The Role of Unemployment Insurance in an Economy with Liquidity Constraints and Moral Hazard

Author(s): Gary D. Hansen and Ayşe Imrohoroğlu

Source: *Journal of Political Economy*, Vol. 100, No. 1 (Feb., 1992), pp. 118-142
Published by: The University of Chicago Press
Stable URL: http://www.jstor.org/stable/2138808
Accessed: 31/08/2013 16:41

The Role of Unemployment Insurance in an Economy with Liquidity Constraints and Moral Hazard

Gary D. Hansen

University of California, Los Angeles

Ayşe İmrohoroğlu

University of Southern California

The potential welfare benefits of unemployment insurance, along with the optimal replacement ratio, are studied using a quantitative dynamic general equilibrium model. To provide a role for unemployment insurance, agents in our economy face exogenous idiosyncratic employment shocks and are unable to borrow or insure themselves through private markets. In the absence of moral hazard, replacement ratios as high as .65 are optimal and the welfare benefits of unemployment insurance are quite large. However, if there is moral hazard and the replacement ratio is not set optimally, but is instead set to an empirically plausible value, the economy can be much worse off than it would be without unemployment insurance.

I. Introduction

Over the postwar period, unemployment insurance programs in the United States have expanded quite dramatically. The fraction of employed individuals covered by these programs has increased from 58

We have benefited greatly from comments made by Bruce Horning, Boyan Jovanovic, Bob Lucas, Bruce Meyer, Ed Prescott, Richard Rogerson, Randy Wright, an anonymous referee, and various seminar participants. This research was supported by a grant from the Minnesota Supercomputer Institute, and Hansen's work was supported by a grant from the National Science Foundation.

[*Journal of Political Economy,* 1992, vol. 100, no. 1]
 0022-3808/92/0001-0011$01.50

percent in 1950 to over 90 percent during the 1980s (*Economic Report of the President,* 1984, 1988). In addition, it has been estimated by Clark and Summers (1982) that unemployed workers receiving benefits will collect, on average, payments equal to two-thirds of their after-tax income. Not surprising, along with the expansion of unemployment insurance programs, a large literature has appeared examining the effects of the programs on the incidence and duration of unemployment.[1] What is surprising, however, is that relatively little effort has been devoted to studying the effect of unemployment insurance programs on social welfare and determining how much insurance, if any, is optimal. In this paper we develop a dynamic equilibrium economy, which we use to address these issues.

The economy we study has two features that are crucial for evaluating the potential social benefits of unemployment insurance. The first is a role for social insurance: individuals are subject to idiosyncratic employment shocks, do not have access to private insurance markets, are unable to borrow, and must hold their savings in the form of a non-interest-bearing asset.[2] In such an economy, it is not surprising that unemployment insurance can significantly improve welfare. These benefits may fall sharply, however, once the second feature of our model is introduced: the possibility that agents can refuse employment opportunities and still receive unemployment benefits. For example, if unemployed workers are able to reject employment opportunities and still collect insurance, the *potential* welfare benefits—benefits realized when the amount of insurance (the "replacement ratio") is chosen optimally—drop by as much as 73 percent. If the replacement ratio is instead arbitrarily set to an empirically plausible value and there is sufficient moral hazard, unemployment insurance can actually be quite harmful to the economy.

[1] Some examples are as follows: Hamermesh (1977) and Welch (1977) provide surveys of work that measure the extent to which unemployment insurance increases the duration of unemployment. More recent contributions to this literature include Fallick (1990) and Meyer (1990). The theory motivating this work is the classic result from search theory that an increase in unemployment insurance will cause workers to increase their reservation wages and search longer (standard references include Ehrenburg and Oaxaca [1976] and Mortensen [1977]). In addition, it may make workers search less intensively. Feldstein (1975, 1978), Topel (1983), and Burdett and Wright (1989) examine the role of unemployment insurance in increasing the rate of temporary layoff unemployment. This work is based on the argument that if the insurance is not fully experience rated (i.e., firms are not fully liable for the benefits paid to their workers), firms will be more likely to lay off workers during bad times.

[2] The restriction that agents are unable to borrow or insure through private markets is imposed by assumption in order to obtain an upper bound on the potential benefits of unemployment insurance. This restriction does not emerge endogenously as it does in environments studied by Townsend (1986) and Green (1987).

Although relatively little attention has been paid in the literature to evaluating the welfare benefits of unemployment insurance, there are some notable exceptions. Baily (1977) presents a model of unemployment insurance as insurance to workers and provides results concerning how much insurance should be provided, and in what form. Flemming (1978) studies how the optimal replacement ratio is affected by the degree of completeness of capital markets. In addition, the extent to which unemployment insurance programs are experience rated affects the optimal replacement ratio (this is studied in Mortensen [1983]). Hamermesh (1982) presents empirical evidence on whether existing levels of unemployment insurance are sufficient to enable individuals to overcome binding liquidity constraints when unemployed. Shavell and Weiss (1979) develop a theoretical search model and use it to determine the optimal timing of benefit payments. Easley, Kiefer, and Possen (1985) present a theoretical model designed to compare the potential welfare benefits from an unemployment insurance program versus a negative income tax program. Finally, Wright (1986) studies an economy with liquidity-constrained workers and derives the unemployment insurance system endogenously as a majority voting equilibrium policy.

This paper differs from most of these previous studies in that we employ a quantitative dynamic general equilibrium approach to study the role of unemployment insurance. This has the advantage of enabling us to simultaneously study the following effects of unemployment insurance programs on equilibrium allocations and welfare: (1) the fact that these programs help agents to overcome liquidity constraints so that they can more effectively smooth consumption; (2) the fact that these programs subsidize leisure so that, in the presence of moral hazard, an agent's incentive to work is reduced; and (3) the fact that the taxes used to finance the programs also distort allocations.

The model economy described in this paper, which is similar to the one studied in İmrohoroğlu (1992), is populated by a continuum of infinitely lived agents with identical preferences defined over consumption and leisure. The agents are offered employment opportunities according to a known stochastic process. Agents who are offered the opportunity to work can choose to accept or reject the offer. Labor is assumed to be indivisible, so an agent who accepts an offer must work some exogenously given number of hours. In the absence of unemployment insurance, agents who reject or are not given an offer must finance their consumption with savings in the form of a non-interest-bearing asset. We also assume a linear technology that is not subject to stochastic shocks. Thus the wage received by an employed worker does not change over time: the employment opportunity is the only source of uncertainty in the model. There is no aggregate uncertainty.

As described so far, in this environment agents have no control over the probability of receiving unemployment insurance benefits. There is no moral hazard. We introduce moral hazard by assuming imperfect monitoring of program applicants. In particular, it is possible for agents to reject an employment opportunity and still collect benefits with positive probability. This probability is assumed to depend on agents' previous employment status so that job quitters do not necessarily face the same imperfect monitoring as agents who are already unemployed. The agents know this probability at the time they make their employment decision, but they do not know whether they will actually receive benefits or not. This feature introduces an incentive for households to reject employment opportunities. Hence, less than the socially optimal amount of employment may result even when benefits are optimally determined. By varying this monitoring probability, we are able to vary the degree of moral hazard in the economy.[3]

For different degrees of moral hazard, we analyze the effect unemployment insurance has on the equilibrium properties of the economy. In particular, we analyze how moral hazard affects the optimal replacement ratio and the potential welfare benefits of unemployment insurance. These welfare benefits are computed by comparing the average utility obtained when payments are optimally set with average utility when there is no unemployment insurance. In addition, we examine how these conclusions are affected by the degree of risk aversion assumed.

The paper is organized as follows: Section II describes the structure of the model and provides a definition of competitive equilibrium. Section III discusses the calibration of the model and the method used to compute equilibrium allocations. This method is the same one used in İmrohoroğlu (1989, 1992) and involves discretizing the state space and employing numerical methods to calculate equilibrium decision rules for employment and asset holdings. Our results are discussed in Section IV. In Section V, we comment on the relevance of our findings for assessing the effectiveness of actual unemployment insurance programs.

[3] This approach is an alternative to that taken by Mortensen (1983), who varies the level of moral hazard by changing the degree to which unemployment insurance is experience rated. Our approach is analogous to adjusting the degree of enforcement of the requirement that someone must be available and actively seeking work in order to collect benefits.

II. Structure of the Economy

The economy consists of a continuum of ex ante identical individuals who maximize

$$E \sum_{t=0}^{\infty} \beta^t U(c_t, l_t), \tag{1}$$

where $0 < \beta < 1$ is a subjective time discount factor, c_t is consumption in period t, and l_t is leisure in period t. The utility function is assumed to have the following form:

$$U(c_t, l_t) = \frac{(c_t^{1-\sigma} l_t^{\sigma})^{1-\rho} - 1}{1 - \rho}. \tag{2}$$

This utility function, which is common in the macroeconomics literature, displays constant relative risk aversion (constant intertemporal elasticity of substitution) and an intratemporal elasticity of substitution between consumption and leisure equal to one. This second feature ensures that growing real wages leave the average time allocation between work and leisure constant. This is consistent with secular features of U.S. time series.

Agents are endowed with one unit of time in each period that can be allocated to work or leisure. However, labor is assumed to be indivisible, which means that an agent can choose to work some given number of hours, $0 < \hat{h} < 1$, or not at all. Each employed agent produces y units of the consumption good, where y is constant over time. Thus total output is a linear function of the number of workers.[4]

Each period, an individual faces a stochastic employment opportunity. Either he is offered the opportunity to work for y units of output or he is not. The individual's employment opportunities state, s, is assumed to follow a two-state Markov chain. If $s = e$, the agent is given the opportunity to work and can choose to work either $\hat{h}$ hours or not at all. If $s = u$, the agent is not given the opportunity to work and will be unemployed that period. The transition function for the employment opportunities state is given by the 2×2 matrix $\boldsymbol{\chi}$ =

[4] This assumption implies that the wage unemployed workers will receive once they are employed is the same as the wage received before becoming unemployed. Thus unemployment insurance can have no effect on postunemployment earnings. This assumption seems reasonable given that the existing literature finds the relationship between benefits and earnings to be both theoretically and empirically ambiguous (see Welch 1977).

$[\chi_{ij}]$, $i, j \in \{e, u\}$, where, for example, $\Pr\{s_{t+1} = e | s_t = u\} = \chi_{12}$ is the probability of being given the employment opportunity in $t + 1$ conditioned on not having been given the employment opportunity in period t.[5]

In the market structure of this economy, individuals are unable to borrow and have no access to private insurance markets. They are able to accumulate a non-interest-bearing asset to help smooth consumption across time.[6] Let m_t be an agent's asset holdings at the beginning of period t. Then his asset holdings at the beginning of period $t + 1$ will be

$$m_{t+1} = m_t + y_t^d - c_t, \tag{3}$$

where y_t^d is disposable income in period t. Since borrowing is not allowed, m_{t+1} is required to be nonnegative.

We now describe how unemployment insurance is administered in this economy. Any agent that qualifies for benefits will receive a payment equal to θy, where the parameter θ is the replacement ratio. All agents who are not offered an employment opportunity ($s = u$) automatically qualify for benefits. Those that receive an employment opportunity ($s = e$) and reject it receive benefits with probability $\pi(\eta_t)$, where η_t is an indicator of the employment status of the agent in the previous period.[7] A value of η equal to one indicates that the individual worked in the previous period, and η equal to zero indicates that the individual did not work. Assuming that π is contingent on η allows for the possibility that individuals who quit jobs have a different probability of receiving benefits than individuals who turn down job opportunities in order to extend unemployment spells.

[5] Under these assumptions, an agent's probability of receiving an employment opportunity depends only on whether he had one during the previous period and is unaffected by his acceptance or rejection of that opportunity. That is, a worker in our economy is like a trade worker, such as a carpenter, for whom the probability of being offered an opportunity to work tomorrow depends on the demand for new construction tomorrow, not so much on whether he is working today. Of course, if the carpenter is working today, he is more likely to be working tomorrow if the demand for his professional services is persistent. However, it is possible in our setup for this worker to turn down an opportunity to work without reducing his chances of finding work later, unless, of course, his sector is hit by a bad shock.

[6] The assumption that agents hold non-interest-bearing assets is justified by the finding of Ibbotson and Sinquefield (1979) that the average real return on highly liquid short-term debt was near zero for the 1926–78 period.

[7] This feature can be interpreted in the following way: Every individual that does not work, for whatever reason, applies for unemployment insurance. However, the government audits a certain fraction of the applications, and when it discovers a person who has rejected an employment opportunity, it rejects that person's application. However, since the government audits only a portion of the applications, a fraction $\pi(\eta)$ of the undeserving applicants successfully beat the system.

These two probabilities, $\pi(0)$ and $\pi(1)$, are parameters of the model that define the degree of moral hazard in the economy. We refer to an agent of type $(s, \eta, \eta') = (e, 0, 0)$ as a *searcher* and an agent of type $(s, \eta, \eta') = (e, 1, 0)$ as a *quitter*, where η' is an agent's current employment decision.

To summarize our unemployment insurance program, let μ_t be an indicator that is equal to one if an agent receives benefits and zero if an agent does not. Our program discriminates among four types of agents as follows:

$$\begin{aligned}
s = u &\Rightarrow \mu = 1,\\
s = e, \eta' = 1 &\Rightarrow \mu = 0,\\
s = e, \eta = 0, \eta' = 0 &\Rightarrow \mu = 1 \text{ with probability } \pi(0) \text{ and}\\
&\quad\;\; \mu = 0 \text{ with probability } 1 - \pi(0),\\
s = e, \eta = 1, \eta' = 0 &\Rightarrow \mu = 1 \text{ with probability } \pi(1) \text{ and}\\
&\quad\;\; \mu = 0 \text{ with probability } 1 - \pi(1).
\end{aligned}$$

To finance this unemployment insurance program, we assume the existence of a government that taxes income. In particular, the government chooses a tax rate, τ, so that the government budget constraint is satisfied with equality. That is, τ is set so that total tax revenue equals total benefit payments. Under these assumptions, the amount of disposable income received by a given agent is

$$y_t^d(s, \eta', \mu) = \begin{cases} (1-\tau)y & \text{when } s = e \text{ and } \eta' = 1\\ (1-\tau)\theta y & \text{when } s = u\\ (1-\tau)\theta y & \text{when } s = e, \eta' = 0, \text{ and } \mu = 1\\ 0 & \text{when } s = e, \eta' = 0, \text{and } \mu = 0. \end{cases} \tag{4}$$

At the beginning of the period, an individual's employment opportunity state is revealed. Given this, their current asset holdings, and their previous employment status (m, s, η), individuals choose whether or not to work (η'). Second, the agents that rejected an employment opportunity find out whether they receive benefits (μ_t is revealed), and given this they choose asset holdings and consumption subject to (3) and the nonnegativity constraint on asset holdings. The remaining agents, those who accept employment opportunities or those who are not offered one, choose asset holdings without having to wait for any uncertainty to be resolved. Therefore, the maximization problem faced by an agent at the beginning of a period is represented by the following dynamic programming problem:

$$V(m, s, \eta) =$$

$$\begin{cases} \max_{m'} \left\{ U(m + (1-\tau)\theta y - m', 1) + \beta \sum_{s'} \chi(u, s') V(m', s', 0) \right\}, & s = u \\ \max\left\{ \max_{m'} \left\{ U(m + (1-\tau) y - m', 1 - \hat{h}) + \beta \sum_{s'} \chi(e, s') V(m', s', 1) \right\}, \right. \\ \quad \pi(\eta) \left[\max_{m'} \left\{ U(m + (1-\tau)\theta y - m', 1) + \beta \sum_{s'} \chi(e, s') V(m', s', 0) \right\} \right] \\ \quad \left. + [1 - \pi(\eta)] \left[\max_{m'} \left\{ U(m - m', 1) + \beta \sum_{s'} \chi(e, s') V(m', s', 0) \right\} \right] \right\}, & s = e \end{cases} \tag{5}$$

subject to $m' \geq 0$.

A *stationary competitive equilibrium* for this economy consists of a set of decision rules $c(x)$, $\eta'(m, s, \eta)$, $m'(x)$ (for consumption, employment, and asset holdings), where $x = (m, s, \eta, \mu)$, a time-invariant measure $\lambda(x)$ of agents in state x, and a tax rate τ such that (*a*) given the tax rate τ, the households' decision rules solve (5); (*b*) the goods market clears:

$$\sum_x \lambda(x) c(x) = \sum_x \lambda(x) \eta'(x) y; \tag{6}$$

(*c*) the government budget constraint is satisfied:

$$\sum_m \{[\lambda(m, e, \eta, 1) + \lambda(m, u, \eta, 1)](1 - \tau)\theta y - \lambda(m, e, \eta, 0)\eta'(m, e, \eta, 0) y \tau\} = 0; \tag{7}$$

and (*d*) the invariant measure solves the following functional equation:

$$\lambda(m', s', \eta', \mu') =$$

$$\begin{cases} 0 & \text{if } s' = u, \mu' = 0 \\ \sum_\mu \sum_\eta \sum_s \sum_{m \in \Omega(m', s, \eta, \mu)} \chi(s, s') \lambda(x) & \text{if } s' = u, \mu' = 1 \\ \sum_\mu \sum_\eta \sum_s \sum_{m \in \Omega} \chi(s, s') \lambda(x) \{\eta'(x') + [1 - \pi(\eta'(x))][1 - \eta'(x')]\} & \text{if } s' = e, \mu' = 0 \\ \sum_\mu \sum_\eta \sum_s \sum_{m \in \Omega} \chi(s, s') \lambda(x) \pi(\eta'(x))[1 - \eta'(x')] & \text{if } s' = e, \mu' = 1, \end{cases} \tag{8}$$

where $\Omega(m', s, \eta, \mu) = \{m : m' = m'(m, s, \eta, \mu)\}$.

Equation (7) says that total unemployment insurance benefits paid (after taxes) must equal the taxes paid by employed workers. Given that we consider only stationary equilibria, equation (8) ensures that the distribution of agents across states is time invariant.[8] The first branch of this equation ensures that the fraction of agents who are not offered an employment opportunity ($s' = u$) and, in addition, are not given benefits ($\mu' = 0$) is zero. It follows from the second branch that all agents not receiving an employment opportunity ($s' = u$) do receive benefits ($\mu' = 1$). The third branch is the fraction of agents who receive an employment opportunity but do not collect benefits. This fraction is equal to the fraction of agents employed plus the fraction that reject an employment opportunity and are unsuccessful in collecting benefits. Finally, the fourth branch counts the fraction of agents receiving both an employment opportunity and benefits.

A. *Optimal Allocations*

In this paper we are primarily interested in studying the competitive equilibrium of the economy described above. However, for computing welfare costs, we also consider the allocation that solves a social planner's problem. The welfare measure we use in Section IV evaluates the gap between the equilibrium allocation and this optimal allocation. In particular, we measure how well, in terms of welfare, the government in the economy above is able to approximate the optimal allocation by choosing the level of unemployment insurance.

The optimal allocation is given by the solution to the following optimization problem:

$$\max \sum_{t=0}^{\infty} \beta^t [N_t U(c_{1t}, 1 - \hat{h}) + (1 - N_t) U(c_{2t}, 1)] \quad \text{subject to } N_t c_{1t} + (1 - N_t) c_{2t} \leq N_t y, \quad N_t \leq \overline{N}. \tag{9}$$

In this problem, N_t is the employment rate, c_{1t} is the consumption of an employed agent, and c_{2t} is the consumption of an unemployed agent in period t. In addition, $\overline{N}$ is the upper bound on the employment rate implied by the transitions probabilities (χ) governing the employment opportunity state, s. Since there is no uncertainty or dynamic linkages in this problem, the solution turns out to be con-

[8] This distribution not only describes the fraction of agents in each state at a given point in time but also specifies the fraction of time a particular individual is in a given state over an infinite lifetime.

stant over time. In particular, the solution is

$$\frac{c_{2t}}{c_{1t}} = a, \quad a = (1 - \hat{h})^{\sigma(\rho - 1)/[1-(1-\sigma)(1-\rho)]},$$

$$c_{1t} = \frac{N_t}{a + (1 - a)N_t}, \tag{10}$$

$$N_t = \begin{cases} \hat{N} & \text{if } \hat{N} < \overline{N}, \quad \hat{N} = \dfrac{a(\rho - 1)(1 - \sigma)}{1 - a} \\ \overline{N} & \text{otherwise.} \end{cases}$$

This allocation can be supported as a competitive equilibrium for an economy in which agents trade employment lotteries rather than hours worked, as in Hansen (1985) and Rogerson (1988).

III. Computing an Equilibrium

A. *Calibration of the Model*

In this section we specify the parameter values used for our experiments and describe the method used for obtaining an equilibrium. We calibrate the economy so that the time period is equal to 6 weeks, and we normalize the output produced by an employed agent to be one ($y = 1$). Two of our parameters, β and σ, are assigned values taken from Kydland and Prescott (1982) and other real business cycle studies. Therefore, we set $\beta = .995$ (which implies an annual discount rate of 4 percent) and $\sigma = .67$. We set $\hat{h}$ by assuming that individuals have 98 hours a week of substitutable time not spent eating, sleeping, or engaged in other personal care. If employed agents spend 45 hours a week working and commuting, $\hat{h}$ is approximately equal to .45.

In choosing a value for the degree of risk aversion (ρ), we note that Mehra and Prescott (1985) cite various empirical studies that provide support for setting the coefficient of relative risk aversion between one and two. Auerbach and Kotlikoff (1987) cite studies that find risk aversion to be in this range and, in addition, some studies that find it to be higher. Baily (1977), who studies issues similar to those in this paper, argues for setting this coefficient equal to one. However, these studies are all based on models in which utility is a function only of consumption, whereas for us utility is a function of both consumption and leisure. Therefore, if these studies find a value for the coefficient of risk aversion equal to $\hat{\rho}$, we must set ρ equal to the value that solves the equation $(1 - \sigma)(1 - \rho) = 1 - \hat{\rho}$. On the basis of the studies cited above, we regard 1.5 to be a reasonable value for $\hat{\rho}$. Given that we set σ equal to .67, this implies a value for ρ equal to 2.5. Although we use this value as our base case, we found that our results were quite sensitive to the degree of risk aversion. Therefore, we also consider results using higher values of ρ.

The transition probabilities, $\chi_{ss'}$, are chosen so that the employment opportunity is offered 94 percent of the time, and the average duration of not having the employment opportunity is equal to two periods (12 weeks). In examples in which employment opportunities are never refused, this implies that the unemployment rate and average duration match averages from postwar U.S. time series. The first requirement implies that the upper bound on the employment rate, $\overline{N}$, is equal to .94. Both these requirements imply that the transition probabilities matrix for the employment opportunities state (s) is[9]

$$\chi = \begin{bmatrix} .9681 & .0319 \\ .5000 & .5000 \end{bmatrix}.$$

B. *Computation Method*

A method of successive approximations is used to numerically solve for a stationary equilibrium for this economy. Given a particular unemployment insurance program (values for θ and $\pi(\eta)$), the iterative procedure employed involves the following steps. Beginning with a guess for the tax rate, τ, value iteration is used to solve the functional equation (5). Next, the invariant distribution, λ, corresponding to these decision rules is found by iterating on equation (8). Finally, the decision rules and the invariant distribution are used to evaluate the government budget constraint (7). If the government is found to be running a surplus (deficit), the tax rate is lowered (increased), and these steps are repeated until an equilibrium is found.

The method used to solve for the decision rules corresponding to a particular tax rate is described in detail in İmrohoroğlu (1989). Briefly, the method involves discretizing the state space by choosing a grid of feasible asset holdings. In our case, the maximum amount of assets that an agent is permitted to hold is assumed to be eight, which is a little less than the annual income of an agent continuously employed for a year. This constraint turns out not to bind in any of our experiments. Given this limit on asset holdings, a grid of 301

[9] The elements of this matrix are obtained by solving the following equations, where subscript 1 denotes $s = e$ and subscript 2 denotes $s = u$:

$$(1 - \chi_{22})^{-1} = 2 \quad \text{(two-period average duration of unemployment)},$$

$$.94 \cdot \chi_{12} + .06 \cdot \chi_{22} = .06 \quad \text{(6 percent average unemployment rate)},$$

$$\chi_{12} = 1 - \chi_{11}, \quad \chi_{21} = 1 - \chi_{22}.$$

points with increments of .027 is utilized. The grid was chosen to be sufficiently fine so that our results are not affected by adding more grid points. Since the employment opportunities state (s) and the individual's employment status (η) can take only two values, the total number of possible states is $301 \times 2 \times 2$. The choice set of agents at each point in time is also discrete and consists of at most 301×2 points, the number of choices for asset holdings times the number of choices for η'. The optimal value function and decision rules for this finite-state discounted dynamic programming problem are obtained by successive approximations. This standard approach involves starting with an initial approximation, $V_0(m, s, \eta)$, and using it to obtain a subsequent approximation by computing the right side of (5). This process is continued until the sequence of value functions so obtained converges.

Given that the state transition function implied by the equilibrium decision rules is ergodic, there exists a unique invariant distribution, $\lambda(x)$.[10] To compute this invariant distribution, we begin with an initial approximation, $\lambda_0(x)$, and evaluate the right side of (8) using the decision rules obtained from solving (5). The result, $\lambda_1(x)$, is used as the next candidate, and the process is continued until successive approximations are arbitrarily close.[11] Once the invariant distribution is found, the government budget constraint (7) is evaluated and a new candidate for the tax rate is chosen. The procedure is then repeated as described above.

C. *An Example*

As an illustration of how the agents in this economy behave, figure 1 shows a plot of an agent's equilibrium asset decision rule when the replacement ratio (θ) is .35, there is no unemployment insurance paid to quitters ($\pi(1) = 0$), and 10 percent of the searchers who reject an employment opportunity collect benefits ($\pi(0) = .1$). In this example, agents hold assets equal to 1.26 on average. The solid line on the graph shows the amount of assets that an employed agent carries into the subsequent period (m') as a function of beginning-of-period holdings (m). This line has a positive intercept, indicating, as one would expect, that an employed agent has positive net saving when

[10] For the experiments described in the next section, we have checked for ergodicity using a procedure similar to that described in the appendix to İmrohoroğlu (1989).

[11] By the law of large numbers, the sample average of any function $f(x)$ converges to the expected value of f with respect to this invariant distribution. Thus we are able to check our results by creating long time series using Monte Carlo methods and comparing summary statistics computed from these with those computed using the invariant distribution.

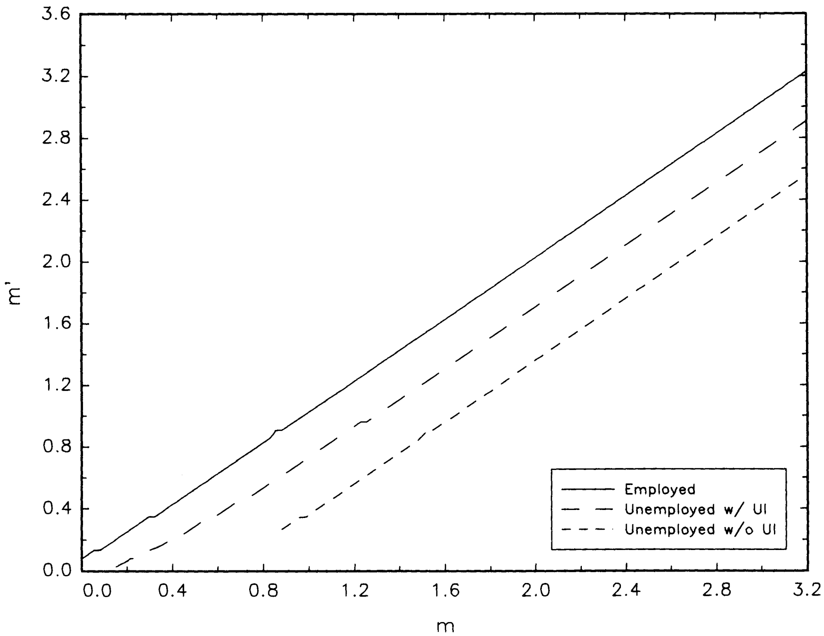

FIG. 1.—Asset decision: $\rho = 2.5$, $\pi(0) = .1$, $\pi(1) = 0$

his asset levels are low. Unemployed agents, as shown by the other two lines in the figure, always dissave.

In this example, since a quitter is not eligible for benefits, no agent ever chooses to quit a job no matter how large his asset holdings. That is, someone who worked during the previous period ($\eta = 1$) and is offered an employment opportunity ($s = e$) always accepts it ($\eta' = 1$). However, if an unemployed agent has asset holdings of 0.88 or more, he will reject an employment opportunity.[12] Ten percent of the agents in this category will collect benefits, and their asset decision is represented by the middle line in figure 1. The agents who do not succeed in collecting benefits accumulate assets according to the bottom line in the figure. This decision rule is undefined for asset levels below 0.88.

IV. Results

In this section we describe the results of various experiments designed to characterize the role of unemployment insurance in our

[12] Of course, this threshold asset level will be different for different specifications of the unemployment insurance program. For example, if there was no unemployment insurance ($\theta = 0$), the threshold asset level would be 5.387.

model economy. In subsection *A* we present summary statistics to illustrate the equilibrium properties of this economy and explore how these are affected by the introduction of unemployment insurance. The main results of the paper are presented in subsection *B*. In particular, we show that the potential welfare benefits from an insurance program are quite sensitive to the presence of moral hazard. Still, if the replacement ratio is chosen optimally, unemployment insurance programs can yield positive welfare benefits even if there is substantial moral hazard. However, if the replacement ratio is not chosen optimally but is instead set equal to the empirically plausible, yet arbitrary, value of .5, the economy can be made considerably *worse* off with unemployment insurance.

A. *Equilibrium Properties and the Role of Unemployment Insurance*

In this subsection we first consider the behavior of our economy when there is no moral hazard and discuss the implications of adding unemployment insurance. We show that by choosing the optimal value for the replacement ratio (θ), it is possible to make equilibrium average utility the same as under the social planner's allocation given in equation (10). We then proceed to show that introducing moral hazard reduces the optimal replacement ratio and makes the average duration of unemployment more sensitive to changes in the replacement ratio. We conclude the subsection with a discussion of how higher risk aversion would change our results.

The equilibrium properties of the economy for various benefit levels and degrees of moral hazard are summarized in table 1. These results are all computed using a value of 2.5 for the risk aversion parameter ρ. Panel A provides results for the no moral hazard case ($\pi(0) = \pi(1) = 0$). Examining the first line of panel A, we find that without unemployment insurance, agents never turn down an employment opportunity and have considerable average asset holdings (about half the annual income of a continuously employed worker) to self-insure against income loss due to unemployment. Adding unemployment insurance to the economy (increasing θ) allows agents to hold substantially fewer assets and enjoy smoother consumption. Utility increases with increases in the replacement ratio until θ reaches .65, which is the optimal replacement ratio for this case.[13] If benefits are increased beyond this level, an agent's average utility will be lower. In addition, agents continue to accept all employ-

[13] To reduce computation costs, we consider only values of θ that lie on the grid $\{0, .05, .10, \ldots\}$.

TABLE 1

SELECTED RESULTS FOR $\rho = 2.5$

Replacement Ratio (θ)	Tax Rate (τ)	Employment Rate (Average Consumption)	Standard Deviation of Consumption	Duration of Unemployment (Weeks)	Average Asset Holdings	Average Utility
			A. No Moral Hazard: $\pi(0) = \pi(1) = 0$			
0	.000	.940	.121	12.000	4.366	−.5539
.25	.016	.940	.113	12.000	.935	−.5521
.50	.031	.940	.100	12.000	.144	−.5505
.65 ←	.040	.940	.079	12.000	.000	−.5499
.75	.046	.940	.071	12.000	.014	−.5499
.80	.049	.936	.076	12.001	.031	−.5500
1	.061	.918	.086	15.792	6.898	−.5506
			B. Some Moral Hazard: $\pi(0) = \pi(1) = .1$			
0	.000	.940	.121	12.000	4.366	−.5539
.10	.006	.940	.117	12.000	1.811	−.5531
.15 ←	.009	.940	.116	12.000	1.482	−.5527
.20	.133	.921	.117	9.720	1.179	−.5528

	C. Some Moral Hazard for Searchers Only: $\pi(0) = .1$, $\pi(1) = 0$					
0	.000	.940	.121	12.000	4.366	−.5539
.25	.016	.930	.102	14.094	1.520	−.5513
.30	.020	.925	.100	15.216	1.398	−.5512
.35←	.023	.921	.099	16.242	1.256	−.5511
.50	.035	.897	.098	21.960	1.341	−.5515
.75	.060	.835	.109	37.812	1.997	−.5556
1	.090	.776	.116	55.950	2.469	−.5619
	D. Extreme Moral Hazard for Searchers: $\pi(0) = 1$, $\pi(1) = 0$					
0	.000	.940	.121	12.000	4.366	−.5539
.05←	.005	.913	.107	17.826	3.367	−.5524
.10	.016	.857	.114	31.122	3.926	−.5549
.25	.134	.621	.150	114.594	4.110	−.5993

NOTE.—The optimal allocation (eq. [10]) implies an employment rate of .94 and average utility of −.5499. The optimal replacement ratio is indicated by an arrow. This ratio is the value of θ in the set {0, .05, .1, .15, . . . , 1} that is associated with the highest average utility in equilibrium. In addition, since we have assumed that the income of an employed agent, y, is equal to one, the employment rate is equal to average consumption.

ment opportunities unless the replacement ratio is increased to a point that is considerably above the optimum ($\theta = .80$). Thus for reasonable benefit levels, the unemployment rate and average duration of unemployment are not affected by unemployment insurance.

In the absence of moral hazard, suboptimal allocations may result even when benefits are set optimally because distorting taxes are used to finance the system. However, for our calibration, if benefits are optimal, the tax distortions are small enough that average utility is the same as under the social planner's allocation. That is, unemployment insurance can be used to eliminate all welfare losses arising from the fact that agents are unable to borrow or insure through private markets.

We now consider the effectiveness of unemployment insurance when it is not possible to perfectly monitor all applicants. In panel B of table 1 we present results obtained under the assumption that 10 percent of all unemployed workers who turn down employment opportunities, including those who quit, escape detection and collect benefits ($\pi(0) = \pi(1) = .1$). The optimal replacement ratio drops from .65 in the no moral hazard case to .15 in this case. In addition, we find that increases in the replacement ratio above the optimum actually *reduce* the duration of unemployment, contrary to the findings of most empirical studies. This follows from the fact that these additional unemployed workers (consisting of about 2 percent of the population for $\theta = .2$) are workers who quit their jobs. Quitters, given that they had been offered an employment opportunity, have shorter average spells of unemployment than individuals who were not because they are more likely to be offered an employment opportunity again next period.[14]

This counterfactual result, plus our conjecture that it is easier for unemployment insurance administrators to detect quitters than it is to detect those who turn down jobs while unemployed (searchers), leads us to concentrate the rest of the paper on cases in which quitters are always refused benefits ($\pi(1) = 0$). In panel C of table 1 we provide results for $\pi(0) = .1$. In this case, the optimal replacement ratio is considerably lower than if moral hazard were absent (.35 compared with .65) but higher than if quitters and searchers were treated symmetrically. Also, we find that no one ever quits in this case. The fall in employment associated with increases in the replace-

[14] In this example, increases in benefits induce workers with high reemployment probabilities to become unemployed, and hence the average duration of unemployment falls. This theoretical possibility has been suggested by Clark and Summers (1982).

ment ratio occurs only when unemployed workers choose to search longer.[15] For example, a 14 percent increase in the replacement ratio from .35 to .40 leads to a 9 percent increase in the duration of unemployment and an 8 percent increase in the rate of unemployment. This implies elasticities of the duration and incidence of unemployment equal to .63 and .55, respectively. These elasticities, however, are not constant with respect to the level of benefits: the incidence and duration of unemployment become more sensitive to a given percentage change in the replacement ratio as the ratio is increased.

In panel D of table 1 we consider the extreme case in which all searchers are able to escape detection and collect benefits after turning down an employment opportunity ($\pi(0) = 1$). In this case, the optimal replacement ratio turns out to be only .05. In addition, the rate and duration of unemployment are extremely sensitive to increases in the replacement ratio. Still, there are no quitters; the reductions in the employment rate occur when agents choose to remain unemployed longer.

We close this subsection by describing how the behavior of the economy changes when a higher value for the degree of risk aversion is assumed. Two results deserve to be stressed. First, if there is no moral hazard, we find that the optimal benefit level falls with increases in risk aversion. In particular, the optimal replacement ratio is .65, .55, and .40 for ρ equal to 2.5, 4, and 10, respectively.[16] The second result, which is more important for our purposes, is that for a given replacement ratio, agents are less likely to take advantage of positive values of π. This follows from the fact that more risk averse agents are less attracted to the lotteries offered to them through imperfect monitoring of benefit applicants. Therefore, as we demonstrate in the next subsection, higher values of ρ imply that the optimal replacement ratio and the potential welfare benefits of unemployment insurance are less sensitive to moral hazard.

[15] That is, agents who are in state $(s, \eta) = (e, 1)$ always choose η' equal to one. Increases in the unemployment rate arise when agents in state $(e, 0)$ choose to reject employment opportunities ($\eta' = 0$).

[16] This result, which may at first seem counterintuitive, follows from the particular utility function we use. These preferences imply that the more risk averse agents are, the more importance they place on smoothing consumption of the composite commodity, $c^{1-\sigma}l^{\sigma}$. For values of ρ above one, this leads agents to choose lower consumption of goods (c) when they are unemployed than when they are employed, even if they have access to complete markets. Hence, the instantaneous utility of an employed agent is lower than that of an unemployed agent. As ρ is increased, given that they face variability in leisure, agents choose a more variable goods consumption sequence in order to better smooth consumption of the composite commodity. Therefore, since agents desire a more volatile c_t sequence, smaller replacement ratios are required for higher values of ρ.

B. *The Welfare Consequences of Unemployment Insurance*

In this subsection we study the magnitude of the potential welfare benefits from unemployment insurance and study how sensitive these benefits are to moral hazard. The welfare measure used in this section is based on deviations of competitive equilibrium allocations from the social planner's allocation described in Section II*A*. For example, with the parameter values given in Section III and with ρ equal to 2.5, the utility level under the social planner's allocation is $-.5499$. Alternatively, the average utility level attained in a competitive equilibrium with no unemployment insurance is $-.5539$. By themselves, these utility numbers tell us that agents would be happier with the social planner's allocation, but little else.

To obtain a more informative measure of welfare costs, we ask the following question: How much more productive would an employed agent in the liquidity-constrained economy have to be (i.e., how much would y have to increase) for that person to have the same average utility as under the optimal allocation? The answer for this example turns out to be an increase of 0.67 percent. Since the elasticity of substitution between consumption and leisure is unity for this economy, a permanent increase in the wage of an employed worker leaves

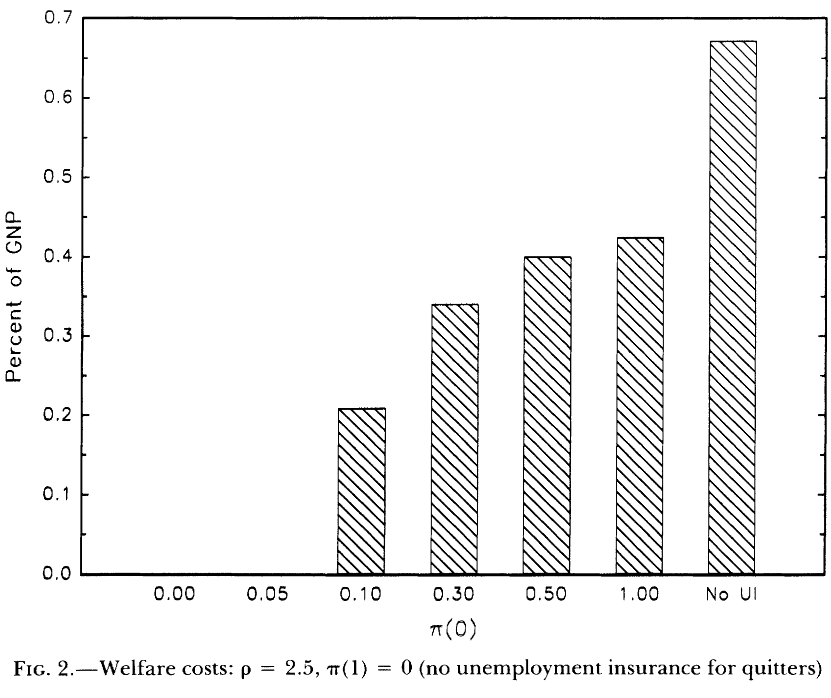

FIG. 2.—Welfare costs: $\rho = 2.5$, $\pi(1) = 0$ (no unemployment insurance for quitters)

TABLE 2

Optimal Replacement Ratios

	A. Selected Results for $\rho = 2.5$					
Moral Hazard ($\pi(0)$)	.00	.05	.10	.30	.50	1.00
Optimal θ	.65	.65	.35	.15	.10	.05
	B. Selected Results for $\rho = 10$					
Moral Hazard ($\pi(0)$)	.00	.55	.60	.65	.75	1.00
Optimal θ	.40	.40	.35	.30	.25	.20

Note.—The values for $\pi(0)$ used in this table correspond to the values used in figs. 2 and 3.

the employment rate unchanged. Hence, equilibrium average consumption and total output will also increase by this same percentage (0.67).

The *potential* welfare benefits of unemployment insurance are determined by comparing this percentage with the welfare cost when the optimal level of benefits is provided. In figure 2 we report these welfare costs for various values of $\pi(0)$, assuming that $\pi(1)$ is equal to zero (quitters do not receive benefits). In addition, the welfare cost associated with no unemployment insurance is shown on the right side of the figure. The optimal replacement ratio (to the nearest .05) associated with each $\pi(0)$ is reported in table 2.

As we have already noted, in the absence of moral hazard, an optimal insurance program is able to make agents as well off as under the social planner's allocation. Thus welfare costs are reduced to zero. This is also true for $\pi(0) = .05$. Once $\pi(0)$ is increased to .10, the potential welfare benefits drop significantly. Yet, even when $\pi(0)$ is equal to one, so that all searchers not accepting employment opportunities receive benefits, welfare costs can be reduced from 0.67 percent to 0.42 percent of gross national product. However, the replacement ratio required to realize this welfare improvement is only 5 percent; increasing θ to .1 would lead to higher welfare costs than in the no insurance case.

As shown in panel A of table 2, the optimal replacement ratio falls considerably in the presence of even small amounts of moral hazard. In particular, a replacement ratio as high as .5, which is a reasonable lower bound for estimates of the replacement ratio in the U.S. economy, is optimal only for values of $\pi(0)$ in the neighborhood of .05 or lower. If $\pi(0) = .10$, the optimal replacement ratio drops to 35 percent. It drops to 15 percent if $\pi(0) = .30$.

To illustrate how these results would change with higher risk aversion, we report results for $\rho = 10$ in figure 3. We focus on this value since we take it to be close to an upper bound for an empirically plausible degree of risk aversion. The results we obtain are not surprising given the results presented in the previous subsection. The fact that agents take less advantage of imperfect monitoring (positive π's) causes the optimal replacement ratio to be less sensitive to increases in $\pi(0)$ as shown in panel B of table 2. For instance, the optimal replacement ratio in the absence of moral hazard, .40, is also optimal for values of $\pi(0)$ as high as .55. In addition, as can be observed in figure 3, the size of the potential welfare benefits from unemployment insurance is lower when risk aversion is high: in the absence of insurance, the welfare cost is equal to 0.54 percent of GNP when ρ is 10, as compared with 0.67 percent when ρ is 2.5. The important result, however, is that in a more risk averse economy, these potential benefits can be realized for relatively high values of $\pi(0)$.

The welfare results presented so far are computed under the assumption that the replacement ratio is set optimally. In figure 4 we show the welfare costs corresponding to various degrees of moral hazard when the replacement ratio is arbitrarily set equal to .50, which we take as a reasonable lower bound for estimates of the replacement ratio in the U.S. economy.[17] We find that for relatively low levels of moral hazard ($\pi(0) < .15$), unemployment insurance with a replacement ratio of .50 yields positive welfare benefits. For example, if $\pi(0) = .1$, the welfare costs are less than half as much as they would be without unemployment insurance. However, for values of $\pi(0)$ greater than or equal to .15, the economy would be better off without unemployment insurance. As another example, if $\pi(0) = .3$, the welfare costs are over four times larger than without unemployment insurance. If $\pi(0) = .5$, the welfare costs are over 17 times larger. Clearly, the economy can suffer enormous welfare costs if substantial unemployment insurance is provided when applicants are imperfectly monitored.

V. Conclusion

In this paper we have studied the role of unemployment insurance in an artificial economy in which agents are liquidity constrained and face stochastic employment opportunities. We find that, as long as the work test is strictly enforced, unemployment insurance programs with replacement ratios similar to those found in the U.S. economy

[17] Clark and Summers (1982) estimate the average replacement ratio to be 66.6 percent, and Feldstein (1978) reports a value of 55 percent. We have chosen a lower bound because in our model individuals are able to collect benefits for as many periods as they are unemployed, whereas in the U.S. economy they can collect only for some specified number of weeks (usually 26 weeks).

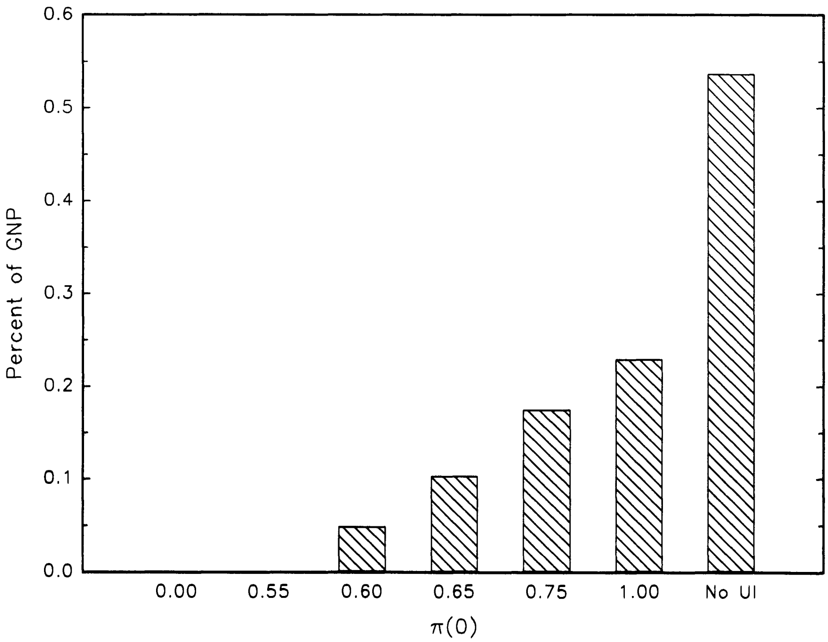

FIG. 3.—Welfare costs: $\rho = 10$, $\pi(1) = 0$ (no unemployment insurance for quitters)

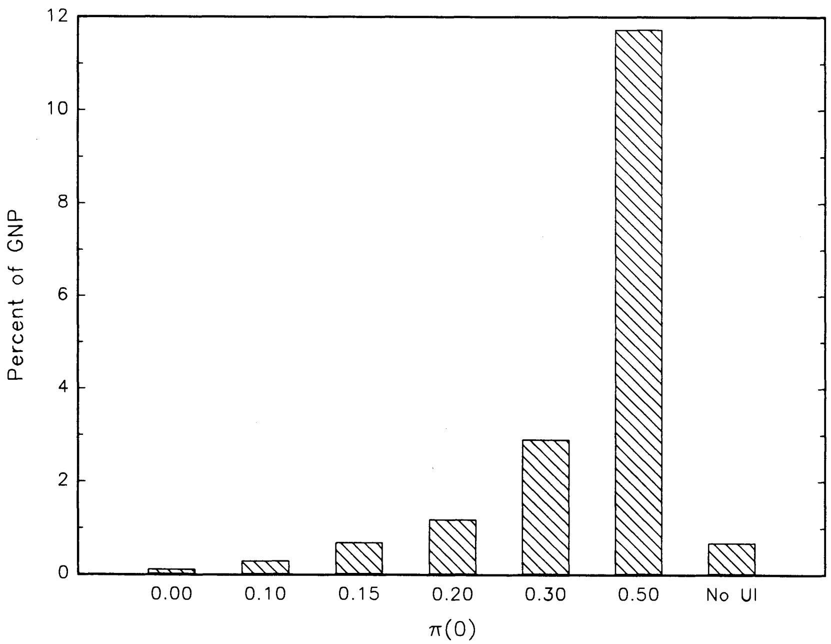

FIG. 4.—Welfare costs for fixed $\theta = .5$: $\rho = 2.5$, $\pi(1) = 0$

are optimal in this model economy. We also find that the welfare costs precipitated by the liquidity constraint can be eliminated by providing unemployment insurance.

We consider how sensitive this conclusion is to the presence of moral hazard and find, not surprisingly, that this depends significantly on the degree of risk aversion. For the coefficient of relative risk aversion that we take as a base case, we find that the optimal benefit level and the potential welfare improvement, although always positive, are quite sensitive to the presence of moral hazard. As the coefficient of risk aversion is increased, moderate amounts of moral hazard become less important. These welfare results, however, are obtained under the assumption that the replacement ratio is set optimally. If instead it is set to an empirically plausible value and there is sufficient moral hazard, the economy can be significantly better off without unemployment insurance.

We conclude this paper by commenting on the relevance of these theoretical results for judging the effectiveness of unemployment insurance programs in the U.S. economy. To address this issue, we must take a stand on how much moral hazard there is in the actual economy. In the paper we have chosen to set $\pi(1)$ equal to zero since it ought to be relatively easy for program administrators to detect quitters.[18] To calibrate $\pi(0)$, we must consider how well the work test requirement, common to essentially all unemployment insurance programs in the United States, is enforced. Clark and Summers (1982) report that fewer than 0.1 percent of benefit claimants are disqualified for this type of reason. This is probably because search activity is very difficult to monitor. This evidence argues for a value of $\pi(0)$ close to one. However, these parameter values, which are used to construct panel D of table 1, would lead to an implausibly large duration elasticity.[19]

This conflict leads us to consider the possibility that other eligibility requirements imposed by actual unemployment insurance programs may attenuate the effects of moral hazard as we have modeled it. Although the work test may not be effectively enforced, Blank and Card (1988), using data from 1977 to 1987, report that only 43 percent of unemployed workers are eligible to collect benefits. The most common reason for ineligibility, accounting for 52.1 percent of the ineligible unemployed in Blank and Card's sample, is that the individual was not employed for a minimum required number of weeks (or

[18] This is probably too extreme since it is certainly possible for some quitters to pass themselves off as having been laid off.

[19] Meyer (1989) reports that most empirical estimates of the duration elasticity lie between .2 and .5. Our model predicts elasticities in this range only for relatively low values of $\pi(0)$, values between .05 and .10.

did not earn a required minimum amount) in the 12-month "base period" prior to becoming unemployed.[20] If during this base period workers acquire firm-specific human capital, unemployed individuals may be unlikely to reject an employment opportunity offered by their previous employer. In fact a very large percentage of those receiving benefits do return to their previous employer.[21] In such an environment, monitoring of search activity may be largely unnecessary.

We leave it to future work to explicitly examine this role of temporary layoff unemployment. In addition, in such a model one could also consider the role of experience rating. For now, we conclude that a low value of $\pi(0)$, one consistent with measured duration elasticities, may best describe actual unemployment insurance programs.

References

Auerbach, Alan J., and Kotlikoff, Laurence J. *Dynamic Fiscal Policy.* Cambridge: Cambridge Univ. Press, 1987.

Baily, Martin Neil. "Unemployment Insurance as Insurance for Workers." *Indus. and Labor Relations Rev.* 30 (July 1977): 495–504.

Blank, Rebecca M., and Card, David. "Recent Trends in Insured and Uninsured Unemployment: Is There an Explanation?" Manuscript. Princeton, N.J.: Princeton Univ., 1988.

Burdett, Kenneth, and Wright, Randall. "Unemployment Insurance and Short-Time Compensation: The Effects on Layoffs, Hours per Worker, and Wages." *J.P.E.* 97 (December 1989): 1479–96.

Clark, Kim B., and Summers, Lawrence H. "Unemployment Insurance and Labor Market Transitions." In *Workers, Jobs, and Inflation,* edited by Martin Neil Baily. Washington: Brookings Inst., 1982.

Easley, David; Kiefer, Nicholas M.; and Possen, Uri. "An Equilibrium Analysis of Optimal Unemployment Insurance and Taxation." *Q.J.E.* 100 (suppl., 1985): 989–1010.

Ehrenberg, Ronald G., and Oaxaca, Ronald L. "Unemployment Insurance, Duration of Unemployment, and Subsequent Wage Gain." *A.E.R.* 66 (December 1976): 754–66.

Fallick, Bruce C. "Unemployment Insurance and the Rate of Re-Employment of Displaced Workers." Manuscript. Los Angeles: Univ. California, 1990.

Feldstein, Martin. "The Importance of Temporary Layoffs: An Empirical Analysis." *Brookings Papers Econ. Activity,* no. 3 (1975), pp. 725–44.

———. "The Effect of Unemployment Insurance on Temporary Layoff Unemployment." *A.E.R.* 68 (December 1978): 834–46.

Flemming, J. S. "Aspects of Optimal Unemployment Insurance: Search, Lei-

[20] Other reasons for not receiving benefits include that the individual quit his job (11.7 percent), the period for which the individual is allowed to receive benefits (usually 26 weeks) has expired (26.1 percent), or the period that one must be unemployed before receiving benefits (usually 1 week) has not yet expired (9.5 percent).

[21] Feldstein (1975) and Lilien (1980) find that over 70 percent of workers laid off from U.S. manufacturing in the 1970s were subsequently rehired by their former employer. Katz (1986) finds that this number is somewhat lower, about 50 percent, for workers laid off from nonmanufacturing jobs.

sure, Savings and Capital Market Imperfections." *J. Public Econ.* 10 (December 1978): 403–25.

Green, Edward J. "Lending and the Smoothing of Uninsurable Income." In *Contractual Arrangements for Intertemporal Trade,* edited by Edward C. Prescott and Neil Wallace. Minneapolis: Univ. Minnesota Press, 1987.

Hamermesh, Daniel S. *Jobless Pay and the Economy.* Baltimore: Johns Hopkins Univ. Press, 1977.

———. "Social Insurance and Consumption: An Empirical Inquiry." *A.E.R.* 72 (March 1982): 101–13.

Hansen, Gary D. "Indivisible Labor and the Business Cycle." *J. Monetary Econ.* 16 (November 1985): 309–27.

Ibbotson, Roger G., and Sinquefield, Rex A. *Stocks, Bonds, Bills and Inflation: Historical Returns (1926–1978).* Charlottesville, Va.: Financial Analysts Found., 1979.

İmrohoroğlu, Ayşe. "Cost of Business Cycles with Indivisibilities and Liquidity Constraints." *J.P.E.* 97 (December 1989): 1364–83.

———. "The Welfare Cost of Inflation under Imperfect Insurance." *J. Econ. Dynamics and Control* 16 (1992), in press.

Katz, Lawrence F. "Layoffs, Recall, and the Duration of Unemployment." Working Paper no. 1825. Cambridge, Mass.: NBER, January 1986.

Kydland, Finn E., and Prescott, Edward C. "Time to Build and Aggregate Fluctuations." *Econometrica* 50 (November 1982): 1345–70.

Lilien, David M. "The Cyclical Pattern of Temporary Layoffs in United States Manufacturing." *Rev. Econ. and Statis.* 62 (February 1980): 24–31.

Mehra, Rajnish, and Prescott, Edward C. "The Equity Premium: A Puzzle." *J. Monetary Econ.* 15 (March 1985): 145–61.

Meyer, Bruce D. "A Quasi-experimental Approach to the Effects of Unemployment Insurance." Working Paper no. 3159. Cambridge, Mass.: NBER, November 1989.

———. "Unemployment Insurance and Unemployment Spells." *Econometrica* 58 (July 1990): 757–82.

Mortensen, Dale T. "Unemployment Insurance and Job Search Decisions." *Indus. and Labor Relations Rev.* 30 (July 1977): 505–17.

———. "A Welfare Analysis of Unemployment Insurance: Variations on Second-best Themes." *Carnegie-Rochester Conf. Ser. Public Policy* 19 (Autumn 1983): 67–97.

Rogerson, Richard. "Indivisible Labor, Lotteries and Equilibrium." *J. Monetary Econ.* 21 (January 1988): 3–16.

Shavell, Steven, and Weiss, Laurence. "The Optimal Payment of Unemployment Insurance Benefits over Time." *J.P.E.* 87 (December 1979): 1347–62.

Topel, Robert H. "On Layoffs and Unemployment Insurance." *A.E.R.* 73 (September 1983): 541–59.

Townsend, Robert M. "Private Information and Limited Insurance." Manuscript. Chicago: Univ. Chicago, 1986.

Welch, Finis. "What Have We Learned from Empirical Studies of Unemployment Insurance?" *Indus. and Labor Relations Rev.* 30 (July 1977): 451–61.

Wright, Randall. "The Redistributive Roles of Unemployment Insurance and the Dynamics of Voting." *J. Public Econ.* 31 (December 1986): 377–99.