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Optimal unemployment insurance

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Abstract

We investigate the design of an optimal unemployment insurance program using an equilibrium search model calibrated using data from the reemployment bonus experiments. There are three main conclusions. First, insurance considerations suggest that the potential duration of UI benefits would be unlimited under an optimal program. Second, if the potential duration to benefits were unlimited, current replacement rates in the U.S. (about 0.5) would probably be about right. Third, the optimal replacement rate rises as the potential duration of benefits is increasingly limited, reaching 1 when the potential duration of benefits is limited to 32 weeks.

Keywords: Optimal social insurance; Unemployment insurance; Risk; Uncertainty

JEL classification: H21; J65; D8

1. Introduction

Risk averse workers facing uncertain employment prospects prefer to insure against adverse conditions such as unemployment. If they could, they would purchase private unemployment insurance in order to finance consumption during jobless spells. In fact, if the insurance were actuarially fair, it is well known that the all risk averse workers would choose to insure fully so that consumption during unemployment would equal consumption while employed. But, for a

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variety of reasons, insurance markets are incomplete, and private unemployment insurance cannot be purchased.

In the absence of private insurance markets, agents will try to save while employed and to dissave during jobless spells. It is unlikely, however, that workers would be able to save enough to smooth consumption completely across periods of unemployment. In response to this problem, virtually every developed country provides public unemployment insurance (UI). In the United States, there is considerable empirical evidence that UI does what it was intended to do—it allows workers to smooth consumption. For example, Gruber (1994) estimates that without UI consumption would fall by 22% during unemployment, whereas it falls by only 7% with UI in place.

But UI has unintended effects as well. There is considerable evidence that UI increases the length of unemployment spells.[1] By providing unemployment insurance, the government reduces the opportunity cost of unemployment. This reduces search effort and increases the length of unemployment spells and the equilibrium rate of unemployment.[2] In designing an optimal UI program, the positive and negative effects of UI must be weighed. Baily (1978) and Flemming (1978) have provided the classic theoretical treatments of optimal UI.[3] Both consider the situation faced by an unemployed worker and solve for optimal search effort as a function of UI. Although the actual spell of unemployment is a random variable, its expected value varies inversely with search effort. Both authors solve the optimal insurance problem by choosing UI to maximize the expected lifetime utility of the representative worker. The papers differ in their treatments of leisure, savings, and the capital market. Nevertheless, both papers and empirical work making use of their approach (e.g. Gruber, 1994; O'Leary, 1994) conclude that UI payments in the United States are too generous.

In this paper we extend the analysis offered by Baily and Flemming in two ways. First, in their models, both authors assume that UI is offered indefinitely—that is, unemployed workers collect UI in every period until they find a job. But few UI systems are set up to pay benefits indefinitely. In the United States, workers usually exhaust their UI benefits after just 26 weeks. The potential duration of benefits is longer in Canada (about 1 year) and in most of Western Europe (3 years or longer in several countries, and indefinite in Belgium (OECD, 1991)). In Section 3, we show that taking into account the finite potential duration

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[1] See Davidson and Woodbury (1996) for a review and new evidence based on the reemployment bonus experiments.

[2] On the other hand, it is often argued that UI makes workers choosier about the jobs that they accept, and that this may improve the quality of job matches. This notion has persisted despite very little empirical evidence to support it.

[3] Shavell and Weiss (1979) also provide a theoretical analysis of UI. However, they are not concerned with the adequacy of current programs. Instead, they focus on the optimal way to pay out benefits over the spell of unemployment *given a fixed level of total expenditures by the government*. In addition, they do not use an equilibrium model so that they ignore the impact of UI on unemployment.

of benefits drastically alters the conclusions reached by Baily and Flemming. For example, Flemming finds that if lending and borrowing are ruled out, the optimal replacement rate—the ratio of weekly UI benefits to the weekly wage—is about two-thirds to three-quarters. The optimal replacement rate is in the same range in our model as well, assuming that UI is offered indefinitely. However, if UI is offered for only 26 weeks, the optimal replacement rate jumps to greater than 1.

Also in Section 3, we solve for the optimal UI program assuming that it can be characterized by two instruments—the level of UI benefits and the potential duration of benefits. Surprisingly, we find that the optimal UI program is characterized by an infinite potential duration of benefits. The argument is as follows. Let x denote the benefit level and let T denote the potential duration of UI. Suppose that we compare two programs (x_1, T_1) and (x_2, T_2) with $x_1 > x_2$ and $T_1 < T_2$ so that the second program offers lower benefits but a longer potential duration of benefits. Suppose further that these two programs cost the same amount to fund so that employed workers earn the same after-tax wage under the two programs. We find that all risk-averse unemployed workers prefer the second program in spite of the fact that benefits are lower. They prefer the second program because the reduction in the probability that they will exhaust their benefits more than offsets the reduction in their benefits. In the terminology of decision making under uncertainty, the second program is "less risky" than the first program and is therefore preferred by all risk averse agents. Since the optimal UI program offers workers benefits indefinitely while most State programs in the United States offer benefits for only 26 weeks, the model's results suggest that the current United States system may not be generous enough.

The second extension we offer concerns the composition of the pool of unemployed workers. Both Baily and Flemming assume that all unemployed workers are eligible for UI. In fact, fewer than half of all unemployed workers in the United States are UI-eligible (Blank and Card, 1991). We show that this fact has important implications for the optimal replacement rate. Briefly, there are two effects. First, an increase in UI benefits reduces the search intensity of UI-eligible workers, so that UI-ineligibles gain as they face less competition for jobs. This positive spill-over effect of UI increases the optimal replacement rate. The second effect is more subtle and depends on the degree of substitutability in production between UI-eligible and ineligible workers. Since UI-ineligibles receive no UI benefits, they search harder than UI-eligible workers. If UI-eligibles and UI-ineligibles are good substitutes, then treating all workers as if they were UI-eligibles will overstate the reemployment prospects for UI-eligible workers. In this case, the presence of UI-ineligibles in the workforce increases the optimal replacement rate; that is, since UI-ineligibles make it harder for UI-eligibles to find reemployment, the government needs to increase the insurance it provides to UI-eligibles. On the other hand, if UI-ineligibles tend to be lower-skilled workers who are poor substitutes for UI-eligible workers, then treating all workers as if they were UI-eligible will understate the reemployment prospects of UI-eligible workers. In this case, the presence of UI-ineligibles in the workforce lowers the optimal replacement rate. When we combine the spill-over effect and the effect of substitutability between UI-eligibles and UI-ineligibles, we find that unless the degree of substitutability between UI-eligibles and UI-ineligibles is extremely low, the presence of UI-ineligibles raises the optimal replacement rate.

In summary, we emphasize the importance of extending the models of Baily and Flemming to incorporate two empirical features of the UI system—that UI benefits are offered for a finite length of time and that not all workers are eligible for UI benefits. When their models are extended to include these features, the optimal replacement rate rises. Indeed, for reasonable parameter values, the model suggests that average UI benefits in the United States are too low and the potential duration of benefits too short.

The plan of the paper is as follows. In Section 2, we introduce a model that is similar in spirit to those of Baily and Flemming in that it assumes that all unemployed workers are eligible for UI. However, our model differs from theirs in that we allow for a finite potential duration of benefits. Using this model, we argue in Section 3.1 that any program that eventually cuts off benefits is Pareto-dominated by another program that offers more periods of coverage. Thus, an optimal program must include an infinite potential duration of benefits. In Section 3.2, we solve for the optimal replacement rate under a program in which benefits are offered indefinitely. In Section 3.3 we calculate optimal replacement rates for sub-optimal programs—that is, programs in which benefits are cut off after a certain length of time. Section 4 discusses several potentially important extensions: we consider a model in which some unemployed workers are ineligible for UI, discuss voluntary saving, show the influence of different degrees of risk aversion, relax the assumption that the separation rate is exogenous, and relax the assumption that the proportion of unemployed workers who are eligible for UI is fixed. Finally, in Section 5 we summarize the results, discuss their applicability, and offer some caveats.

2. Model and approach

2.1. The model

We follow Baily and Flemming by modeling the behavior of a typical unemployed worker who is searching for employment. This worker earns a wage of w while employed and collects UI benefits of x while unemployed provided that he has not exhausted his benefits. Benefits are provided by the government to all jobless workers who have been unemployed for no more than T weeks. UI is funded by taxing all employed workers' incomes at a constant rate τ.

We assume that unemployed workers choose search effort (p) to maximize expected lifetime income and that all workers are infinitely lived.[4] Given total labor demand (F), search effort determines equilibrium steady-state unemployment (U).[5] The government's goal is to choose x (the level of UI benefits) and T (the potential duration of benefits) to maximize aggregate expected lifetime income. Increases in x and/or T provide additional insurance, but these increases have costs—they lower optimal search effort and therefore increase equilibrium unemployment, and they must be paid for with lower net earnings while employed. The optimal government policy must weigh these factors.

Formally, we use L to denote total labor supply and let J represent the total number of jobs held in the steady-state equilibrium. Then, since every worker is either employed or unemployed, we have:

$$L = J + U \tag{1}$$

For later use, we define U_t to be the equilibrium number of workers who are in their t^{th} week of insured unemployment ($t = 1, \ldots, T$) and let U_x represent the equilibrium number of unemployed workers who have exhausted their UI benefits. We then write total unemployment as:

$$U = \Sigma_t U_t + U_x \tag{2}$$

Consider next firms. For simplicity, we assume that each firm provides one job opportunity.[6] Thus, F denotes both the number of firms and the number of jobs available. Each job is either filled or vacant. If we let V denote the number of vacancies in a steady-state equilibrium, it follows that:

$$F = J + V \tag{3}$$

The remainder of the model is explained in three stages. First, we describe the dynamics of the labor market and derive conditions that must hold in a steady-state. These conditions guarantee that the unemployment rate and its composition remain constant over time. Second, we relate search intensity by unemployed workers to their reemployment probabilities. We then use these reemployment probabilities to derive the expected lifetime incomes of employed and unemployed workers. Finally, in stage three, we derive the optimal level of search effort for all unemployed workers.

To describe the dynamics of the labor market, let s denote the probability that an employment relationship will break up in any given period (i.e. the turnover or

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[4] We assume infinite life since it makes the model much more tractable. Flemming also makes this assumption while Baily uses a two-period model.

[5] Following Baily and Flemming, we do not model the firm, and we treat F and w as exogenous variables. This is discussed at greater length in Section 4.4.

[6] This assumption is commonly used in general equilibrium search models (see, for example, Diamond, 1982 or Pissarides, 1990). Alternatively, we could simply assume that each firm recruits for and fills each of its many vacancies separately.

separation rate). In addition, let m_t and m_x denote the reemployment probabilities for workers in their t^{th} period of search and for UI-exhaustees, respectively. For any given worker, there are $T+2$ possible employment states—U_1, U_2,..., U_T, U_x, and J. If employed (i.e. if in state J) the worker faces a probability s of losing her job and moving into state U_1. If unemployed for t periods (i.e. if in state U_t), the worker faces a probability of m_t of finding a job and moving into state J. With the remaining probability of $1-m_t$ this worker remains unemployed and moves on to state U_{t+1}. UI exhaustees face a reemployment probability of m_x, in which case they move into state J. Otherwise, they remain in state U_x.

In a steady-state equilibrium the flows into and out of each state must be equal so that the unemployment rate and its composition do not change over time. Using the above notation, the flows into and out of state U_1 are equal if:

$$sJ = U_1 \tag{4}$$

The flows into and out of state U_t (for $t=2$,..., T) are equal if:

$$(1 - m_{t-1})U_{t-1} = U_t \tag{5}$$

Finally, the flows into and out of state U_x are equal if:

$$(1 - m_T)U_T = m_x U_x \tag{6}$$

In each case, the flow into the state is given on the left-hand-side of the expression while the flow out of the state is given on the right-hand-side.

Consider next the reemployment probabilities. Each unemployed worker chooses search effort to maximize expected lifetime income. We use p_t to denote the search effort of a worker who is in her t^{th} period of search, with p_x playing the same role for UI exhaustees. Search effort is best thought of as the number of firms a worker chooses to contact in each period of job search.[7] Once a worker contacts a firm, she files an application for employment if the firm has a vacancy. Since there are F firms and V of them have vacancies, the probability of contacting a firm with a vacancy is V/F. Finally, once all applications have been filed, each firm with a vacancy fills that vacancy by choosing randomly from its applicants. Thus, if N other workers apply to the firm, the probability of a given worker getting the job is $1/(N+1)$. Since each other worker either does or does not apply, N is a random variable with a Poisson distribution with parameter λ equal to the average number of applications filed at each firm. This implies that the probability of getting a job offer conditional on having applied at a firm with a vacancy is $(1/\lambda)[1-e^{-\lambda}]$.[8] The reemployment probability is then the product of these three terms—the number of firms contacted, the probability that a given firm will have a

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[7] For workers who contact fewer than one firm on average, p_t could be thought of as the probability of contacting any firm.

[8] See Davidson and Woodbury (1993) for details.

vacancy, and the probability of getting the job conditional on having applied at a firm with a vacancy:

$$m_t = p_t(V/F)(1/\lambda)[1 - e^{-\lambda}] \quad \text{for } t = 1,\dots, T \tag{7}$$

$$m_x = p_x(V/F)(1/\lambda)[1 - e^{-\lambda}] \tag{8}$$

$$\lambda = \{\Sigma_t p_t U_t + p_x U_x\}/F \tag{9}$$

These equations define the reemployment probabilities of workers as a function of search effort and the length of time that they have been unemployed (since m_t varies over time). Note that for any given worker, the search effort of other workers affects that worker's reemployment probability through λ.

Finally, to determine search effort we must first define expected lifetime income for all workers. Let V_w denote the expected lifetime income of an employed worker and let V_t and V_x play the same role for the unemployed in their t^{th} period of search and for UI-exhaustees, respectively. For an employed worker, current income is the net wage, $w(1-\tau)$, where τ is the marginal tax rate. Her future income depends upon her employment status—with probability s she loses her job and can expect to earn V_1 in the future, and with probability $1-s$ she keeps her job and continues to earn V_w in the future. Thus,

$$V_w = U[w(1 - \tau)] + [sV_1 + (1 - s)V_w]/(1 + r) \tag{10}$$

Note that future income is discounted with r denoting the interest rate.

For unemployed workers, current income is equal to unemployment insurance (if benefits have not yet been exhausted) less search costs. We assume that the cost of search is given by $c(p)$ where c is a convex function with $c(0)=0$. Future income depends on future employment status—with probability m_t the worker finds a job and can expect to earn V_w in the future, while with the remaining probability she remains unemployed and can expect to earn V_{t+1} in the future. Thus,

$$V_t = U(x) - c(p_t) + [m_t V_w + (1 - m_t)V_{t+1}]/(1 + r) \quad \text{for } t = 1,\dots, T \tag{11}$$

$$V_x = -c(p_x) + [m_x V_w + (1 - m_x)V_x]/(1 + r)^9 \tag{12}$$

Unemployed workers choose search effort (p_t) to maximize expected lifetime income (V_t). Thus,

$$p_t = \arg\max V_t \quad \text{for } t = 1,\dots, T \tag{13}$$

$$p_x = \arg\max V_x \tag{14}$$

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[9] Note that we have normalized utility so that $U(0)=0$.

This completes the model. Structurally it is similar to Flemming's. However, since Flemming assumed that UI benefits are offered indefinitely, in his model all unemployed workers are identical. One of our purposes is to relax the assumption of indefinite benefits. Our model allows us to capture the notion that unemployed workers who have been jobless for a longer period of time will search harder as they near benefit exhaustion. In addition, as we show below, once we take into account the fact that UI is *not* offered indefinitely, conclusions about optimal UI levels are greatly changed.

Before we turn to optimal policy, it is useful to first describe the structure of equilibrium and some of its comparative dynamic properties. It is straightforward to show that the structure of equilibrium is such that $V_w > V_1 > V_2 > \ldots > V_T > V_x$. That is, expected lifetime utility is highest for employed workers, lowest for unemployed workers who have exhausted their benefits, and decreasing in the number of weeks that a worker has been unemployed. Intuitively, workers in the early stages of a spell of unemployment have more weeks to find a job before they have to worry about losing their UI benefits. Because of this, workers who have recently become unemployed will not search as hard as those who have been unemployed for a longer period of time—that is, optimal search effort will be increasing in t, the number of weeks of unsuccessful search $(p_1 < p_2 < \ldots < p_T < p_x)$.

A decrease in benefits (x) or the potential duration of benefits (T) decreases the insurance offered and triggers an increase in search effort by all UI-eligible workers (and therefore lowers unemployment). Either change results in a decrease in V_t for all t. But decreases in x and T have opposite effects on the probability of exhausting benefits. A decrease in x makes it less likely that a worker will exhaust her benefits before finding a job (since she searches harder). But a decrease in T makes it more likely that benefits will be exhausted since the time horizon over which benefits are offered has been shortened.[10]

The fact that search effort varies across any spell of unemployment has implications for the equilibrium rate of unemployment. In our model, as in any matching model, there is an underlying matching technology that determines the number of vacancies filled in any given period as a function of search effort. This matching function is analogous to a production function with jobs as the output and search effort as the inputs. Typically, this matching technology is assumed to have the same properties as a standard production function, and there is substantial empirical evidence that this is indeed the case.[11] In particular, the number of new jobs created in any period is *concave* in search effort. This implies that unemployment is *convex* in search effort. Thus, if we hold aggregate search effort constant and reduce the variation in search effort over t, unemployment will fall—that is, holding total search effort constant, unemployment is lower when all workers search with the same intensity than when some search harder than others.

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[10] This is true even though search effort increases as a result of the decrease in T.

[11] See, for example, Pissarides (1986); Blanchard and Diamond (1989), (1990); Chirinko (1982).

This provides some initial insight into why an indefinite potential duration of UI benefits ($T=\infty$) is optimal—if UI benefits are offered indefinitely, all unemployed workers will behave in the same fashion and choose the same level of search effort.[12]

2.2. Calibration

The model outlined above is too complex to yield closed form solutions for the optimal values of T and x. Thus, again following Baily and Flemming, we choose parameter values and solve the model for the optimal UI program. Assuming that our parameters are chosen wisely, this should give us some idea of the range in which the optimal level of benefits falls.

The parameters of the model include the separation rate (s), the interest rate (r), the wage (w), the total number of jobs available (F), the size of the labor force (L), and the search cost function ($c(p)$). We can obtain an estimate of s from the existing literature on labor market dynamics. Ehrenberg (1980) and Murphy and Topel (1987) both provide estimates of the number of jobs that break-up in each period. If we measure time in 2-week intervals, their work suggests that s lies in the range of 0.007 to 0.013. For the interest rate we set $r=0.008$ which translates into an annual discount rate of approximately 20%.[13] Since our previous work suggests that results from this model are not sensitive to changes in r over a fairly wide range, this is the only value for the interest rate that we report.[14]

For F and L we begin by noting that our model is homogeneous of degree zero in F and L so that we may set $L=100$ without loss of generality. If we then vary F holding all other parameters fixed we can solve for the equilibrium unemployment and vacancy rates. Abraham's (Abraham, 1983) work suggests that the ratio of unemployment to vacancies (U/V) varies between 1.5 and 3 over the business cycle. Although the actual values of U and V depend on the other parameters, we

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[12] Note that we assume that agents act to maximize expected lifetime income in order to maximize expected lifetime utility. Although equivalence of expected income and expected utility usually implies risk neutrality, the agents in our model are in fact risk averse. Risk aversion follows from the assumption that search costs are convex in search effort. Any increase in the wage or decrease in UI benefits triggers an increase in search effort; but since search costs are convex, optimal search effort is concave in w and x. This implies that expected lifetime income is concave in w and x, making the worker risk averse with respect to income. This is important because it implies that any policy change that reduces the risk associated with unemployment will be welfare enhancing.

[13] Recent empirical work by Feldstein and Samwick (1995) suggests a bimodal distribution of discount rates for households, with about 27 percent of households at 5% and about 18 percent of households at 20%. Since unemployed workers are likely to discount future income more than other agents, we set $r=20\%$ in our calculations.

[14] For completeness, we have checked the robustness of our results with respect to changes in r, and find that the results are not sensitive to such changes. For example, the optimal replacement rates in Table 1 all increase by only 1 percentage point when r is set equal to 2% (as opposed to 20%).

find that to obtain such values for U/V in our model F must lie in range of 95 to 97.5.

The remaining parameters are the wage rate and the search cost function. For these values we turn to our previous work, which makes use of data and results from the Illinois Reemployment Bonus Experiment (Davidson and Woodbury, 1993 and Woodbury and Spiegelman, 1987). In the Illinois experiment, a randomly selected group of new claimants for UI were offered a $500 bonus for accepting a new job within 11 weeks of filing their initial claim. The average duration of unemployment for these bonus-offered workers was approximately 0.7 weeks less than the average unemployment duration of the randomly selected control group (Davidson and Woodbury, 1991). In our earlier work, we estimated the parameters of the search cost function that would be consistent with such behavioral results. That is, we assumed a specific functional form for $c(p)$ and then solved for the parameters that would make the model's predictions match the outcome observed in the Illinois experiment. The functional form that we used was $c(p)=cp^z$, where z denotes the elasticity of search costs with respect to search effort. Our results indicated that for the average bi-weekly wage rate observed in Illinois ($511), the values of c and z that are consistent with the Illinois experimental results are $c=282$ and $z=1.269$.[15]

In summary, our reference case with a linear utility function uses the following parameter values: $s=0.010$, $r=0.008$, $L=100$, $F=96.25$, $w=511$, $c=282$, and $z=1.269$. Once we solve for the optimal value for x in the reference case, we vary s and F over the ranges described above to test for the sensitivity of our results with respect to each.

3. Social welfare and optimal UI benefits

In the context of our model, social welfare can be calculated by summing expected lifetime income across all workers. In a steady-state equilibrium there are J employed workers with expected lifetime incomes of V_w, U_t unemployed workers who are in their t^{th} period of search with expected lifetime incomes of V_t, and U_x unemployed workers who have exhausted their UI benefits with expected lifetime incomes of V_x. Summing yields Social Welfare (SW):

$$SW = JV_w + \Sigma_t U_t V_t + U_x V_x \tag{15}$$

The government's problem is to choose x (the UI benefit level) and T (the

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[15] As we show elsewhere (Davidson and Woodbury, 1996), the Illinois bonus impact suggests that a 10 percentage point increase in the UI replacement rate lengthens the expected duration of unemployment by 0.8 week, and that a 1 week increase in the potential duration of benefits lengthens unemployment duration by 0.2 week. These are in the middle to upper-middle of the range of existing estimates of the disincentive effects of UI.

potential duration of benefits) to maximize Eq. (15) with the tax rate, τ, set such that the government budget balances:

$$Jw\tau = x(U - U_x) \tag{16}$$

As noted above, increases in x or T increase the level of insurance provided but also increase equilibrium unemployment and require that τ increase in order to fund the expanded program.

3.1. Optimal potential duration of benefits

We begin by arguing that any optimal UI program must offer benefits indefinitely. This is accomplished by showing that any program in which T is finite is Pareto Dominated by another program in which T is larger and x is smaller. We then set $T=\infty$, calibrate the model, and solve for the optimal replacement rate.

To understand why it is optimal to set $T=\infty$, we start with any program (x, T) that restricts T to be finite, then proceed in two steps. First, we increase the potential duration of benefits (T) by one week and lower the weekly benefit amount (x) in a tax neutral manner *holding the search effort of all workers constant at their original levels.* Two programs are defined to be tax neutral if they require the same amount of tax revenue to fund. We then show that this change in policy benefits all agents. Second, we allow search effort to adjust to the new equilibrium levels and argue that this second adjustment further increases the expected lifetime utilities of all workers.

Let (x, T) denote the initial program and consider the impact of lowering x and increasing T by one week in a tax-neutral manner. *If we hold search effort constant,* this change results in a Pareto improvement. To see why, consider the effect on the current income of each agent (see Fig. 1). With search effort held constant, reemployment probabilities, employment, and unemployment do not change. Thus, tax revenue does not change, and neither do the marginal tax rate (τ) or net income while employed. For the unemployed, benefits are lower in the first T periods of unemployment but are now offered for an additional period. Thus, current income falls for workers who have been unemployed T periods or less, rises for unemployed workers in their $(T+1)^{\text{st}}$ period of search, and remains the same for anyone who has been unemployed more than $T+1$ periods. Note that (a) income falls during periods of unemployment in which current income is relatively high and rises in one of the most adverse states of unemployment (period $T+1$), and (b) the total amount of money distributed to the unemployed is the same under the two programs. It follows that this change in policy reduces the risk associated with unemployment by smoothing income across the spell of unemployment—that is, by increasing T by one week and lowering x in a tax-neutral manner, we obtain a Rothschild and Stiglitz (1970) decrease in the risk associated with unemployment. This makes all unemployed workers better-off (V_t increases for all t).

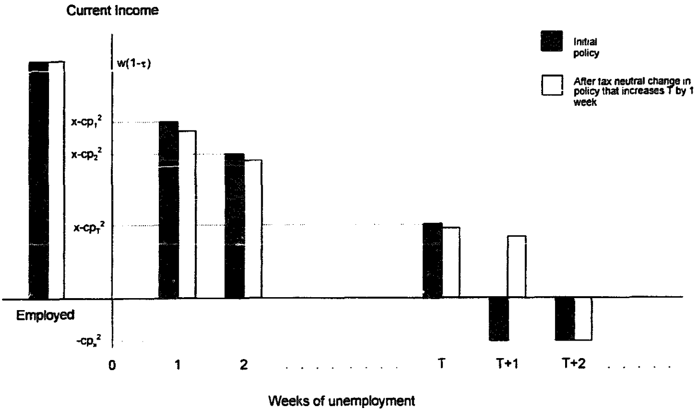

Fig. 1. The optimal potential duration of UI benefits is unlimited.

Furthermore, since all employed workers face a risk of unemployment in the future, *they* gain as well (V_w rises since V_1 increases—see Eq. (10)). Thus, we have a Pareto improvement.

Now let search effort adjust to the new equilibrium levels. Since the tax-neutral change in policy makes the unemployed better-off, it reduces the opportunity cost of unemployment, and therefore lowers the search effort of all unemployed workers. This reduction in search effort has effects on lifetime utility (which we refer to as "direct" effects) and effects on unemployment, tax revenue, and benefits paid (which we refer to as "indirect" effects).

The direct effects are easy to characterize (see Eq. (11)). First, let agent *i* reduce her own search effort. Since she chooses search effort to maximize expected lifetime income, this adjustment must make her better off. Second, let everyone else reduce their search effort. This also benefits agent *i* by increasing her reemployment probability. Thus, the direct effects benefit all unemployed workers.

The indirect effects of adjusting search effort are effects on unemployment, tax revenues, and benefits paid. Since aggregate search effort falls when the potential duration of benefits increases, unemployment will increase, tax revenues will fall, and total benefits paid to the unemployed will fall. This reduction in benefit payments could conceivably outweigh the benefits of the program outlined above (that is, reductions in risk and the direct effects of changes in search effort). However, it is unlikely that it would. For although the reduction in *aggregate* search effort does increase equilibrium unemployment, the *distribution* of search effort changes so as to (at least partially) offset that increase. To see why, note that the change in the UI program results in a more even distribution of search effort across spells of unemployment. Since, as argued above, the number of new jobs created in each period is *concave* in search effort, unemployment is *convex* in $(p_1,..., p_x)$—hence, the more equal distribution of search effort across time results in lower equilibrium unemployment. As a result, unemployment (and tax revenue) could either rise or fall as a result of adjustments in search effort.

Table 1 shows the net of the indirect effects by simulating the impact of a tax-neutral extension of UI benefits on unemployment. These simulations are based on the parameter values in our reference case (see Section 2.2 above), but similar results hold for other reasonable parameter values. As Table 1 indicates, unemployment does rise as T rises, but by a very small amount. Hence, the reductions in tax revenues (and benefits paid to unemployed workers each period) that result from increasing T are minuscule. Since the reductions in revenue are more than offset by the increases in utility due to the Rothschild–Stiglitz decrease in risk and the direct effects of the change in search effort, the indirect effects of the change in search effort on unemployment and tax revenue do not overturn the result that the optimal value of T is infinity.[16][17]

3.2. Optimal replacement rates with unlimited benefit duration

We next obtain the optimal replacement rate—the ratio of benefits to the wage—assuming that the potential duration of benefits equals infinity. Setting $T=\infty$ simplifies the model because it makes all jobless workers behave identically over the spell of unemployment (the details are provided in Appendix A). Since no worker gets close to exhausting benefits, all earn the same present and future

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[16] This result can be viewed as an extension of Shavell and Weiss's (Shavell and Weiss, 1979) Proposition 1 in which they argue that UI benefits should be independent of the number of weeks an unemployed worker has been jobless. They derive this result assuming that (a) an individual cannot influence his reemployment probability and (b) UI has no impact on the rate of unemployment. Our approach differs in that we do not allow x to vary with t and we do consider the impact of UI on search intensity and unemployment. Nevertheless, we both reach the conclusion that UI should be offered indefinitely. The result is also related to the well known result of Shavell (1979) that any optimal insurance policy in the presence of moral hazard always offers some positive level of coverage (and, therefore, if x is allowed to vary with t, there should be no period in which the government sets $x=0$).

[17] An alternative explanation of this result may help clarify the forces at work. Since UI is a transfer from the employed to the unemployed, we may write Social Welfare (SW) as

$$SW=wL[1-\mu(p)]-C(p)$$

where μ is the unemployment rate, p is the vector of search effort, and $C(p)$ is aggregate search costs. A tax neutral increase in T has two effects—it results in a more even distribution of search effort across spells of unemployment and it lowers aggregate search effort. The more even distribution of p_t over time lowers both μ and C, since $\mu(p)$ and $C(p)$ are both convex in p; therefore, SW increases (with aggregate search effort held constant). The reduction in aggregate search effort lowers $C(p)$, further increasing SW. However, the reduction in aggregate search effort also increases unemployment (μ), which in turn lowers SW. If the increase in unemployment is large enough, the overall impact of the policy shift may be to lower Social Welfare. But Table 1 indicates that this is highly unlikely (and not found in the simulations we have run), since the overall increase in μ is extremely small.

Table 1
Simulated impact of tax-neutral changes in the potential duration of UI benefits (T) on the unemployment rate (μ)

T	μ at T	μ at $T+1$	$\Delta\mu$
26	8.767	8.786	.019
27	8.786	8.805	.019
28	8.805	8.824	.019
29	8.824	8.842	.018
30	8.842	8.860	.018
31	8.860	8.878	.018
32	8.878	8.895	.017
33	8.895	8.912	.017

In each case, the loss in tax revenue from the increase in unemployment is smaller than the aggregate savings from reduced search costs.
The "reference case" parameter values are used in these simulations (see Section 2.2 or the notes to Table 2).

income and choose the same level of search effort. If the potential duration of benefits were limited, search intensity would vary over the spell of unemployment, rising as the exhaustion point neared.

Table 2 summarizes the results of solving the model with infinite potential duration of benefits for the optimal bi-weekly UI benefit and the optimal replacement rate. For the reference case the optimal replacement rate is 0.66.[18] For other values of the separation rate and total available jobs, the optimal replacement

Table 2
Optimal unemployment insurance benefits and replacement rates under various assumptions, model with infinite potential duration of UI benefits

Assumptions	Optimal bi-weekly UI benefit (x)	Optimal replacement rate (x/w)
Reference case ($s=0.010$, $F=96.25$)	335	0.66
Low turnover ($s=0.007$, $F=96.25$)	380	0.74
High turnover ($s=0.013$, $F=96.25$)	305	0.60
Fewer total jobs available ($s=0.010$, $F=95$)	356	0.70
More total jobs available ($s=0.010$, $F=97.5$)	317	0.62

Note: Parameter values in the reference case are as follows: separation rate (s)=0.010; total jobs available (F)=96.25; labor force (L)=100; bi-weekly interest rate=0.008; bi-weekly reemployment wage=\$511; search cost parameter (c)=282; $z=1.269$.

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[18] Remarkably, this rate is identical to the rate suggested by Hamermesh (Hamermesh, 1977, p. 105) in his early review.

rate varies from 0.60 to 0.74. This range is very similar to the optimal replacement rate ranges found by Baily (0.64 to 0.72) and Flemming (0.66 to 0.73 in a model without borrowing or lending).

We obtain higher optimal replacement rates when either s or F is low. The reasons are related. Intuitively, when either s or F is low, unemployment spells are longer. (Lower s implies that jobs turnover infrequently, so there are fewer vacancies and it is harder for unemployed workers to find jobs. Lower F directly implies fewer vacancies, so again it is harder to find jobs.) When unemployment spells are longer, more generous insurance is desired by risk averse workers.[19] So with the potential duration of UI benefits unlimited, savings ruled out, and an elasticity of search with respect to UI benefits that is in the upper-middle of the range of existing estimates, we find that the optimal replacement rate is in the neighborhood of two-thirds. This result accords well with the results reported by Baily (1978) and Flemming (1978) under similar assumptions.

3.3. Optimal replacement rates with limited benefit duration

Most countries that offer UI limit the number of weeks of benefits that a worker may collect. This raises the following question: What is the optimal replacement rate when the potential duration of benefits is 26 weeks (as in the United States), or 52 weeks (as in Canada), or 104 weeks (as in some European countries)? To answer this question, we return to the model introduced in Section 2, set T (the potential duration of benefits), and then solve for the optimal replacement rate.

The relationship between the optimal replacement rate (x/w) and the potential duration of benefits (T) in our reference case is depicted in Fig. 2. The figure reveals a striking finding of this exercise: for $T<32$, the optimal replacement rate exceeds 1. For $T=26$, the optimal replacement rate is 1.30 and as T increases beyond 26, the optimal rate falls fairly slowly, reaching 0.67 for $T=104$. As T continues to increase, the optimal rate approaches 0.66 asymptotically.[20]

The model therefore suggests that if benefits are limited to 26 weeks, as is usually the case in the United States, the government should more than fully replace the lost earnings of UI-eligible unemployed workers during that limited period. This result suggests that unemployment insurance in the United States is sub-optimal. Either the potential duration of benefits should be increased substan-

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[19] Lower s implies higher optimal replacement rates for an additional reason. When s is low, separations occur infrequently and the equilibrium unemployment rate is relatively low. With high employment, the government can afford to provide more generous assistance to the relatively few who are unemployed without generating a large tax burden for the employed.

[20] A similar figure could be drawn for each set of parameters reported in Table 2. The differences, however, are minor. For example, increasing s from its reference value of 0.010 to 0.013 lowers the optimal level of insurance that the government should provide. This shifts the curve in Fig. 2 down for all T. For the values of s, F, and q reported in Table 2, the curve never shifts from its reference position by more than 0.10 points for any T. In addition, for all of the values of s, F, and q in Table 2, the optimal replacement rate always exceeds 1 when $T=26$.

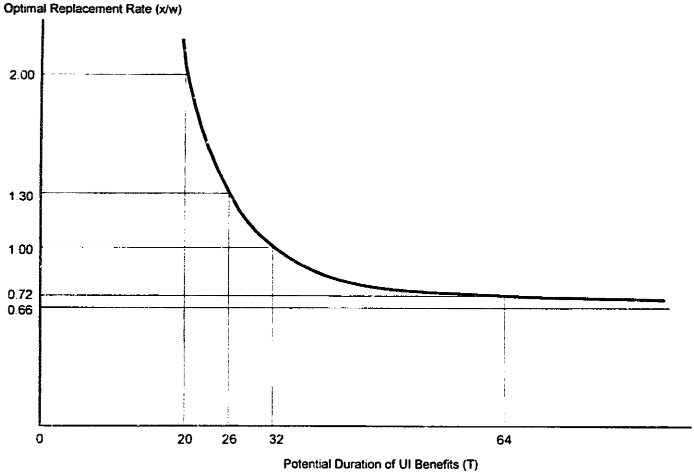

Fig. 2. The optimal UI replacement rate increases as the potential duration of benefits is reduced.

tially, or, if the potential duration of benefits is to remain limited, the replacement rate should be increased substantially

Our main conclusion—that the existing UI system in the United States is too stingy—differs from that of Baily and Flemming mainly because they assume that benefits are provided in perpetuity, whereas we consider optimal UI benefits under finite benefit duration. It is easy to see that the optimal UI replacement rate could never approach or exceed 1 if benefits were offered in perpetuity—if full income replacement were offered indefinitely, the unemployed would have no incentive to become reemployed and the economy would shut down. On the other hand, if the government were to offer full income replacement for only a limited time (say, 26 weeks), the unemployed would begin searching around the time their benefits were exhausted. The unemployment rate would not explode and the economy would not shut down. With full income replacement for 26 weeks, the unemployment rate *would* increase (to about 10% in our reference case, from 7% with a replacement rate of 0.5), but there would be a substantial smoothing of income that would increase the utility of all risk averse agents.

In summary, the assumption that the potential duration of UI benefits is unlimited in both the Baily and Flemming models leads to a misinterpretation of their results. Only if the government follows the optimal policy of offering UI benefits indefinitely is the optimal replacement rate as low as two-thirds or less, as

Baily and Flemming report. If the potential duration of UI benefits is limited, then the optimal replacement rate is significantly higher.

4. Extensions

4.1. UI-Ineligibles

To this point we have assumed, as did Baily and Flemming, that all unemployed workers are eligible for UI benefits. But in fact many workers are ineligible for UI—workers with a weak attachment to the labor force, new labor force entrants, and labor force reentrants, for example. Estimates for 1987 show that of all unemployed workers, only 42% were UI-eligible in the U.S., and only 53% were UI-eligible in Canada (Blank and Card, 1991; Card and Riddell, 1993).[21]

Consideration of UI-ineligibles can change the optimal replacement rate for two reasons. First, an increase in the generosity of the UI system will have a spill-over effect on the welfare of UI-ineligible workers. In general, a more generous UI system reduces the search effort of UI-eligible jobless workers. This reduction in search effort makes it easier for UI-ineligibles to find jobs and increases their expected lifetime utility. Once we take this spill-over effect into account, the optimal replacement rate rises.[22]

Second, when we account for the fact that not all workers are UI-eligible, the reemployment probability faced by UI-eligible workers changes. Whether their reemployment prospects are brightened or dimmed depends on how hard UI-ineligibles search and the degree of substitutability in production between UI-eligible and UI-ineligible workers. For example, suppose that UI-eligibles and UI-ineligibles are considered close substitutes by firms and that UI-ineligibles search harder than UI-eligibles (since they receive no UI benefits). In this case, adding UI-ineligibles to the model will lower the reemployment probabilities faced by UI-eligibles and increase the optimal replacement rate.

On the other hand, suppose that UI-ineligibles are low-skilled workers who do not vie for the same jobs as UI-eligible workers. In this case, treating all workers as if they are UI-eligible will overstate the difficulty that UI-eligibles will have in finding a job (since, in fact, there will be fewer workers vying for the jobs UI-eligibles seek than the model predicts). Since the presence of UI-ineligibles in the model makes it easier for UI-eligibles to find jobs, the level of insurance that

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[21] We are aware of no similar estimates for Western Europe or Japan, but it is evident that a significantly higher fraction of the unemployed actually *receive* benefits in the U.K., Germany, Belgium, Denmark, and Sweden than in either Canada or the United States. The same cannot be said of Japan, France, Italy, or Spain (Layard, Nickell, and Jackman (Layard et al., 1991), Table A2).

[22] Few researchers have investigated the interactions between UI-eligible and UI-ineligible workers—Levine (1993) is a rare exception.

the government needs to provide to UI-eligibles falls (i.e. the optimal replacement rate falls).

To investigate the size of these effects we add UI-ineligibles to the model in which the potential duration of benefits is unlimited and solve for the optimal replacement rate. We consider two versions of the model-one in which the firms consider UI-eligibles and UI-ineligibles perfect substitutes in production and one in which the firms consider them poor substitutes.

In the first version of the model (the perfect substitutes case), the only difference between UI-eligible and UI-ineligible workers is that former receive benefits while unemployed. Thus, new equations are added that define the UI-ineligibles' reemployment probabilities, their search effort, their expected lifetime income, and so on. These equations are identical to those introduced earlier for UI-eligibles except that UI-ineligibles receive no benefits when unemployed (details are in Appendix B). It follows that, in this case, UI-ineligibles search harder than UI-eligibles in equilibrium.

Table 3 shows the optimal replacement rates that result from the model in which workers are perfect substitutes. The only new parameter in the model is q, the proportion of unemployed workers who are UI-ineligible. Based on Blank and Card (1991) and Card and Riddell (1993), we consider $q=0.6$ most likely for the U.S. and $q=0.45$ most likely for Canada[23] Results are shown for various assumptions about turnover (s) and the total number of jobs available (F).

Table 3 shows that accounting for the fact that some workers are ineligible for

Table 3
Optimal UI replacement rates when some workers are ineligible for UI, various assumptions, model with infinite potential duration of UI benefits

	Proportion of unemployed workers ineligible for UI (q)				
	0	0.15	0.30	0.45	0.60
Reference case ($s=0.010$, $F=96.25$)	0.66	0.67	0.69	0.72	0.74
Low Turnover ($s=0.007$, $F=96.25$)	0.74	0.75	0.77	0.79	0.81
High Turnover ($s=0.013$, $F=96.25$)	0.60	0.62	0.64	0.67	0.70
Fewer total jobs available ($s=0.010$, $F=95$)	0.70	0.71	0.73	0.75	0.77
More total jobs available ($s=0.010$, $F=97.5$)	0.62	0.64	0.66	0.69	0.72

Notes: See Table 2. The results shown are from a model in which UI-eligibles and -ineligibles are good substitutes.

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[23] We report the optimal replacement rate for other values of q for comparison. As already noted, q is widely believed to be lower in many Western European nations than in the U.S. or Canada.

UI increases the optimal replacement rate. In our reference case the optimal replacement rate rises from 0.66 when there are no UI-ineligibles to 0.74 when 60% of the unemployed are UI-ineligible. The optimal replacement rate also increases with q for the other cases considered in Table 3. Thus, assuming that all workers are eligible for UI tends to bias downward estimates of the optimal replacement rate. This downward bias occurs because of the positive spill-over effect of UI on UI-ineligibles, and because the reemployment probabilities of UI-eligibles are lower when UI-eligibles and UI-ineligibles are good substitutes.

Consider now the case in which UI-eligible and UI-ineligible workers are poor substitutes. We do this by assigning UI-ineligibles a low degree of search effort (or, in effect, a low reemployment probability) that is unaffected by the behavior of UI-eligibles. Specifically, we set the reemployment probability for UI-ineligibles equal to a parameter β where β takes on some low value. In effect, β serves as an index of substitutability between UI-eligibles and UI-ineligibles. Assigning a low degree of search effort to UI-ineligibles captures the notion that UI-ineligibles do not compete for the same jobs as UI-eligibles.

To solve for the optimal replacement rate in this case we need to choose a value for β, the search effort of UI-ineligibles. As β falls, the reemployment prospects of UI-eligibles improve and less insurance is needed. If β were low enough, adding UI-ineligibles to the model could actually lower the optimal replacement rate (compared with the model in which all workers were UI-eligible). That is, the positive effect of a low β on UI-eligible reemployment probabilities (which lowers the optimal replacement rate) could outweigh the spill-over effect (which raises the optimal replacement rate because UI-ineligibles benefit indirectly from higher benefits paid to UI-eligibles).

The question then is, how low a value of β would be needed to actually make the optimal replacement rate less than it would be in a model in which all workers are UI-eligible? To answer this, we solve the model for the value of β that would leave the optimal replacement rate unchanged from the model in which all workers are UI-eligible. For the cases we have checked (those shown in Table 3), the result is that β would need to be very low—so low that it would represent a level of UI-ineligible search effort equal to approximately 15% of the search effort for UI-ineligibles that was found in the model in which UI-eligibles and UI-ineligibles were close substitutes. In other words, the degree of substitutability between UI-eligibles and UI-ineligibles would need to be extremely low for the optimal replacement rate to fall when UI-ineligibles are added to the model.

4.2. Savings

Workers are not allowed to save in the model, which biases estimates of the optimal replacement rate upwards since agents cannot self-insure by saving during periods of employment. Extending the model to allow for savings is not straightforward—we would have to choose a specific form for the utility function, model the capital market, and recalibrate the model to obtain estimates of the search cost parameters. But we can say something about the effect of extending our model to include saving without actually going through this exercise. First, it should be clear that the basic result—that the optimal potential duration to UI benefits is infinite—would continue to hold even in a model where workers could save.[24]

Second, we can refer to Flemming's work to gauge how our results might be altered by allowing workers to save, since Flemming compared the results of models in which savings were and were not allowed, and in which UI benefits were offered indefinitely. If agents cannot borrow or lend, Flemming's model yields optimal replacement rates of 0.66 to 0.73. If capital markets are perfect, his optimal replacement rate falls to the range of 0.18 to 0.20 (see Table 5, under the "Flemming" column). The difference between these two ranges is about 0.45 to 0.55. We infer that if we included a perfect capital market in our model, our optimal replacement rates would fall by 0.45 to 0.55. But we can probably rule out such a large decrease as a matter of policy, since although capital markets do exist, they are not perfect. This leaves us with a conjecture that including saving in our model might lower optimal replacement rates by perhaps of 0.25, so that they would fall from the 0.70–0.81 range to about 0.45–0.55. Such replacement rates are optimal, however, only if the potential duration of UI benefits is infinite.

4.3. Increasing the degree of risk aversion

To this point the results have been derived under the assumption that utility is linear in consumption. Although this usually implies risk neutrality, our agents are in fact risk averse due to the convexity of the cost of search function (see footnote 12). Nevertheless, it is important to know how sensitive our results are to the assumption of linearity. To find out, we consider a different utility function, one in which utility is equal to the natural log of consumption. This utility function is characterized by an Arrow–Pratt measure of *relative* risk aversion that is constant and equal to one. (It is the utility function used by Baily.) We recalibrate the model with this utility function to obtain estimates of the search cost parameters that make the model's predictions consistent with the experimental outcomes observed in the Illinois reemployment bonus experiment (assuming that all other parameters are set at their reference values).[25] We then set the remaining parameters to their reference case values and solve for the optimal replacement rate. The results are

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[24] Unless capital markets were perfect, agents would not save enough while employed to fully smooth consumption across periods of unemployment. Thus, the qualitative nature of Fig. 1 would continue to hold with savings in the model—the vertical axis could simply be relabeled "present consumption." Extending benefits in a tax neutral manner will lower present consumption in the "good" states of unemployment (when present consumption is relatively high) and increase it in the most adverse states.

[25] We obtain $c = 2.047$ and $z = 1.381$.

reported in the bottom row of Table 5 (under "This Paper"). With log utility the optimal replacement rate is lower by about 0.06 than under the assumption of linear utility (the reference case). Similar results obtain for all of the other reported results—switching to a log utility function lowers the optimal replacement rate by only a small amount.

Although the optimal replacement rate is slightly lower in a model with log utility, the true level of insurance provided by these benefits is higher than the level provided under linear utility. The level of insurance can be measured by comparing *utility* while receiving UI benefits with *utility* while employed. With a linear utility function this ratio is identical to the replacement rate. But with log utility, a replacement rate of 0.60 (implying a benefit of \$305 for a worker with a pre-layoff wage of \$511) gives a utility ratio of 0.91. Thus, optimal insurance is increasing in the degree of workers' risk aversion.

4.4. Endogenous separations and endogenous UI-eligibility

To keep the analysis tractable, we have retained many of the simplifying assumptions used by Baily and Flemming. In this section, we briefly discuss how relaxing two of these assumptions might alter the conclusions. We focus on the assumptions that (1) the separation rate is independent of the generosity of the UI program and (2) the proportion of the unemployed who are UI-eligible is fixed.

It is well established that the incomplete experience rating of the UI payroll tax in the U.S. subsidizes firms that temporarily lay-off workers.[26] It follows that if UI benefits were to become more generous, the rate at which firms layoff workers would increase. Or, in terms of our model, s should be an increasing function of x. But there exist no estimates of the elasticity of the separation rate with respect to the UI replacement rate. So at this point it would be impossible to calibrate a model that included an endogenous separation rate.

Nevertheless, we can get an idea of how important this issue is by conjecturing a relationship between x and s and calculating the optimal replacement rate. To do so, we take the model in which all workers are UI-eligible and add the assumption that there is a constant elasticity of s with respect to x. We then set all the parameters (except for s) equal to their reference case values and solve for the optimal replacement rate for several values for this elasticity. We also assume that s takes its reference case value (0.010) when UI benefits (x) equal 252 (as in the Illinois reemployment bonus experiment).

The results are reported in columns 1 and 2 of Table 4. It is clear that endogenizing s lowers the optimal replacement rate. This is consistent with intuition—if making UI more generous raises unemployment by increasing the number of layoffs, the replacement rate should be lowered so as to discourage

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[26] For example, Card and Levine (1994) estimate that half of all temporary layoffs in the U.S. in the trough of a recession can be attributed to the incomplete experience rating of the UI payroll tax.

Table 4
Optimal UI replacement rates with endogenous separation rate (s) and endogenous UI-eligibility ($1-q$)

(1) Elasticity of s with respect to x (UI benefits)	(2) Optimal replacement rate	(3) Elasticity of (1-q) with respect to x (UI benefits)	(4) Optimal replacement rate
0	0.66	0	0.74
0.1	0.64	0.1	0.73
0.2	0.63	0.2	0.72
0.3	0.62	0.3	0.72
0.4	0.61	0.4	0.72
0.5	0.60	0.5	0.71
0.6	0.58	0.6	0.71
0.7	0.56	0.7	0.70
0.8	0.51	0.8	0.70
0.9	0.30	0.9	0.70
1.0	0.00	1.0	0.69

In all cases, the parameters are set to their reference case values (see notes to Table 2).

For the simulations in columns (1) and (2), q is set to zero (that is, all workers are eligible for UI), the starting value of s is 0.010, and the starting value of x is 252 (the value of UI benefits in Illinois during the reemployment bonus experiments).

For the simulations in columns (3) and (4), s is set to 0.010, the starting value of q is 0.6, and the starting value of x is 252.

layoffs. Unfortunately, the table shows clearly that the reduction in the optimal replacement rate indicated by such considerations depends heavily on the size of the elasticity. For relatively low elasticities (e.g. 0.1 to 0.7), the results change only modestly, whereas for larger elasticities (e.g. 0.9 to 1) the results change dramatically. This suggests the importance of obtaining sound estimates of the elasticity of the separation rate with respect to UI benefits.

We have also assumed that the fraction of the unemployed that are eligible for UI benefits is fixed. In fact, we would expect that a more generous UI program would induce workers to make greater efforts to become eligible for UI. Thus, it seems reasonable to expect that $1-q$, the fraction of the unemployed that are UI-eligible, would be an increasing function of the replacement rate. To investigate the importance of endogenizing q, we take the model with UI-ineligibles and add the assumption that there is a constant elasticity of $(1-q)$ with respect to x. We then set all of the parameters (except for q) equal to their reference case values and solve for the optimal replacement rate for different values of the elasticity. We assume that q takes on its reference case value (0.6) when $x=252$ (as in the Illinois Reemployment Bonus Experiment).

The results are reported in columns 3 and 4 of Table 4. Consistent with intuition, making UI eligibility an increasing function of UI benefits lowers the optimal replacement rate. But the size of this effect is small, even for reasonably large elasticities.

5. Discussion, caveats, and conclusions

Table 5 provides a summary of our results and compares them with Baily's and Flemming's results. Baily, Flemming, and we obtain similar optimal replacement rates for the reference case shown in the first row. In this reference case, Baily finds an optimal replacement rate in the range of 0.64 to 0.72. But his optimal replacement rate falls below 0.50 when the elasticity of search effort with respect to UI is very high or when workers' degree of relative risk aversion is unity. Since Baily considers these cases most relevant, he suggests that replacement rates in the United States, which are designed to be about 0.50, are too high. Also in the reference case, Flemming finds an optimal replacement rate in the range of 0.66 to 0.73. But Flemming finds that when savings are incorporated into his model, the optimal replacement rate falls well below 0.50. Accordingly, Flemming, too, suggests that most existing UI programs are too generous.

Our work also yields an optimal replacement rate around two-thirds in the reference case. But we interpret our results to suggest that the structure of the existing UI system in the United States is not generous enough. Most existing state systems limit the potential duration of UI benefits to 6 months, whereas insurance considerations suggest that it would be better to provide an unlimited potential duration of benefits, as we argue in Section 3.1. Moreover, most states' UI systems pay replacement rates on the order of 0.5 to most workers during their 6 months of

Table 5
Summary and comparison of optimal replacement rates from Baily (1978); Flemming (1978), and this paper

Assumptions	Baily	Flemming	This Paper
Reference case[1]	0.64 –0.72	0.66 –0.73	0.60 –0.74
Reference case, except potential duration of UI benefits limited to 26 weeks	–	–	1.30
Reference case, except saving allowed (perfect capital market)	–	0.18 –0.20	0.45 –0.55
Reference case, except 60% of workers ineligible for UI	–	–	0.70 –0.81
Reference case, except elasticity of search effort w.r.t. UI very high[2]	0.34 –0.49	–	–
Reference case, except lower degree of relative risk aversion (1.0)	0.34 –0.49	0.58 –0.65	0.54 –0.68

1. Assumptions for the Reference case are as follows:

a. Potential duration of UI benefits is unlimited.

b. Voluntary saving by workers is not allowed (except in Baily, in a two-period setting).

c. All workers are eligible for UI.

d. The elasticity of search effort with respect to UI benefits is moderate. In Baily, a 10 percentage point increase in the UI replacement rate leads to a 0.5 to 0.7 week increase in the duration of unemployment; in Flemming, a 10 percentage point increase in the replacement rate leads to a 0.4 week increase in duration; in Davidson-Woodbury, a 10 percentage point increase in the replacement rate leads to a 0.8 week increase in duration.

e. Workers' degree of relative risk aversion is 2.0 in Baily and Flemming. (Workers are risk averse in Davidson-Woodbury, but the degree is indeterminate.)

f. The discount rate is 20% in Flemming and Davidson-Woodbury. Baily assumes no discounting.

g. In all models, workers are homogeneous (except that in a variant of this paper, UI-eligibles and UI-Ineligibles are considered separately).

2. For the range shown, Baily assumes that a 10 percentage point increase in the UI replacement rate leads to an increase in the duration of unemployment of 1.0 to 1.4 weeks.

Sources: Baily (1978), Table 2; Flemming (1978), Tables 1 and 3; this paper, Tables 2 and 3.

eligibility. But only when the potential duration of benefits is unlimited are UI replacement rates as low as 0.5 optimal (see Section 3.2 Section 4.2). When the potential duration of benefits is limited to 32 weeks or less, insurance considerations suggest that a replacement rate of 1 or greater would be optimal (see the second row of Table 5 and Section 3.3).

A likely objection to the finding that an infinite potential duration of benefits is optimal is that, if benefits were inexhaustible, workers would never return to work. Indeed, in our model, increasing the potential duration of UI benefits from 6 months to unlimited with a UI replacement rate of 0.5 would raise the unemployment rate from 7% to 10% (see Section 3.3). But this is not a shut-down of the economy—workers would not collect UI benefits paying a replacement rate of 0.5 (or 0.75) forever. Moreover, the increase in the unemployment rate would result from voluntary behavior, not from economic hard times, and would connote an improvement in workers' well-being.[27]

We also extend the work of Baily and Flemming by considering how the optimal UI replacement rate is affected by the presence of workers who are ineligible for UI. This is important because fewer than half of all unemployed workers in the United States are UI-eligible. We show in Section 4.1 that ignoring the presence of UI-ineligibles leads to an overstatement of the reemployment prospects for UI-eligible workers, and that the optimal UI replacement rate needs to be increase to compensate. In our model, the presence of UI-ineligibles in the workforce increases the optimal replacement rate by 7 to 10 percentage points (see the fourth row of Table 4).

Of the additional extensions considered in Section 4, only one appears potentially significant. When we allow the separation rate (s) to depend on the generosity of UI benefits (x), the optimal replacement rate falls. For low elasticities of s with respect to x, the optimal replacement rate falls only slightly, but for high elasticities (0.8 to 1), it falls dramatically. However, since there exist no estimates of the relevant elasticity, it is hard to gauge just how important this extension might be.

We close with a caveat. We believe that the disincentive effects of UI used in obtaining our results are well-informed, have argued that the optimal duration of UI benefits is unlimited even if saving is allowed (Section 4.1), and believe that the results reported are robust to a variety of other variations (Section 4.2 Section 4.3 Section 4.4). But we have not investigated the sensitivity of the results to the maintained assumption of worker homogeneity. Worker heterogeneity could be considered in a number of ways. One approach would be to suppose that some UI-eligible workers are strongly attached to the labor force (as most appear to be), but that a significant minority are weakly attached to the labor force. (All UI-eligible workers are strongly attached to the labor force in this paper.) Another

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[27] Increased unemployment, when it is in part increased leisure, is hardly a bad thing. This real business cycle argument is made in a rather amusing way by Landsburg (1993).

approach would be to suppose that some UI-eligible workers face a high probability of layoff with a low expected duration of unemployment (as do many blue-collar production workers), while others might face a low probability of layoff with a longer expected duration of unemployment (for example, white-collar non-production workers). Although insurance considerations suggest that an unlimited potential duration of benefits would remain optimal when workers are heterogeneous, the optimal replacement rate could well be different in such models, and could differ across groups of workers. We consider these ripe topics for further research.

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Appendix A

Optimal replacement rates with $T=\infty$ (refer to Section 3.2)

When T is set equal to infinity, Eq. (1) and Eq. (3) are unchanged, while Eq. (2) becomes unnecessary. In addition, since we no longer need to keep track of the composition of unemployment, the steady-state equations can be simplified. Eq. (5) and Eq. (6) can be dropped while Eq. (4) needs to be modified. While the flow into unemployment is still sJ, the flow out of unemployment becomes $(1-m)U$, where m represents the reemployment probability for any unemployed worker. Thus, the new steady-state condition becomes $sJ=mU$. The probability of reemployment (m) also becomes simpler to define in that the t subscripts on m and p in Eq. (7) may be dropped and Eq. (8) is no longer needed. In addition, the definition of λ simplifies to $\lambda=pU/F$.

Turn next to expected lifetime income and search effort. Define V_u to be the expected lifetime income earned by all unemployed workers. Then, using the same logic as in Section 2, Eq. (10) and Eq. (11) can be written as:

$$V_w = w(1-\tau) + [sV_u + (1-s)V_w]/(1+r)$$

and

$$V_u = x - c(p) + [mV_w + (1-m)V_u]/(1+r)$$

Optimal search effort (p) is chosen to maximize V_u.

Finally, for the government, Social Welfare can now be written as $SW = JV_w + UV_u$ while the government budget constraint can be simplified to $Jw\tau = xU$. The government's goal is now to choose x to maximize SW subject to its budget constraint.

Appendix B

The model with UI-ineligibles (refer to Section 4.1)

Listed below are the fundamental equations of the model in which UI-eligible and UI-ineligible workers are considered good substitutes in production.

$$L = J + U \tag{17}$$

$$U = U_e + U_i \tag{18}$$

$$F = J + V \tag{19}$$

$$sJq = m_i U_i \tag{20}$$

$$sJ(1-q) = m_e U_e \tag{21}$$

$$m_j = p_j (V/F)(1/\lambda)[1 - e^{-\lambda}] \quad \text{for } j = i, e \tag{22}$$

$$\lambda = \{p_e U_e + p_i U_i\}/F \tag{23}$$

$$V_{wj} = w(1-\tau) + [sV_j + (1-s)V_{wj}]/(1+r) \quad \text{for } j = i, e \tag{24}$$

$$V_e = x - c(p_e) + [m_e V_{we} + (1-m_e)V_e]/(1+r) \tag{25}$$

$$V_i = -c(p_i) + [m_i V_{wi} + (1-m_i)V_i]/(1+r) \tag{26}$$

$$p_j = \arg\max V_j \quad \text{for } j = i, e \tag{27}$$

The subscripts e and i refer to UI-eligible and UI-ineligible workers. Thus, U_e and U_i are the numbers of UI-eligible and UI-ineligible workers seeking jobs in the steady-state equilibrium. The only new parameter is q (in Eq. (20) and (21)), which is the fraction of the unemployed who are UI-ineligible.

As before, Eq. (17)–(19) are simple accounting identities. Eq. (20) and Eq. (21) are the new steady-state equations—Eq. (21) equates the flows into and out of state U_e (UI-eligible unemployment) while Eq. (20) equates the flows into and out of state U_i (UI-ineligible unemployment). Eq. (22) defines the reemployment probabilities for unemployed workers. Eq. (24)–(26) define expected lifetime income for employed and unemployed workers. Note that in each case, a separate definition is provided for UI-eligible and UI-ineligible workers. Finally, Eq. (27) defines optimal search effort.

The government's problem is the same as before, except that Social Welfare must now include the expected lifetime income of UI-ineligible workers as well.

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