolve the ambiguity in equation (42). The day is chosen as the time unit and the matching function is Cobb-Douglas with constant returns to scale, i.e. $H = av_i^{1-s} S_i^s$. We set $y_1 = 1$, $y_2 = 1.65$; the wage differential between college and high school graduates in the U.S. is 1.65 in 1990 according to Katz and Autor (1999). The Hosios efficiency condition, i.e.

$\mathbf{b} = \mathbf{s}$, is also imposed (see Hosios 1990). We set $\mathbf{b} = \mathbf{s} = 0.5$, which is a reasonable approximation according to recent empirical studies of the matching function.²¹

The real interest rate is equal to zero and the hours of work are set to $h = T/(1 + \mathbf{g})$, which is what the employed worker would choose to maximise utility. The model is calibrated for a uniform benefit system and $b_1 = b_2 = 0.3$, which is also close to the average replacement rates in OECD countries according to Martin (1996). The remaining parameters are as follows: $a = 0.023$, $\mathbf{g} = 0.72$, $T = 1.6$, $k = 4.13$ and $\mathbf{f}_1 = \mathbf{f}_2 = 0.000828$, which implies an annual separations rate of around 30% (see Layard et al 1991). The variables \mathbf{g} , \mathbf{f}_1 , \mathbf{f}_2 , T and k were chosen such that we obtained $s_1 = s_2 = 1$ and $u_1 = u_2 = 0.065$, which roughly matches the recent average rate of unemployment in United States.²²

Table 2 shows the results of the simulations.²³ We have conducted two types of policy experiments, the optimal uniform benefit system and the optimally differentiated benefit system, and measure the welfare gain associated with particular policies. In all these experiments there is always a decrease in replacement rates associated with an increase in workers' productivity. The last line of table 2 presents welfare gains associated with particular policies. The welfare gain has the interpretation of a consumption tax that would make the individual welfare across two policy regimes indifferent. The welfare gains are reported relative to the base run that has a replacement rate of 30%. The welfare gain is measured by the following equation

$$W_P[(1 - \mathbf{x})c] = W_B$$

where W_B represents welfare associated with the base run and W_P is welfare associated with an alternative policy. We let \mathbf{x} denote the value of the tax rate that measures the welfare gain of a particular policy relative to the base run.

²¹ See for example Broersma and Van Ours (1999) and Blanchard and Diamond (1989).

²² See OECD (1997).

²³ All simulations in this section concern redistributive taxation. For the uniform case see appendix.

Table 2. Optimal Replacement Rates with Different Tax Rates

	$b_1 = b_2 = 0.3$	$b_1 = b_2$	$b_1 \neq b_2$
	Base Run	Optimal	Optimal
y_2 / y_1	1.650	1.650	1.650
b_1	0.300	0.379	0.419
b_2	0.300	0.379	0.353
b_1 / b_2	1.000	1.000	1.187
s_1	1.000	0.848	0.742
s_2	1.000	0.848	0.906
s_1 / T	0.625	0.530	0.464
s_2 / T	0.625	0.530	0.566
u_1	0.065	0.084	0.100
u_2	0.065	0.084	0.076
u_1 / u_2	1.000	1.000	1.316
q_1	0.268	0.216	0.190
q_2	0.268	0.216	0.233
t_1	-0.298	-0.281	-0.281
t_2	0.213	0.224	0.225
W_1	-0.191	-0.187	-0.177
W_2	-0.191	-0.187	-0.195
W	-0.383	-0.374	-0.372
x (%)	...	0.867	1.077

The optimal replacement rate in a uniform system is 37.9 percent. The higher replacement rate reduces search effort to 0.85 and increases the unemployment rate to 8.4 percent for both groups. However, there is a welfare gain equal to 0.9 percent. It means that individuals would pay 0.9 percent of their consumption to move from the base run system to the optimal uniform one. They would be willing to pay even more, 1.1 percent of their consumption, in order to move from the base run regime to the optimally differentiated one. However, the unemployment rate increases for group 1 as it decreases for group 2 in the differentiated

regime compared with uniform regime which is not surprising since group 1's replacement rate rises but group 2's declines.

5.2 The Impact of Productivity Differences

To see the relationship between replacement rates and workers' productivity, we have conducted an experiment. We let productivity differences between the two groups increase by changing the value of y_2 . Table 3 presents the results of the numerical experiments. The simulations imply that there is a negative relationship between replacement rates and individuals' productivity. The bigger differences in productivities and wages, the bigger differences in replacement rates. If $y_2 = 1.65y_1$, then $b_1 = 1.2b_2$ and when $y_2 = 2.5y_1$, we have $b_1 = 1.4b_2$.

Table 3. The Effects of Higher Productivity Differences

	b_1	b_2	b_1/b_2	e (%)	e^* (%)
$y_2 = 1.65y_1$	0.419	0.353	1.187	1.077	0.210
$y_2 = 2y_1$	0.439	0.344	1.276	1.297	0.431
$y_2 = 2.5y_1$	0.468	0.337	1.389	1.734	0.868

Note: e is the gain relative to the base run; e^* is the welfare gain relative to the optimal uniform system.

5.3 The Effects of Unequal Separation Rates

We conclude this section by analysing the case with different separation rates for each group. By assuming higher separation rates for low-income group, we will examine if this fact affect our results from table 2. We look only at the case of log utility and variables f_1 and f_2 are chosen such that we obtain $u_1 = 2u_2$. All other parameter values are the same as in table 2. Table 5 shows the results of the calibrations. The benefit system with unequal separation rates is more generous than the system with uniform separation rates in both optimal and differentiated policy regimes. The optimal uniform replacement rate increases from 37.9% to 39.8% and in the case of optimally differentiated regime from 35.3% to 35.6% for high income group and from 41.9% to 42.6% for low wage group. In addition, the benefit system becomes more differentiated when separation rates are unequal. With equal separation rates, we have $b_1/b_2 = 1.187$, and with unequal separation rates $b_1/b_2 = 1.197$. However, these numbers suggest that the degree of differentiation should be small. There are also welfare

gains associated with switching to a differentiated benefit system. The size of these gains are larger than in the case with equal separation rates (see table 2 and 5).

Table 4. Different Separation Rates

	$b_1 = b_2 = 0.3$	$b_1 = b_2$	$b_1 \neq b_2$
	Base Run	Optimal	Optimal
y_2 / y_1	1.650	1.650	1.650
b_1	0.300	0.398	0.426
b_2	0.300	0.398	0.356
b_1 / b_2	1.000	1.000	1.197
s_1	0.997	0.797	0.712
s_2	1.018	0.836	0.925
s_1 / T	0.623	0.498	0.445
s_2 / T	0.636	0.523	0.578
u_1	0.070	0.097	0.113
u_2	0.035	0.048	0.04
q_1	0.265	0.201	0.183
q_2	0.286	0.219	0.247
t_1	-0.361	-0.344	-0.345
t_2	0.228	0.238	0.239
W_1	-0.156	-0.145	-0.136
W_2	-0.137	-0.138	-0.145
W	-0.293	-0.283	-0.281
\mathbf{x} (%)	...	0.969	1.153

Note: $f_1 = 0.000888604$ and $f_2 = 0.000454412$.

6. Concluding Remarks

This paper has considered the structure of optimal earnings-related unemployment benefits by developing a two-sector general equilibrium model of search unemployment. One analytical

result is that an optimal insurance system implies lower replacement rates for workers with higher wages if taxes are uniform. The same result may hold even though taxes are redistributive. The numerical results suggest that there are welfare gains associated with switching from an optimal uniform benefit system to an optimally differentiated one in both cases, i.e., uniform and redistributive taxation.

To gain insight into the essentials of the problem, saving has been ignored in the analysis. Households can not smooth consumption through borrowing or private saving in the model. Consumption is at the *Polonius point*.²⁴ However, an analysis of equilibrium search including saving would presumably make the model extremely complex.

A complete welfare analysis of UI policies should also take into account the fact that unemployment benefits are often supplemented with family and housing benefits, which may affect the behaviour of all individuals in the labour market. Another component to consider in the analysis is the effects of eligibility rules on workers' incentives. Existing UI systems require a number of conditions that the unemployed must satisfy in order to receive some form of unemployment compensation, which means that many unemployed do not qualify for benefits. A third factor we should keep in mind is the possibility that high wage individuals may have other incentives than the benefit level to search for a job when unemployed. These factors may well have stronger effects on their search intensity and acceptance criteria than unemployment benefits.

Appendix. Uniform Taxation

To see whether replacement rates and welfare gain changes when we move from an optimal differentiated tax system to an optimal uniform tax system, we have also simulated the uniform tax model. We use the same parameter values as in table 2. The effects on replacement rates of switching from redistributive tax system to the uniform one seem to be small and negligible (compare tables 2, 3 and 4 with A1, A2 and A3).

²⁴ *Hamlet*, Act I, scene III; Polonius giving advice to his son, Leartes: "Neither a borrower nor a lender be: for loan oft loses both itself and friend; and borrowing dulls the edge of husbandry." (Shakespeare 1601). I owe this reference to Varian (1996).

Table A1. Optimal Replacement Rates

	$b_1 = b_2 = 0.3$	$b_1 = b_2$	$b_1 \neq b_2$
	Base Run	Optimal	Optimal
y_2 / y_1	1.650	1.650	1.650
b_1	0.300	0.379	0.410
b_2	0.300	0.379	0.350
b_1 / b_2	1.000	1.000	1.171
s_1	1.000	0.848	0.768
s_2	1.000	0.848	0.910
s_1 / T	0.625	0.530	0.480
s_2 / T	0.625	0.530	0.569
u_1	0.065	0.084	0.096
u_2	0.065	0.084	0.075
u_1 / u_2	1.000	1.000	1.280
q_1	0.268	0.216	0.195
q_2	0.268	0.216	0.234
t	0.020	0.033	0.033
W_1	-0.473	-0.468	-0.461
W_2	0.028	0.032	0.026
W	-0.445	-0.436	-0.434
x (%)	...	0.867	1.039

Table A2. The Effects of Higher Productivity Differences

	b_1	b_2	b_1 / b_2	e (%)	e^* (%)
$y_2 = 1.65y_1$	0.410	0.350	1.171	1.039	0.172
$y_2 = 2y_1$	0.422	0.341	1.238	1.190	0.323
$y_2 = 2.5y_1$	0.434	0.330	1.315	1.443	0.542

Note: e is the gain relative to the base run; e^* is the welfare gain relative to the optimal uniform system.

Table A3. Different Separation Rates

	$b_1 = b_2 = 0.3$	$b_1 = b_2$	$b_1 \neq b_2$
	Base Run	Optimal	Optimal
y_2 / y_1	1.650	1.650	1.650
b_1	0.300	0.394	0.414
b_2	0.300	0.394	0.353
b_1 / b_2	1.000	1.000	1.173
s_1	0.997	0.806	0.752
s_2	1.018	0.844	0.930
s_1 / T	0.623	0.504	0.470
s_2 / T	0.636	0.528	0.581
u_1	0.070	0.096	0.105
u_2	0.035	0.047	0.041
u_1 / u_2	2.00	2.043	2.561
q_1	0.265	0.203	0.191
q_2	0.286	0.221	0.249
t	0.015	0.027	0.026
W_1	-0.479	-0.468	-0.463
W_2	0.107	0.106	0.101
W	-0.372	-0.363	-0.361
x (%)	...	0.972	1.104

Note: $f_1 = 0.000888604$ and $f_2 = 0.000454412$.

References

Agell J (2000), *On the Determinants of Labour Market Institutions: Rent Seeking versus Social Insurance*, CESifo Working Paper Series 384, CESifo, Munchen.

Alber J (1981), Government Responses to the Challenge of Unemployment: The Development of Unemployment Insurance in Western Europe, in Flora P and A J Heidenheimer (eds), *The Development of Welfare States in Europe and America*, London.

Alber J and P Flora (1981), Modernisation, Democratization and the Development of Welfare States in Western Europe, in Flora P and J Heidenheimer (eds), *The Development of Welfare States in Europe and America*, London.

Atkinson A and J Micklewright (1991), Unemployment Compensation and Labour Market Transitions: A Critical Review, *Journal of Economic Literature* 29: 1979-1727.

Baily M A (1978), Some Aspects of Optimal Unemployment Insurance, *Journal of Public Economics* 10: 379-402.

Blanchard O J and P Diamond (1989), The Beveridge Curve, *Brooking Papers on Economic Activity*, no. 1: 1-60.

Broersma L and J C Van Ours (1999), Job Searchers, Job Matches and the Elasticity of Matching, *Labour Economics* 6: 77-93.

Brooks J (1893), *Compulsory Insurance in Germany*, Washington.

Devine T and N Kiefer (1991), *Empirical Labour Economics: The Search Approach*, Oxford University Press.

Esping-Andersen G (1990), *The Three Worlds of Welfare Capitalism*, Cambridge.

Flemming J (1978), Aspects of Optimal Unemployment Insurance: Search, Leisure, Savings and Capital Market Imperfections, *Journal of Public Economics* 10:403-25.

Flora P (1987), *State, Economy and Society in Western Europe 1815-1975*, London: Macmillan.

Fredriksson P and B Holmlund (2001), Optimal Unemployment Insurance in Search Equilibrium, *Journal of Labour Economics* 19 (2): 370-399.

Freeman R B (1998), War of the Models: Which Labour Market Institutions for the 21st Century?, *Labour Economics* 5: 1-24.

Holmlund B (1998), Unemployment Insurance in Theory and Practice, *Scandinavian Journal of Economics* 100 (1): 113-141.

Hosios A (1990), On the Efficiency of Matching and Related Models of Search and Unemployment, *Review of Economic Studies* 57: 279-98.

Johnson G and R Layard (1986), The Natural Rate of Unemployment: Explanation and Policy, in O Ashenfelter and R Layard (eds), *Handbook of Labour Economics*, vol. 1, North Holland.

Katz L F and D H Autor (1999), Changes in the Wage Structure and Earnings Inequality, in O Ashenfelter and D Card (eds), *Handbook of Labour Economics*, vol. 3A, North Holland.

Layard R, S Nickell and R Jackman (1991), *Unemployment: Macroeconomic Performance and the Labour Market*, Oxford.

- Leibfried S (1993), Towards a European Welfare State? in Jones C (ed), *New Perspective on the Welfare State in Europe*, London
- Leman C (1980), *The Collapse of Welfare Reform: Political Institutions, Policy, and the Poor in Canada and the United States*, MIT Press, Cambridge.
- Martin J (1996), Measures of Replacement Rates for the Purpose of International Comparisons: A Note, *OECD Economic Studies* 26: 99-115.
- Mortensen D (1977), Unemployment Insurance and Job Search Decisions, *Industrial and Labor Relations Review* 30 (4):505-17.
- Munzi T and A Salomäki (1999), Net Replacement Rates of the Unemployed. Comparisons of Various Approches, *OECD Economic Papers*, OECD.
- Organisation for Economic Co-Operation and Development, OECD (1999), *Benefit System and Work Incentives*, Paris.
- Petrongolo B and C Pissarides (2001), Looking into the Black Box: a Survey of the Matching Function, *Journal of Economic Litterature* 39: 390-431.
- Pissarides C A (2000), *Equilibrium Unemployment Theory*, Basil Blackwell, MIT Press.
- Shakespeare W (1601), *Hamlet*, England.
- Shavell S and L Weiss (1979), The Optimal Payment of Unemployment Insurance Benefits over Time, *Journal of Political Economy* 87: 1347-62.
- SOU (1996), *Grundläggande drag i en ny arbetslöshetsförsäkring* (The Main Features of a New Unemployment Insurance), SOU 1996:51, Stockholm.
- Tsukada H (2002), *Economic Globalization and the Citizens' Welfare State*, England.
- Varian H (1996), *Intermediate Microeconomics : A Modern Approach*, New York.