Optimal Unemployment Insurance

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Paper prepared for the Advisory Council on Unemployment Compensation, whose support is gratefully acknowledged. We are grateful to Richard Deibel and Ellen Maloney for help in preparing the manuscript. Davidson is Professor of Economics, Michigan State University, East Lansing, MI 48824; Woodbury is Professor of Economics, Michigan State University and senior economist, W.E. Upjohn Institute.
I. Introduction

Risk averse workers facing uncertain employment prospects prefer to insure against adverse economic 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 fully insure so that consumption during unemployment would exactly equal consumption while employed. But, for a variety of reasons, insurance markets are incomplete, and private unemployment insurance cannot be purchased.

In the absence of private insurance markets, agents will try and save during periods of employment and dissave during jobless spells. It is unlikely, however, that workers would be able to save enough to completely smooth consumption across periods of employment and 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, in a recent paper, 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. By now there is considerable evidence that UI increases the length of unemployment
spells.\textsuperscript{1} By providing unemployment insurance, the government reduces the opportunity cost of unemployment. This reduces search effort and increases both the length of unemployment spells and the equilibrium rate of unemployment.\textsuperscript{2} In designing an optimal UI program, the positive and negative effects of UI must be weighed against one another.

There are two classic theoretical treatments of optimal UI -- Baily (1978) and Flemming (1978). Both take the same approach, considering the situation faced by a typical unemployed worker and solving 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 the empirical work making use of their approach all seem to conclude that UI payments in the United States are too generous (see, for example, Gruber 1994 and O'Leary 1994).

The purpose of this paper is to extend the analysis offered by Baily and Flemming in two ways. First, in formulating their models, both authors assume that UI is offered indefinitely -- that

\textsuperscript{1} See Davidson and Woodbury (1995b) for a review and new evidence based on the reemployment bonus experiments.

\textsuperscript{2} It is often argued, on the other hand, that UI makes workers choosier about the jobs they accept, and that this may improve the quality of job matches. This notion has persisted despite very little empirical evidence in support of it.
is, unemployed workers collect UI benefits 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 26 weeks of unemployment. The potential duration of benefits is longer in Canada -- where it is about 1 year -- and in most of Western Europe -- where it is 3 years or longer in several countries, and indefinite in Belgium (OECD 1991). Even in the countries where UI is offered for 3 years or longer, a significant number of workers remain unemployed long enough to exhaust their benefits. In section III, we show that taking into account the finite potential duration 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 is approximately .75. The optimal replacement rate is close to .75 in our model as well (it is actually around two-thirds), assuming that UI is offered indefinitely. However, if UI is offered for only 26 weeks, the optimal replacement rate rises to 1.

Also in section III, we solve for the optimal UI program assuming that it can be characterized by two instruments -- the level of UI benefits (or the replacement rate) 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 level of benefits and let $T$ denote the potential duration of UI. Suppose that we compare two UI 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 taxpayers 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 benefits. In reality, 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, since an increase in UI benefits reduces the search intensity of UI-eligible workers, UI-ineligibles gain as they face less competition for jobs. This positive spillover 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 these two types of workers are close substitutes, then treating all workers as if they are 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 level of 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 (i.e., less insurance is needed). 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-eligible workers 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 only 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. In fact, we find
that for reasonable parameter values, our model suggests that average statutory UI benefits in the United States are too low and that the potential duration of benefits is too short.

The paper is divided into three additional sections. In section II, 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 show in section III.A that any program that eventually cuts off benefits is Pareto-Dominated by another program that offers more periods of coverage. Thus, any optimal program must include an infinite potential duration of benefits. In section III.B, we solve for the optimal replacement rate under a program in which benefits are offered indefinitely. In section III.C we calculate optimal replacement rates for sub-optimal programs -- that is, programs in which benefits are cut off after a certain length of time. In section IV.A we drop the assumption that all unemployed workers are eligible for UI, and show that when UI-ineligibles are added to the model the optimal replacement rate is likely to increase. In section IV.B we consider the effects of adding voluntary saving to the model. We reason that, although including savings would reduce the optimal replacement rate somewhat, it would not alter our conclusion that an infinite potential duration of benefits is optimal. Finally, in section V we discuss the omission of worker heterogeneity from the model and offer some conjectures as to how this omission might
affect our results. We also summarize and discuss the applicability of the results.
II. Model and Approach

We follow Baily and Flemming by modeling the behavior of a representative 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 \( T \) periods. UI is funded by taxing all employed workers' incomes at a constant rate \( r \).

We assume that unemployed workers choose search effort (\( p \)) to maximize expected lifetime income and that all workers are infinitely lived. Given total labor demand (\( F \)), search effort determines equilibrium steady-state unemployment (\( U \)). The government's goal is to choose \( x \) and \( T \) to maximize aggregate expected lifetime income. Increases in \( x \) and/or \( T \) provide unemployed workers with additional insurance but these increases also lower optimal search effort and therefore increase equilibrium unemployment. The optimal government policy must balance these two opposing forces.

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

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

4 Following Baily and Flemming, we do not model the firm and treat \( F \) and \( w \) as exogenous variables.
unemployed, we have:

(1) \[ L = J + U. \]

For later use, we define \( U_t \) to be the equilibrium number of workers who have been unemployed for \( t \) periods \((t = 1, \ldots, T)\) and let \( U_x \) represent the equilibrium number of unemployed workers who have exhausted their UI benefits. We then write total unemployment as:

(2) \[ U = \sum U_t + U_x. \]

Turn next to the firms. For simplicity, we assume that each firm provides only one job opportunity.\(^5\) Thus, \( F \) denotes both the total number of firms and the total number of jobs available at any time. Each job is either filled or vacant. If we let \( V \) denote the number of vacancies in a steady-state equilibrium, it follows that:

(3) \[ F = J + V. \]

The remainder of the model is explained in three stages. First, we describe the dynamics of the labor market and derive the conditions that must hold in a steady-state equilibrium. These conditions guarantee that the unemployment rate and the composition...
of unemployment both 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 -- that is, the job turnover or 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 -- $U_1, U_2, \ldots, U_T, U_x$, 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 $U_{t+1}$. Finally, 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:

$$ (4) \quad sJ = U_1. $$
The flows into and out of state $U_t$ (for $t = 2, \ldots, T$) are equal if:

$$(5) \quad (1 - m_{t,t})U_{t,t} = U_t.$$ 

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

$$(6) \quad (1 - m_T)U_T = m_xU_x.$$ 

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.

Turn next to 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 $t^{\text{th}}$ 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. (For workers who contact fewer than one firm on average, $p_t$ could be thought of as the probability of contacting any firm.) Once a worker contacts a firm, she files an application for employment if the firms 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 pool of 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 \( \lambda \) equal to the average number of applications filed at each firm. It is straightforward to show that this implies that the probability of getting a job offer conditional on having applied at a firm with a vacancy is \((1/\lambda)[1 - e^{-\lambda}]\). The reemployment probability for any given worker is then the product of these three terms -- the number of firms contacted, the probability that a given firm will have a vacancy, and the probability of getting the job conditional on having applied at a firm with a vacancy:

\[
(7) \quad m_t = p_t(V/F)(1/\lambda)[1 - e^{-\lambda}]
\]

for \( t = 1, \ldots, T \)

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

where

\[
(9) \quad \lambda = (\sum p_t U_t + p_x U_x)/F.
\]

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 \( \lambda \).

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

\[
(10) \quad V_w = w(1 - r) + [sV_t + (1 - s)V_w]/(1 + r).
\]

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,

\[
(11) \quad V_t = x - c(p_t) + [m_tV_w + (1 - m_t)V_{t+1}]/(1 + r) \quad \text{for } t = 1, \ldots, T.
\]

\[
(12) \quad V_x = -c(p_x) + [m_xV_w + (1 - m_x)V_x]/(1 + r).
\]
Unemployed workers choose search effort \((p_t)\) to maximize expected lifetime income \((V_t)\). Thus,

\[(13) \quad p_t = \arg \max V_t \quad \text{for } t = 1, \ldots, T\]

\[(14) \quad p_x = \arg \max V_x.\]

This completes the description of the model. Structurally it is very similar to Flemming's model. However, Flemming assumed that UI benefits are offered indefinitely and therefore, 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 unemployed for a longer period of time will search harder as they begin to worry about exhausting their benefits. 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 altered drastically.

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 income 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 the number of weeks of unsuccessful search (p_1 < p_2 < \ldots < p_r < p_s).

A decrease in UI benefits (x) or the potential duration of benefits (T) decreases the level of insurance offered unemployed workers and triggers an increase in search effort by all UI-eligible workers (and therefore lowers equilibrium 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 UI 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 (this is true even though search effort increases as a result of the decrease in T).

One final feature of the model needs to be emphasized. Although we assume that agents act to maximize expected lifetime income (as opposed to utility), they 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.
III. Social Welfare and Optimal UI Benefits

In the context of the model outlined above, social welfare can be calculated by aggregating 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 \( V_x \). Aggregating yields Social Welfare (SW):

\[
(15) \quad SW = JV_w + \sum U_t V_t + U_x V_x.
\]

The government's problem is to choose \( x \) (the UI benefit level) and \( T \) (the potential duration of benefits) to maximize (15) with the tax rate, \( \tau \), set such that the government budget balances:

\[
(16) \quad JWT = x(U - U_x).
\]

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

A. Optimal Potential Duration of Benefits

The most straightforward way to determine the optimal UI program is to proceed in two steps. First, for any tax rate (\( \tau \)),...
we consider the set of all tax neutral programs (so that workers' incomes are the same while employed under any of the programs) and determine which one leads to the highest expected lifetime income for unemployed workers. Two programs are defined to be tax neutral if they are funded by taxing income at the same rate. It follows that if two programs are tax neutral, workers' net income while employed will be the same under either program. Thus, if one program leads to a higher $V_i$ for all $t$ and a higher $V_x$, it must be superior to the other program. This is in fact the case -- if we consider two tax neutral programs, the program with the longer potential duration of benefits (higher $T$) and the lower level of benefits (lower $x$) will lead to larger values of $V_i$ for all $t$ and a larger value of $V_x$. Thus, for any given $\tau$, the optimal program is characterized by $T = \infty$. Setting $T = \infty$ allows us to write the optimal program for any given $\tau$ as $x(\tau)$. In the second step, we then maximize social welfare over $x(\tau)$.

To see why it is optimal to set $T = \infty$, consider any program $(x, T)$ where $T$ is finite. Now, increase the potential duration of benefits ($T$) by one period and lower the weekly benefit amount ($x$) in a tax neutral manner. What are the affects of this change in policy? Since the change is tax neutral, net income while employed is unchanged. For the unemployed, there are both direct and indirect effects on current income. The direct effect is that benefits are lower in the first $T$ periods of unemployment but benefits are now offered for an additional period. The indirect effect works through search effort. For reasons that will become
clear shortly, the policy change reduces search effort in all periods of unemployment, thereby lowering search costs. Once we combine these effects, we are left with three cases to consider -- there are periods $t = 1, \ldots, T$ in which the worker is eligible to receive UI under either program, there is period $T+1$ in which the worker receives UI under the new program but not the old program, and there are periods $t = T+2, \ldots$ in which the worker does not receive UI benefits under either program. In periods $1, \ldots, T$, the direct effect of lowering benefits swamps the cost savings from reduced search effort so that current income falls. In period $T+1$, the worker receives benefits under the new program, raising current income. Finally, in periods $T+2$ and on, there are no benefits to lower, so everything depends on the indirect effect -- since search costs are lower, current income is higher.

This impact of the policy change on current income is depicted in Figure 1. Current income for the employed is unchanged, it falls for unemployed workers in the first $T$ periods of search, and it increases for all unemployed workers who have been searching at least $T+1$ periods. Thus, this policy change increases income in the most adverse states of unemployment and lowers it in the least adverse states of unemployment -- it smoothes income across possible states of unemployment. Since the unemployed are risk averse and since total UI benefits given to the unemployed are the same under the two programs, this raises the expected lifetime
utility of all unemployed workers.\(^6\)

In this model with homogeneous workers, increasing \(T\) and lowering \(x\) in a tax neutral manner makes all unemployed workers better off. Accordingly, their expected lifetime incomes rise (\(V_t\) increases for all \(t\)). This is why the policy change lowers search effort — since expected lifetime income while unemployed rises, the opportunity cost of unemployment falls, triggering a decrease in search effort.

Extending the potential duration of benefits in a tax neutral way also increases the expected lifetime income for employed workers (\(V_w\)). To see why, consider (10) which defines \(V_w\). Since the policy change is tax neutral, \(w(1 - \tau)\) does not change. However, since the unemployed are better off, \(V_t\) rises. Thus, \(V_w\) increases. It follows that the shift in policy makes all agents better off.

In summary, a tax neutral change in policy that increases the potential duration of benefits (\(T\)) and lowers the weekly benefit amount (\(x\)) smoothes the receipt of income over states of unemployment without lowering the total amount of income received by the unemployed. Since all risk averse agents wish to smooth consumption, this makes all agents better off.

\(^6\) In the terminology of decision making under uncertainty, the policy change results in a "Rothschild-Stiglitz decrease in risk" for unemployed workers (see Rothschild and Stiglitz, 1970).
B. Optimal Replacement Rates with Unlimited Benefit Duration

We next obtain the optimal UI replacement rate under the assumption that $T$ -- the potential duration of UI benefits -- equals infinity. Setting $T$ equal to infinity makes sense for two reasons. First, we found above that it is the optimal policy. Second, setting $T$ to infinity simplifies the model greatly because it makes all unemployed workers behave in an identical fashion over the entire spell of unemployment. Since no worker is getting close to exhausting benefits, all earn the same present and future 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. (In the next sub-section, we obtain the optimal replacement rate under limited potential duration of UI benefits.)

When $T$ is set to infinity, equations (1) and (3) are unchanged, while (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. Equations (5) and (6) can be dropped while (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 -- it is now defined by (7) with the $t$ subscripts on $m$ and $p$ dropped. Equation (8) can be dropped, and the definition of $\lambda$
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 A, (10) and (11) can be written as:

$$V_w = w(1 - r) + [sV_u + (1 - s)V_w]/(1 + r) \quad \text{and,}$$

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

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 $Jwr = xu$. The government’s goal is now to choose $x$ to maximize $SW$ subject to its budget constraint.

Although this model is far simpler than the one laid out in section A, it is still too complex to yield a closed form solution for the optimal value of $x$. Again following Baily and Flemming, we choose parameter values and solve the model explicitly for the optimal $x$. 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 .007 to .013. For the interest rate we set $r = .008$ which translates into an annual discount rate of approximately 20%. 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 consider.

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 (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 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, 1995). In the Illinois Reemployment Bonus 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 .7 weeks less than the average unemployment duration of the randomly selected control group (Davidson and Woodbury 1991). In our previous 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 \( z = 1.269 \).\(^7\)

In summary, our reference case uses the following parameter values: \( s = .010 \), \( r = .008 \), \( L = 100 \), \( F = 96.25 \), \( w = 511 \), \( c = 282 \), and \( z = 1.269 \). Once we have solved 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.

Table 1 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 our reference case the optimal replacement rate -- the ratio of bi-weekly UI

\(^7\) As we show elsewhere (Davidson and Woodbury 1995), the Illinois bonus impact suggests that a 10 percentage point increase in the UI replacement rate lengthens the expected duration of unemployment by .8 week, and that a 1 week increase in the potential duration of benefits lengthens the expected duration of unemployment by .2 week. These are in the upper-middle of the range of existing estimates of the disincentive effects of UI.
benefits to the bi-weekly wage -- is .66. For other values of the separation rate (s) and total available jobs (F), the optimal replacement rate varies from a low of .60 to a high of .74. This range falls between the optimal replacement rate estimates obtained by Baily (around .50) and Flemming (.75 in a model without borrowing or lending).

We obtain higher optimal replacement rates when s is low. Intuitively, 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. Also, we obtain higher optimal replacement rates when F low.

\* Remarkably, this rate is identical to the rate suggested by Hamermesh (1977) in his classic study of UI.
C. Optimal Replacement Rates with Limited Benefit Duration

We have argued that the optimal UI program entails offering benefits to unemployed workers indefinitely. Moreover, with 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 roughly two-thirds. This result accords fairly well with some of the results reported in Baily (1978) and Flemming (1978). Baily finds an optimal replacement rate of approximately .50 when the elasticity of search effort with respect to UI benefits is relatively low. But his optimal replacement rate falls below .50 when this elasticity is high, which is the case he considers most relevant. In the end, he suggests that replacement rates in the United States, which designed to be about .50, are too high. Flemming finds that the optimal replacement rate is roughly .75 when agents cannot borrow or lend (as in our model). But he argues that when savings are incorporated into the model, the optimal replacement rate falls below .50. Thus, both authors strongly suggest that the existing UI programs in the United States are too generous.

As emphasized earlier, both Baily and Flemming assume that the potential duration of UI benefits is infinite. Although we have

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9 Again, Illinois bonus impact, which was used to calibrate our model, suggests that a 10 percentage point increase in the UI replacement rate lengthens the expected duration of unemployment by .8 week, and that a 1 week increase in the potential duration of benefits lengthens the expected duration of unemployment by .2 week.
argued that such a policy is optimal, in reality every country that offers UI places a limit on the number of weeks of benefits that a worker may collect. This raises the following question: What is the optimal replacement rate when $T = 26$ (as in the United States), or $T = 52$ (as in Canada), or $T = 104$ (as in some European countries)? To answer this question, we return to the model introduced in sub-section A, fix $T$, and then solve for the optimal replacement rate.

The relationship between the optimal replacement rate ($x/w$) and the potential duration of UI benefits ($T$) in our reference case is depicted in Figure 2. The Figure reveals a striking finding of this exercise: for $T < 32$, the optimal replacement rate is 1. As $T$ increases, the optimal rate falls fairly slowly, reaching .67 for $T = 104$. As $T$ continues to increase, the optimal rate approaches .66 asymptotically.

Our model therefore suggests that if benefits are limited to 26 weeks, as is usually the case in the United States, the government should 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 substantially, or, if the potential duration of benefits is to remain limited, the replacement rate should be increased substantially.

Our basic conclusion -- that the existing UI system in the United States is too stingy -- is opposite that of Baily and
Flemming mainly because Baily and Flemming assume that UI benefits are provided in perpetuity, whereas we have examined optimal UI benefits under finite benefit duration. It is easy to see that the optimal UI replacement rate could never approach 1 if UI benefits were offered in perpetuity -- if full income replacement were offered indefinitely to unemployed workers, 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 around 10% in our reference case, compared with 7% with a replacement rate of .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 basic 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 the values of .5 and below that Baily and Flemming report. If the potential duration of UI benefits is limited, then the optimal replacement rate is significantly higher.
IV. Extensions

A. UI-Ineligibles

Another assumption made by Baily and Flemming is that all unemployed workers are eligible to collect UI benefits. In reality this is not the case. Workers with a weak attachment to the labor force, new labor force entrants, and labor force reentrants are typically not eligible to collect benefits while unemployed. Blank and Card (1991) estimate that in the United States no more than 45% of the unemployed are UI-eligible.

Consideration of UI-ineligibles in the model 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.

Second, when we explicitly 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 desirable level of insurance (i.e., the optimal replacement rate will rise).

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 reality, 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 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 a model in which the potential duration of benefits is unlimited and solve for the optimal replacement rate. The fundamental equations of the model as follows:

\[(1') \quad L = J + U\]
\[(2') \quad U = U_e + U_i\]
\[(3') \quad F = J + V\]
\[(4') \quad sjq = m_iU_i\]
\( (5') \quad sJ(1 - q) = m_e U_e \)

\( (7') \quad m_j = p_j(V/F)(1/\lambda)[1 - e^\lambda] \quad \text{for } j = i, e \)

\( (9') \quad \lambda = (p_e U_e + p_i U_i)/F \)

\( (10') \quad V_{wij} = w(1 - \tau) + [sV_j + (1 - s)V_{wij}]/(1 + r) \quad \text{for } j = i, e \)

\( (11') \quad V_e = x - c(p_e) + [m_e V_{we} + (1 - m_e)V_e]/(1 + r) \)

\( (12') \quad V_i = - c(p_i) + [m_i V_{wi} + (1 - m_i)V_i]/(1 + r) \)

\( (13') \quad p_j = \text{arg max } V_j \quad \text{for } j = i, e \)

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 equations 4' and 5'), which is the fraction of the unemployed who are UI-ineligible.

As before, (1')-(3') are simple accounting identities. Equations (4') and (5') are the new steady-state equations -- (4') equates the flows into and out of state \( U_e \) (UI-eligible unemployment) while (5') equates the flows into and out of state \( U_i \) (UI-ineligible unemployment). Equation (7') defines the reemployment probabilities for unemployed workers. Equation (10')-(12') 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, (13') 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.

It is important to note that in the above model the only difference between UI-eligible and UI-ineligible workers is that the UI-eligibles receive benefits while unemployed. That is, in this model firms consider the two types of workers good substitutes in production, and in equilibrium UI-ineligibles search harder than UI-eligibles (since UI-ineligibles receive no benefits).

An alternative to assuming that UI-eligibles and UI-ineligibles are good substitutes who compete for the same jobs is to assume that they are poor substitutes. We accomplish this by assigning UI-ineligibles a low reemployment probability that is unaffected by the behavior of UI-eligibles. That is, we replace (13') for j = i with:

(14) \[ p_i = \beta \]

where \( \beta \) takes some low value. Assigning a low reemployment probability to UI-ineligibles captures the notion that UI-ineligibles do not compete for the same jobs as UI-eligibles -- that is, they are poor substitutes for UI-eligibles.

We solve the model under the two alternative assumptions about
substitutability between UI-eligible and UI-ineligible and compare 
the results. Table 2 shows the optimal replacement rate under 
various assumptions about turnover (s) and the total number of jobs 
available (F), and assuming that UI-ineligibles and UI-eligibles 
are close 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), we consider q = .6 the most likely case, 
but report the optimal replacement rate for other values of q for 
comparison.

Table 2 shows that accounting for the fact that some workers 
are ineligible for UI increases the optimal replacement rate. In 
our reference case the optimal replacement rate rises from .66 when 
there are no UI-ineligibles to .74 when 60% of the unemployed are 
UI-ineligible. The optimal replacement rate also increases with q 
for the other cases considered in Table 2. Thus, assuming that all 
workers are eligible for UI (as we did above and as Baily and 
Flemming did) tends to bias downward estimates of the optimal 
replacement rate.

The intuition behind this result was described above. If all 
workers are assumed to be UI-eligible, the model cannot take into 
account the positive spill-over effect of UI on UI-ineligibles 
(that is, UI benefits improve the well-being of UI-ineligibles). 
Also, the model will overstate the reemployment prospects of UI-
eligibles unless UI-eligible and UI-ineligible are very poor 
substitutes in production. Accounting for either of these effects 
results in a higher optimal replacement rate.

33

BB-36
Consider now the case in which UI-eligible and UI-ineligible workers are not close substitutes. To solve for the optimal replacement rate in this case we need to choose a value for $\beta$, the search effort of UI-ineligibles. As $\beta$ falls, the reemployment prospects of UI-eligibles brighten and less insurance is needed -- that is, as $\beta$ falls, the optimal replacement rate falls. If $\beta$ is low enough, adding UI-ineligibles to the model could actually lower the optimal replacement rate. That is, the positive effect of a low $\beta$ on UI-eligible reemployment probabilities could outweigh the spill-over effect of UI on the well-being of UI-ineligibles.

The question now is, how low a value of $\beta$ would be needed to leave the optimal replacement rate equal to what it would be in a model in which all workers are UI-eligible? For each of the cases shown in Table 2, we solve the model for the value of $\beta$ that would have to be approximately 15% of the value that it would have been in the first model -- that is, in order for the optimal replacement rate to remain constant when UI-ineligibles are added to the model, UI-ineligibles would have to face a reemployment probability that is roughly 85% lower than the reemployment probability they face in the model in which UI-eligibles and UI-ineligibles are close substitutes. Thus, the degree of substitutability between UI-eligibles and UI-ineligibles would have to be extremely low for the optimal replacement rate to fall when UI-ineligibles are added to the model.
B. Savings

In our model workers are not allowed to save. This biases our estimates of the optimal replacement rate upwards since agents cannot self-insure against unemployment by saving during periods of employment. Extending our 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. Fortunately, we can say something about the effect of extending our model to include saving without actually going through the exercise. First, it should be clear that our basic result -- that the optimal potential duration to UI benefits is infinite -- would continue to hold even in a model where workers could save. Unless capital markets were perfect, agents would never save enough while employed to fully smooth consumption across periods of unemployment.10 Thus, the qualitative nature of Figure 1 would continue to hold with savings in the model -- the vertical axis can 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. It follows that it will still be optimal to offer UI indefinitely.

Second, since it is optimal to offer UI benefits indefinitely, and since Baily and Flemming allowed for savings in their models,

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10 As noted in the introduction, the empirical evidence is clear on this issue -- consumption does fall during periods of unemployment.
we can refer to their work to gauge how our results might be altered by allowing workers to save. Consider first Baily’s findings. In a two-period model in which agents can save in the first period of life, he finds that the optimal replacement rate falls between .33 and .50, depending on the elasticity of search effort with respect to UI. If the elasticity is low, the optimal replacement rate is close to .50. If the elasticity is high, the optimal replacement rate falls to .33. 12 Our results suggest that if Baily were to include UI-ineligibles in his model, his optimal replacement rates would rise by about 8 to 10 percentage points. Thus, combining our results with Baily’s suggests that if workers can save, the optimal replacement rate will lie somewhere between .40 and .60. This rate is optimal, however, only if the potential duration of UI benefits is infinite.

Consider next Flemming’s results. Flemming develops a model with infinitely lived agents and allows for varying degrees of capital market imperfections. If agents cannot borrow or lend, his model yields an optimal replacement rate of around .70. If capital markets are perfect, the optimal replacement rate lies in the range of .10 to .20. 13 Our results suggest that adding UI-ineligibles to

11 Baily makes a reasonable assumption about the degree of risk aversion -- specifically, that all agents have the same constant value of absolute risk aversion, and that this value is one.

12 See his Table 2, column 2, rows 2 and 3.

13 See his Tables 1 and 3 under the column d' (for the "optimal dole").
Flemming's model would boost these rates by about 8 to 10 percentage points, yielding a range of .25 to .80 for the optimal replacement rate. However, we can probably rule out the extreme values since they are based on extreme assumptions -- capital markets do exist, but they are not perfect. This leaves us with optimal replacement rates quite similar to those discussed in the previous paragraph -- that is, .40 to .60. Again, it is important to emphasize that these rates are optimal only if the potential duration of UI benefits is infinite.

We conclude that if workers are allowed to save during periods of employment, the optimal replacement rate falls to a level that is consistent with existing average statutory rates in the United States. Hence, the current level of UI benefits would appear to be about right if the potential duration of benefits were infinite. But the current potential duration of benefits -- 26 weeks in most states in nonrecessionary times -- appears to be too short.
V. Discussion, Caveats, and Conclusions

Our results suggest that the structure of the existing UI system in the United States is sub-optimal. 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 (see section III.A). Also, most states' UI systems pay replacement rates on the order of .5 to most workers. But only when the potential duration of benefits is unlimited are UI replacement rates even as low as two-thirds optimal (section III.B). When the potential duration of benefit is limited to 32 weeks or less, insurance considerations suggest that an optimal replacement rate of 1 would be optimal (section III.C).

A likely objection to the finding that an infinite potential duration of benefits is optimal is that, if benefits were inexhaustible, then workers would never return to work. It is true that increasing the potential duration of benefits would lead workers to remain unemployed longer and would lead to a higher unemployment rate. In our model, increasing the potential duration of UI benefits from 6 months to infinity with a UI replacement rate of .5 would raise the unemployment rate from 7% to 10% (see section III.C). Raising the replacement rate to 1 (from existing levels around .5) would, similarly, increase the length of unemployment spells and increase the unemployment rate. But a higher unemployment rate is not a shut-down of the economy -- workers
would not collect UI benefits paying a replacement rate of .5 (or .67) 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.¹⁴

The model used to derive these conclusions is set out in section II, and extends earlier work by Baily (1978) and Flemming (1978) in two ways. First, whereas Baily and Flemming assumed that UI benefits are offered indefinitely, we consider a UI system in which the potential duration of benefits is limited to 26 weeks, as in the United States. We find that the optimal UI replacement rate under such a system is 1, rather than .75 or less, as Baily and Flemming suggested (see sections III.C).

Second, we consider how the optimal UI replacement rate is affected by the presence of workers who are ineligible for UI (section IV.A). This is important because fewer than half of all unemployed workers in the United States are UI-eligible. Adding UI-ineligibles to the model has two effects. The first is a positive spill-over effect that increases the optimal UI replacement rate: Since UI benefits reduce the search intensity of UI-eligible workers, UI-ineligibles face less competition for jobs when UI benefits are higher. The second concerns the substitutability in production between UI-eligible and ineligible workers. If UI-eligibles and UI-ineligibles are substitutes, then the presence of UI-ineligibles makes it harder for UI-eligibles to

¹⁴ Increased unemployment, when it is in part increased in leisure, is hardly a bad thing. This point is made in an unusually entertaining way by Landsburg (1993).
find reemployment. (UI-ineligibles presumably search harder than UI-ineligibles because they receive no UI benefits.) Ignoring the presence of UI-ineligibles leads to an overstatement of the reemployment prospects for UI-eligible workers, and the optimal UI replacement rate needs to be increase to compensate. In general, then, the presence of UI-ineligibles in the workforce increases the optimal replacement rate.  

In section IV.B we consider the effects of adding voluntary saving to the model. If workers are able to save, then the optimal replacement rate falls by about 10 percentage points (for example, from .6 tp .5). But allowing workers to save would not alter our conclusion that an infinite potential duration of benefits is optimal.

In the model developed in section II, we assume that UI-eligible workers are homogeneous, that the disincentive effects of UI benefits are in the upper-middle of the range of effects that have been estimated, and that workers are unable to save. [Is there any way of saying something about the degree of risk aversion?] We have argued that the results are not especially sensitive to the savings assumption -- in particular, the finding that the optimal duration of UI benefits is unlimited holds even if

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15 We also consider the case in which UI-ineligibles are lower-skilled workers who are poor substitutes for UI-eligible workers. In this case, the presence of UI-ineligibles in the workforce lowers the optimal replacement rate (i.e., less insurance is needed). Nevertheless, unless the degree of substitutability between UI-eligibles and UI-ineligibles is extremely low, the presence of UI-ineligibles raises the optimal replacement rate on net.
savings are allowed (section IV.A). Also, we believe that the assumptions about the disincentive effects of UI are reasonable and well-informed. However, we have not investigated whether results are sensitive to the 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 face a high probability of layoff with a low expected duration of unemployment (blue-collar production workers), while others might face a low probability of layoff with a longer expected duration of unemployment (white-collar non-production workers). Another approach might 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. Whether an unlimited potential duration of benefits would remain optimal in a model that accounts for one or both of these types of heterogeneity is an open question.
References


Figure 1
The Optimal Potential Duration of UI Benefits Is Unlimited

Current Income

- $w(1-\tau)$
- $x-cp_1^2$
- $x-cp_2^2$
- $x-cp_T^2$

Employed

- $-cp_x^2$

Weeks of unemployment

- $0$
- $1$
- $2$
- $T$
- $T+1$
- $T+2$

Initial policy

After tax neutral change in policy that increases $T$ by 1 week
The Optimal UI Replacement Rate Increases as the Potential Duration of UI Benefits is Reduced

Optimal Replacement Rate $(x/w)$

Potential Duration of UI Benefits $(T)$

- Optimal Replacement Rate $(x/w)$
  - 1.00
  - 0.72
  - 0.66
Table 1
Optimal Unemployment Insurance Benefits and Replacement Rates under Various Assumptions, Model with Infinite Potential Duration of UI Benefits

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>Optimal bi-weekly UI benefit (x)</th>
<th>Optimal replacement rate (x/w)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference case (s = .010, F = 96.25)</td>
<td>335</td>
<td>.66</td>
</tr>
<tr>
<td>Low turnover (s = .007, F = 96.25)</td>
<td>380</td>
<td>.74</td>
</tr>
<tr>
<td>High turnover (s = .013, F = 96.25)</td>
<td>305</td>
<td>.60</td>
</tr>
<tr>
<td>Fewer total jobs available (s = .010, F = 95)</td>
<td>356</td>
<td>.70</td>
</tr>
<tr>
<td>More total jobs available (s = .010, F = 97.5)</td>
<td>317</td>
<td>.62</td>
</tr>
</tbody>
</table>

Note: Parameter values in the reference case are as follows: separation rate (s) = .010; total jobs available (F) = 96.25; labor force (L) = 100; bi-weekly interest rate = .008; bi-weekly reemployment wage = $500; search cost parameter (c) = 282; z = 1.269.
Table 2
Optimal UI Replacement Rates When Some Workers Are Ineligible for UI, Various Assumptions, Model with Infinite Potential Duration of UI Benefits

<table>
<thead>
<tr>
<th>Proportion of unemployed workers ineligible for UI (q)</th>
<th>0</th>
<th>.15</th>
<th>.30</th>
<th>.45</th>
<th>.60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference case (s = .010, F = 96.25)</td>
<td>.66</td>
<td>.67</td>
<td>.69</td>
<td>.72</td>
<td>.74</td>
</tr>
<tr>
<td>Low turnover (s = .007, F = 96.25)</td>
<td>.74</td>
<td>.75</td>
<td>.77</td>
<td>.79</td>
<td>.81</td>
</tr>
<tr>
<td>High turnover (s = .013, F = 96.25)</td>
<td>.60</td>
<td>.62</td>
<td>.64</td>
<td>.67</td>
<td>.70</td>
</tr>
<tr>
<td>Fewer total jobs available (s = .010, F = 95)</td>
<td>.70</td>
<td>.71</td>
<td>.73</td>
<td>.75</td>
<td>.77</td>
</tr>
<tr>
<td>More total jobs available (s = .010, F = 97.5)</td>
<td>.62</td>
<td>.64</td>
<td>.66</td>
<td>.69</td>
<td>.72</td>
</tr>
</tbody>
</table>

Notes: See Table 1. The results shown are from a model in which UI-eligibles and UI-ineligibles are good substitutes. Optimal replacement rates can fall below those shown in the table if UI-eligibles and UI-ineligibles are sufficiently poor substitutes.