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ON THE NATURE OF UNEMPLOYMENT IN ECONOMIES WITH EFFICIENT RISK SHARING

by

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I. Introduction

In any economy where the first best allocation of risk is feasible (so that, in particular, private information is not a problem), workers will be efficiently insured against the possibility of unemployment. This does not mean, however, that the employed and the unemployed will have the same total utility in equilibrium (it actually means that they have the same marginal utility). Several authors (Rogerson 1985b, Hansen 1985, and Greenwood and Huffman 1985) have recently studied business cycle phenomena in representative agent economies that have the problem – or at least, the quirk – that the unemployed enjoy greater utility than the employed in equilibrium. This should not be surprising given the parameterizations used in all of these models – additively separable utility functions. With separable preferences the efficient allocation of risk implies the employed and the unemployed receive the same consumption, and since the latter also enjoy leisure, they ought to be better off.

The degree of conflict with reality in this implication is a matter of opinion.[1] In any case, the purpose of this note is to see if reasonable alternative specifications for preferences imply that employment is the preferred status in these economies, and also in other models with efficient risk sharing such as implicit contract models. We discuss some simple utility functions with this property, including one that involves a "social stigma" attached to the status of unemployment. We also demonstrate the existence of equilibria when workers have these preferences, with unemployment strictly between 0 and 1 (so that our results are not vacuous). We then provide the following general characterization: in the equilibria of either representative agent or implicit contract economies, the employed will have greater utility than the unemployed if and only if an increase in exogenous income implies a reduction in the probability of unemployment. Finally, we clarify the following fact: even if the unemployed are better off, this does not imply that the economy is better off when unemployment is higher.[2,2a]

II. A Simple Economy With Unemployment

The state of the economy is given by a random variable x, drawn from the set X, with cumulative distribution function $F(x_0) = \text{prob}(x \leq x_0)$. Aggregate technology is described by the state-dependent production function $f(\ell,x): \mathbb{R}_+ \times X \rightarrow \mathbb{R}_+$, where ℓ denotes labor input and is given by $\ell \equiv n \cdot h$, n denoting the number of workers and h denoting hours per worker.[3] On the interior of its domain, f is twice continuously differentiable with $f_1 > 0$ and $f_{11} < 0$. We also assume $f_2 > 0$ and $f_{12} > 0$, so both the total and marginal product are uniformly increasing in the state, and we assume $f_1(\ell,x) \rightarrow \infty$ as $\ell \rightarrow 0$ $\forall x$ in order to guarantee production does not shut down in equilibrium. For now, the population consists of a continuum of homogeneous agents called "workers" on the interval [0,1], each with the von Neumann - Morgenstern utility function over consumption-leisure pairs $U(c,1-h): \mathbb{R}_+ \times [0,1] \rightarrow \mathbb{R}$. On the interior of its domain, U is twice continuously differentiable, concave, strictly concave in c (so that agents are strictly averse to consumption risk), and strictly increasing. We also assume $U_1(c,1-h) \rightarrow \infty$ as $c \rightarrow 0$ $\forall h$.

Each worker is endowed with y units of the consumption good and one unit of labor time in every state. If we allow them to supply any amount of their time in the interval [0,1], there will never be unemployment in this economy: labor input may vary with the realization of x, but fluctuations will always occur along the intensive margin (changes in hours per worker) rather than the extensive margin (changes in the number of workers). This is an implication of convexity. Introducing certain non-convexities into the model changes things, and can serve to generate outcomes with some workers employed and others unemployed in a given state. The simplest approach is to assume that hours are indivisible, and this is how we begin (several other approaches, including fixed costs and the introduction of tax-financed unemployment insurance, will be discussed in the next section). Thus we impose the restriction $h \in \{0, h_0\}$, and without loss in generality, we normalize $h_0 \equiv 1$.

One way — the standard way — to define an allocation for this economy is a list $[h^i(x), c^i(x)]$, specifying for each agent i in each state x his hours of employment and his income (his consumption will equal his income plus his endowment, $c^i(x) + y$). A competitive equilibrium could then be defined as an allocation together with prices for labor and output contingent on x, satisfying the usual optimization and feasibility (market clearing) conditions. However, it is demonstrated in Rogerson (1985b) that these competitive equilibrium allocations can actually be Pareto dominated if we expand the commodity space to include "employment lotteries." Call agent i employed in state x if $h^i(x) = 1$ and unemployed if $h^i(x) = 0$, and redefine an allocation to be a list $[n^i(x), w^i(x), b^i(x)]$, specifying for each agent in each state a probability of employment, income if employed, and income if unemployed. Worker i's expected utility (before the lottery) in state x is given by

$$V^i(x) = n^i(x)U[w^i(x)+y,0] + [1-n^i(x)]U[b^i(x)+y,1].$$

In terms of $EV^i = \int V^i(x)dF(x)$, allocations with lotteries can Pareto dominate those without.[4]

Allocations with lotteries can be supported as competitive equilibria where agents trade probabilities (instead of hours) of employment. The lotteries can be interpreted as random layoffs (as in the implicit contract literature). Their advantage to the workers in this economy derives from the fact that, since leisure is valued, it may not be desirable to have the entire labor force working full time in all states of productivity, but because of the non-convexity it is not possible to have them all work part time. Lotteries make it possible to "convexify" the environment and have everyone work with some probability.[5] Their advantage to us as economic analysts derives from the fact that, since the augmented commodity space is convex and workers are identical, they will all receive the same bundle in equilibrium, and so we may concentrate on the allocation of a single representative worker, $[n(x),w(x),b(x)]$.[6] We can now find optimal (and, by the welfare theorems, equilibrium) allocations by solving the following planning problem:

$$\begin{aligned} &\max EV = \int\Big\{n(x)U[w(x)+y,0] + [1-n(x)]U[b(x)+y,1]\Big\}dF(x) \\ (1)\quad &\text{st}\;\; f[n(x),x] - n(x)w(x) - [1-n(x)]b(x) \geq 0\;\; \forall x \\ &n(x)\in[0,1]\;\; \forall x \end{aligned}$$

(non-negativity constraints on consumption have been ignored by virtue of our curvature assumption on U).

To characterize solutions to (1), form the Lagrangian

$$\begin{aligned} (2)\quad L = &\int\Big\{n(x)U[w(x)+y,0] + [1-n(x)]U[b(x)+y,1] \\ &+ \lambda(x)\Big[f[n(x),x] - n(x)w(x) - [1-n(x)]b(x)\Big] + \theta(x)[1-n(x)]\Big\}dF(x) \end{aligned}$$

where for each x, $\lambda(x)$ and $\theta(x)$ are non-negative multipliers. Our curvature assumption on f guarantees $n(x) > 0$; hence, the first order conditions can be summarized as follows: For all x,

(3) $$L_{n(x)} = U[w(x)+y,0] - U[b(x)+y,1] + \lambda(x)\left\{f_1[n(x),x] - w(x) + b(x)\right\} - \theta(x) = 0$$

(4) $$L_{w(x)} = n(x)U_1[w(x)+y,0] - \lambda(x)n(x) = 0$$

(5) $$L_{b(x)} = [1-n(x)]U_1[b(x),1] - \lambda(x)[1-n(x)] = 0$$

plus the technology constraint at equality, the constraint $n(x) \leq 1$, and the condition $n(x) < 1 \Rightarrow \theta(x) = 0$. (One could check that the second order conditions — see Takayama (1985), for example — will always be satisfied here.)

Condition (4) implies $U_1[w(x)+y,0] = \lambda(x)$ for all x. As long as $n(x) < 1$ condition (5) implies $U_1[b(x)+y,1] = \lambda(x)$, and when $n(x) = 1$ the choice of $b(x)$ is clearly irrelevant, so we may as well assume $U_1[b(x)+y,1] = \lambda(x)$ for all x. Together, these imply the efficient risk sharing conditions, a special case of the well known Arrow-Borsch conditions,

(6) $$U_1[w(x)+y,0] = U_1[b(x)+y,1] = \lambda(x) \;\forall x.$$

Equation (6) indicates that within every state the marginal utility of consumption should be equated across employed and unemployed agents, a condition that will be a key ingredient in much of the analysis to follow. Notice that since $\lambda(x)$ in general depends on x, it is not true here that the marginal utility of consumption is equated across states, as would be the case if all risk was diversifiable. We will explore this by introducing an additional, "unrepresentative" agent (and making some other modifications in our basic assumptions) in the next section, before we discuss the nature of unemployment.

III. Alternative Assumptions

Here we relate the above model to the implicit contract literature, and also investigate some alternative reasons for the existence of unemployment. To begin, introduce a new agent into the economy who is risk neutral. His consumption (equal to his utility) in state x is given by

$$\pi(x) = k + f[n(x),x] - n(x)w(x) - [1-n(x)]b(x),$$

where k is his endowment income. Implicit contract theory chooses $[n(x),w(x),b(x)]$ to solve the following problem (or its dual):

$$\begin{aligned} &\max\ EV = \int\{n(x)U[w(x)+y,0] + [1-n(x)]U[b(x)+y,1]\}dF(x)\\ (1')\quad &\text{st}\ \ E\pi = \int\{k + f[n(x),x] - n(x)w(x) - [1-n(x)]b(x)\}dF(x) \geq \pi_0\\ &\qquad n(x)\in[0,1]\ \forall x \end{aligned}$$

(We will ignore non-negativity constraints on the risk neutral agent's consumption here; this detail could always be finessed by making k sufficiently large.)

As π_0 is varied we trace out the contract curve.[7] In particular, with $\pi_0 = k$ (so the expected value, which equals the market value, of the risk neutral agent's excess demand is zero), the allocation that solves (1') is also the competitive equilibrium allocation for this economy.[8] With $\pi_0 = k$, problem (1') looks a lot like problem (1), except that in (1') the resource constraint only has to hold on average and not pointwise across states. The risk neutral agent is willing and able to insure workers against fluctuations in their productivity with k acting as a buffer stock. The introduction of such an insurance agent into the economy obviously makes the workers better off by allowing them to diversify away more of the uncertainty they face.

To characterize solutions to (1′), form the Lagrangian

$$L = \int\Big\{n(x)U[w(x)+y,0] + [1-n(x)]U[b(x)+y,1] \\ + \lambda\Big[f[n(x),x] - n(x)w(x) - [1-n(x)]b(x)\Big] + \theta(x)[1-n(x)]\Big\}dF(x) \tag{2′}$$

where for each x, $\theta(x)$ is the multiplier for $n(x) \leq 1$, while λ is the single multiplier for the constraint $E\pi \geq 0$. First order conditions are as follows: For all x,

$$L_{n(x)} = U[w(x)+y,0] - U[b(x)+y,1] \\ + \lambda\Big\{f_1[n(x),x] - w(x) + b(x)\Big\} - \theta(x) = 0 \tag{3′}$$

$$L_{w(x)} = n(x)U_1[w(x)+y,0] - \lambda n(x) = 0 \tag{4′}$$

$$L_{b(x)} = [1-n(x)]U_1[b(x)+y,1] - \lambda[1-n(x)] = 0 \tag{5′}$$

plus the constraints $E\pi = 0$ and $n(x) \leq 1$, and the condition $n(x) < 1 \Rightarrow \theta(x) = 0$. Observe that, except for the resource constraint, these look rather similar to the first order conditions from the previous section.

Equations (4′) and (5′) together imply the efficient risk sharing conditions for the implicit contract economy

$$U_1[w(x)+y,0] = U_1[b(x)+y,1] = \lambda \;\; \forall x \tag{6′}$$

(compare with 6). This indicates not only that the marginal utility of consumption is to be equated across employment status within each state, but also that the marginal utility of consumption is constant across states (since λ does not depend on x). An immediate implication is that income and consumption are state independent,

$$w(x) = w_0 \text{ and } b(x) = b_0 \ \forall x.$$

Although in some sense workers face less uncertainty in this economy, risk must be allocated efficiently across employment status within each state both here and in the economy studied in previous section.

Indivisible hours, while probably the most straightforward, is not the only possible reason for unemployment in these models. Other explanations that have been considered include a technology that depends on men and hours as separate arguments, a fixed cost per employee (say, a payroll head tax), a fixed cost to working (say, transportation), or certain institutional features of the unemployment insurance (UI) system.[9] Generalize the model so that now labor input is given by $\ell = \ell(n,h)$, assume f_0 is a fixed cost per employee, and d_0 is a fixed cost of getting to work. Further assume UI takes the following form. Benefits $G^i(x)$ are paid to worker i in state x according to the discontinuous schedule

$$G^i(x) = \begin{cases} g & \text{if } h^i(x) = 0 \\ 0 & \text{if } h^i(x) > 0 \end{cases}$$

where $g > 0$. Total benefits paid out in state x are $g[1-n(x)]$. Firms pay taxes according to the schedule

$$T(x) = eg[1-n(x)] + t(x)$$

where e indexes the degree of "experience rating" and $t(x)$ is a lump sum but possibly state dependent tax.[10] Even if we allow hours to vary, we can guarantee there will be some unemployment in equilibrium if we make f_0, d_0, or $(1-e)g$ large (the proof follows the arguments in Burdett and Wright, 1986).[11]

Now $V(x)$ is given by

$$V(x) = n(x)U[c_e(x), 1-h(x)] + [1-n(x)]U[c_u(x), 1]$$

where $c_e(x) = y + w(x)h(x) - d_0$ and $c_u(x) = y + b(x) + g$, while $\pi(x)$ is given by

$$\pi(x) = k + f[\ell(x), x] - f_0 - n(x)h(x)w(x) - [1-n(x)]b(x) - T(x).$$

An allocation is now defined to be a list, $[n(x), h(x), c_e(x), c_u(x)]$. Equilibrium allocations for the representative agent economy can be found as solutions to

$$\text{(7)} \qquad \max EV \text{ st } \pi(x) = 0 \ \forall x,$$

while equilibrium allocations for the contract economy can be found as solutions to

$$\text{(7')} \qquad \max EV \text{ st } E\pi = 0,$$

(also subject to $n(x)\in[0,1]$ and $h(x)\in[0,1]$ $\forall x$, of course).

Among the conditions characterizing solutions to (7) is (6), and among the conditions characterizing solutions to (7′) is (6′). We conclude, then, that whatever the origin of unemployment, risk should always be allocated efficiently at least within each state. Therefore in what follows we will concentrate exclusively on models with the indivisible hours assumption. We will, however, attempt to display some interesting differences and similarities between the representative agent and contract economies.

IV. The Nature of Unemployment

Consider first the general additively separable utility function,

$$U(c,1-h) = \alpha(c) + \beta(1-h),$$

where α and β are functions satisfying $\alpha' > 0$, $\alpha'' < 0$, $\beta' > 0$, $\beta'' < 0$. It is immediate that the efficient risk sharing conditions — (6) for the representative agent economy, (6') for the contract economy — now imply $\alpha'[w(x)+y] = \alpha'[b(x)+y]$, and thus $w(x) = b(x) \equiv c(x)\ \forall x$.[12] Now

$$U[c(x)+y,0] = \alpha[c(x)+y] + \beta(0)$$
$$< \alpha[c(x)+y] + \beta(1) = U[c(x)+y,1]$$

as long as leisure yields some utility, so the unemployed are unambiguously better off than the employed in all states. More generally, as long as $U_{12} \geq 0$ we have

$$U_1[w(x)+y,1] \geq U_1[w(x)+y,0] = U_1[b(x)+y,1],$$

which implies $w(x) \leq b(x)$ and therefore the unemployed are better off.

Conversely, $U_{12} < 0$ implies $w(x) > b(x)$ and the employed have a chance of being better off; in other words, $U_{12} < 0$ is a necessary but not sufficient condition for employment to be the preferred status. Another way to see this is to observe that the efficient employment conditions — (3) for the representative agent and (3') for the contract economy — imply

$$U[b(x)+y,1] - U[w(x)+y,0] = \lambda(x)\left\{f_1[n(x),x] - w(x) + b(x)\right\},$$

as long as $n(x) < 1$. This simply equates the cost in lost utility to the benefit in terms of utility from employing a marginal worker. In order for the employed to have more utility than the unemployed, the term in braces must be negative, which means

$$w(x) - b(x) > f_1[n(x),x].$$

Not only must workers receive extra consumption to make them prefer employment, but their extra consumption must exceed their marginal product.

Consider the utility function

$$U(c,1-h) = \varphi[c + \eta(1-h)] + a_0 c + a_1(1-h),$$

where a_0 and a_1 are non-negative constants while φ and η are functions satisfying $\varphi' > 0$, $\varphi'' < 0$, $\eta' > 0$, and $\eta'' \leq 0$. It is easy to check U is strictly increasing, concave, strictly concave in c, and strictly concave in (c,1-h) jointly if $\eta'' < 0$. Now the efficient risk sharing conditions imply

$$\varphi'[w(x) + y + \eta(0)] + a_0 = \varphi'[b(x) + y + \eta(1)] + a_0.$$

Thus, $w(x) + \eta(0) = b(x) + \eta(1)$, and $w(x) > b(x)\ \forall x$. Total utility levels are

$$U[w(x)+y,0] = \varphi[w(x) + y + \eta(0)] + a_0[w(x) + y]$$

$$\begin{aligned} U[b(x)+y,1] &= \varphi[b(x) + y + \eta(1)] + a_0[b(x) + y] + a_1 \\ &= \varphi[w(x) + y + \eta(0)] + a_0[w(x) + y + \eta(0) - \eta(1)] + a_1. \end{aligned}$$

The employed are therefore better off if and only if $a_0[\eta(1) - \eta(0)] = a_0[w(x) - b(x)]$ exceeds a_1 (which we can guarantee by setting $a_0 > 0 = a_1$), meaning their extra consumption is worth more to them than their loss in leisure.[13]

We now demonstrate that there can exist equilibria with these preferences and $n(x) < 1$. To keep things simple, assume x is degenerate so that the implicit contract and representative agent models collapse to the same economy, and write $n = n(x)$, $w = w(x)$, etc. Set $a_0 > 0$ and $a_1 = 0$ (so any unemployed will definitely be worse off) and set $y = 0$. Now suppose that in equilibrium $n = 1$; then consumption is given by $w = f(1)$ and utility by

$$V = \varphi[f(1) + \eta(0)] + a_0 f(1).$$

The alternative allocation that sets $n = n^* < 1$ and $w = b = f(n^*)$ yields expected utility

$$\begin{aligned} V^* &= n^*\varphi[f(n^*) + \eta(0)] + (1-n^*)\varphi[f(n^*) + \eta(1)] + a_0 f(n^*) \\ &> \varphi[f(n^*) + \eta(0)] + a_0 f(n^*) \end{aligned}$$

By continuity, there exists some $n^* < 1$ such that the right hand side is arbitrarily close to V. Hence we can choose $n^* < 1$ so that $V^* > V$, contradicting the hypothesis $n = 1$. We conclude there can be strictly positive unemployment with the unemployed strictly worse off.

Another way to think about the issue is suggested by the following argument. In certain economies where unemployment insurance is very generous (like the Scandinavian countries, for example), it is sometimes said that the system does not get exploited as much as an outsider might expect because of a "social stigma" attached to unemployment. That is, being gainfully employed carries with it some measure of prestige, while being on the dole is considered to be in bad taste. A similar argument is that having a job may carry with it a psychological reward that comes from being part of a team, fraternizing with one's co-workers, or simply getting out of the house.[14] No less a thinker on the topic than Phelps (1985) has put it this way: "Even a 100 percent replacement of lost income could not replace the loss of self-esteem that results from losing one's job." (p. 478).

A simple specification reflecting this idea is given by the state dependent (really, employment status dependent) utility function

$$U(c,1-h) = \begin{cases} U^e(c,1-h) = \alpha(c) + \beta(1-h) & \text{if } h > 0 \\ U^u(c,1-h) = \alpha(c) + \beta(1) - \sigma & \text{if } h = 0 \end{cases}$$

where σ represents the disutility due to the stigma of being unemployed.[15] Efficient risk sharing implies $\alpha'[w(x)+y] = \alpha'[b(x)+y]$ and thus $w(x) = b(x) = c(x)\ \forall x$ (Phelps' extreme case of 100 percent income replacement). Comparing total utilities,

$$U^e[c(x)+y,1] - U^u[c(x)+y,0] = \beta(0) - \beta(1) + \sigma,$$

and the employed are better off just in case the social stigma exceeds the value of leisure. But if this is true we will never have unemployment in equilibrium. For suppose that $n(x) < 1$; as long as $f_1 \geq 0$, $n(x) = 1$ is both feasible and preferable, since the unemployed would be willing to forgo their leisure to avoid the stigma with no change in their consumption.[16]

Therefore a non-vacuous example of the social stigma effect must involve the unemployed wishing to trade consumption-leisure bundles with the employed, but not wishing to accept work without an increase in their income. It must be a combination of the loss in status plus the loss in income that makes unemployment undesirable for the individual while at the same time efficient for the economy — and not merely the loss in status as Phelps suggested. For a simple example, let

$$U(c,1-h) = \begin{cases} U^e(c,1-h) = \varphi[c+\eta(1-h)] & \text{if } h > 0 \\ U^u(c,1-h) = \varphi[c+\eta(1)] - \sigma & \text{if } h = 0 \end{cases}$$

Efficient risk sharing implies $w(x) + \eta(0) = b(x) + \eta(1)$, so

$$U^e[b(x)+y,1] - U^u[w(x)+y,0] = \sigma$$

and the unemployed are worse off by exactly the stigma. It is easy to construct an equilibrium with $n(x) < 1$, along the lines of the example given earlier. In this case laid off individuals would like to trade places with those who remain employed but not without trading incomes.

IV. A General Result

In this section we provide the following general characterization: in either the representative agent or the implicit contract economy with efficient risk sharing, the employed have greater utility than the unemployed in equilibrium if and only if an increase in exogenous income entails a reduction in the probability of unemployment (equivalently, an increase in the number of employed workers). In other words, employment is the preferred status if and only if employment is a normal good. One thing that was surprising (at least to us) is the similarity between the results for the two models. In what follows, we use the notation

$$X_u = \{x: n(x) < 1\} \text{ and } X_e = \{x: n(x) = 1\}$$

to denote the subset of X in which there is positive unemployment and the subset in which there is full employment, respectively.

Considering the representative agent model first, notice that it is legitimate to analyze this economy as a separate system for each x, since the equilibrium conditions must hold in every state and there is nothing tying the states together (this will not be true in the contract model). To begin, clearly $\forall x \in X_e$ a small change in y does not change employment, $n(x) = 1$, or income, $w(x) = f(1,x)$, and therefore consumption changes by exactly the change in y, $\partial(w+y)/\partial y = 1$ (assuming x is not a marginal state so that employment does not fall from 1 to $n < 1$). On the other hand, $\forall x \in X_u$ we know that $\theta(x) = 0$, and by eliminating $\lambda(x)$ from the first order conditions we can conveniently summarize the equilibrium allocation by

$$f_1[n(x),x] - w(x) + b(x) + \frac{U[w(x)+y,0] - U[b(x)+y,1]}{U_1[w(x)+y,0]} = 0.$$

$$(8) \qquad U_1[w(x)+y,0] - U_1[b(x)+y,1] = 0$$

$$f[n(x),x] - n(x)w(x) - [1-n(x)]b(x) = 0$$

Since equations (8) must hold whenever there is unemployment, choose any fixed $x_0 \in X_u$ and write $[n,w,b]$ for $[n(x_0),w(x_0),b(x_0)]$. Totally differentiating, after some simplification using the first order conditions, we have

$$f_{11}dn - \lambda^{-2}(U^e-U^u)U^e_{11}dw + \lambda^{-2}(U^e-U^u)U^e_{11}dy = 0.$$

$$(9) \qquad U^e_{11}dw - U^u_{11}db + (U^e-U^u)dy = 0$$

$$\lambda^{-1}(U^e-U^u)dn - ndw - (1-n)db = 0$$

To save space we have replaced $U_1(w+y,0) = U_1(b+y,1)$ by λ and used the superscripts e and u to indicate that the utility function is being evaluated at the points $(w+y,0)$ and $(b+y,1)$, respectively. Solving this system, we arrive at the following results (reporting the effects on consumption, $w+y$ and $b+y$, rather than income),

$$\partial n/\partial y = \Delta^{-1}\lambda^{-2}U^e_{11}U^u_{11}(U^e-U^u)f^{-1}_{11}$$

$$(10) \qquad \partial(w+y)/\partial y = \Delta^{-1}U^u_{11}$$

$$\partial(b+y)/\partial y = \Delta^{-1}U^e_{11}$$

where

$$\Delta = \lambda^{-3}(U^e-U^u)^2U^e_{11}U^u_{11}f^{-1}_{11} + nU^u_{11} + (1-n)U^e_{11} < 0$$

(by our concavity assumptions).

Before interpreting these results we derive analogous expressions for the contract economy. Again, $\forall x \in X_e$ a small change in y does not change $n(x) = 1$, but the other results are not discerned so easily. The analysis of the contract economy is made more difficult by the fact that we cannot consider the effects for each x individually, since all states are tied together by the equation $E\pi = 0$. Recalling $w(x) = w_0$ and $b(x) = b_0$ $\forall x$ and eliminating λ, the equilibrium allocation is summarized by

$$
(8') \quad
\begin{aligned}
& f_1[n(x),x] - w_0 + b_0 + \frac{U(w_0+y,0) - U(b_0+y,1)}{U_1(w_0+y,0)} = 0 \quad \forall x \in X_u \\
& f_1(1,x) - w_0 + b_0 + \frac{U(w_0+y,0) - U(b_0+y,1)}{U_1(w_0+y,0)} = \theta(x) \quad \forall x \in X_e \\
& U_1(w_0+y,0) - U_1(b_0+y,1) = 0 \quad \forall x \\
& \int_X \left\{k + f[n(x),x] - n(x)w_0 - [1-n(x)]b_0\right\} dF(x) = 0
\end{aligned}
$$

Totally differentiating these (under the integral in the last equation), after some simplification we find

$$
(9') \quad
\begin{aligned}
& f_{11} dn(x) - \lambda^{-2}(U^e - U^u)U^e_{11} dw_0 - \lambda^{-2}(U^e - U^u)U^e_{11} dy = 0 \quad \forall x \in X_u \\
& \lambda^{-2}(U^e - U^u)U^e_{11} dw_0 + \lambda^{-2}(U^e - U^u)U^e_{11} dy - d\theta(x) = 0 \quad \forall x \in X_e \\
& U^e_{11} dw_0 - U^u_{11} db_0 + (U^e_{11} - U^u_{11})dy = 0 \quad \forall x \\
& \lambda^{-1}(U^e - U^u)\int_{X_u} [dn(x)]dF(x) + En\,dw_0 + (1-En)db_0 = 0
\end{aligned}
$$

where $En = \int n(x)dF(x)$. Now we can substitute $dn(x)$ from the first into the fourth equation and integrate out $dn(x)$. Solving the resulting system entails

$$\partial n(x)/\partial y = (E\Delta)^{-1}\lambda^{-2}(U^e-U^u)U^e_{11}U^u_{11}f^{-1}_{11} \quad \forall x\in X_u$$

$$(10') \qquad \partial(w_0+y)/\partial y = (E\Delta)^{-1}U^u_{11}$$

$$\partial(b_0+y)/\partial y = (E\Delta)^{-1}U^e_{11}$$

where $E\Delta < 0$ is the integral of Δ,

$$E\Delta = \lambda^{-3}(U^e-U^u)^2U^e_{11}U^u_{11}\cdot\int_{X_u} f_{11}[n(x),x]^{-1}dF(x) + EnU^u_{11} + (1-En)U^e_{11}.$$

Comparing (10) and (10′), we see that the results for the two models are qualitatively (but, obviously, not necessarily quantitatively) quite similar. In either case, the net consumptions of both employed and unemployed agents are unambiguously normal — $w+y$ and $b+y$ necessarily rise with an increase in y (although w or b could fall). Also, $\text{sign}(\partial n/\partial y) = \text{sign}(U^e-U^u)$. This allows us to conclude that (the probability of) employment increases with an exogenous increase in endowment income if and only if employment is the preferred status. This makes good sense — when unemployment is bad, wealthier economies will have less of it. But we have seen that for many specifications (including any for which $U_{12} \geq 0$) unemployed workers are better off, and so these economies will reduce employment when wealth increases. We wish to emphasize, however, that this does <u>not</u> imply that periods of high unemployment are associated with good economic times, and it is to this issue that we now turn.

To simplify the presentation, let us assume $[n(x),w(x),b(x)]$ is differentiable with respect to x. For the representative agent economy, $\forall x\in X_e$ $n'(x) = 0$ and $w'(x) = f_2(1,x)$. For $x\in X_u$, differentiating the equations in (8) and solving we derive the following results:

$$n'(x) = \Delta^{-1}\lambda^{-2}(U^e - U^u)U^e_{11}U^u_{11}f^{-1}_{11}\cdot f_2 - \Delta^{-1}\left[nU^u_{11} + (1-n)U^e_{11}\right]f^{-1}_{11}\cdot f_{12}$$

$$w'(x) = \Delta^{-1}U^u_{11}\cdot f_2 + \Delta^{-1}\lambda^{-1}(U^e - U^u)U^u_{11}f^{-1}_{11}\cdot f_{12}$$

$$b'(x) = \Delta^{-1}U^e_{11}\cdot f_2 + \Delta^{-1}\lambda^{-1}(U^e - U^u)U^e_{11}f^{-1}_{11}\cdot f_{12}$$

In each case, the net effect is the sum of the income effect derived in (10) multiplied by f_2, plus a substitution effect multiplied by f_{12}. We know that the income effect on employment has the same sign as $(U^e - U^u)$, and we now see that the substitution effect is unambiguously positive. We know that the income effect on w and b is positive, but now the substitution effect depends on $(U^e - U^u)$ (leaving the net effect ambiguous).

Summarizing the results for $x \in X_u$ in the representative agent economy:[17]

$$U^e > U^u \Rightarrow n' > 0,\ w'\ ?,\ b'\ ?$$

$$U^e < U^u \Rightarrow n'\ ?,\ w' > 0,\ b' > 0$$

$$U^e = U^u \Rightarrow n' > 0,\ w' > 0,\ b' > 0$$

In the implicit contract economy, different realizations of x do not have wealth effects — they have been insured away. This makes the analysis simple. Since $w(x) = w_0$ and $b(x) = b_0$ $\forall x$, $w'(x) = b'(x) = 0$. Obviously $\forall x \in X_e$ $n'(x) = 0$, while $\forall x \in X_u$ differentiation of the first equation in (8′) immediately yields

$$n'(x) = -f^{-1}_{11}\cdot f_{12} > 0.$$

Introducing a risk neutral agent not only smooths worker income, but by eliminating the wealth effect also guarantees that employment (and therefore output) fluctuates positively with x.[18]

We can now investigate how welfare depends on the state. Let the utility of employed and unemployed workers in state $x \in X_u$ be

$$V_e(x) = U[w(x)+y,0] \text{ and } V_u(x) = U[b(x)+y,1],$$

respectively. For $x \in X_e$, $V_e(x) = U[f(1,x)+y,0]$ and $V_u(x)$ is undefined. Also, let

$$V(x) = n(x)V_e(x) + [1-n(x)]V_u(x)$$

be the average level of utility in the economy in state x. This is also the expected utility of any given worker before the lottery is held — that is, before it is revealed which of the workers will be randomly laid off.

In the representative agent model, $\forall x \in X_u$ we have

$$V_e'(x) = U_1 w'(x) \text{ and } V_u'(x) = U_1 b'(x).$$

These expressions are ambiguous in general but positive if $U^e < U^u$ (since then w′ and b′ are positive), and in any case necessarily take the same sign. After a little simplification, we find that $\forall x$

$$V'(x) = \lambda f_2$$

is unambiguously positive, so that higher realizations of x are always accompanied by a higher average level of utility.[19] The point we wish to emphasize is that even if the unemployed have greater utility than the employed in a given state, this does not mean that utility will be higher in states with higher unemployment rates.

For the contract economy, on the other hand, $V_e = U(w_0+y,0)$ and $V_u = U(b_0+y,1)$ are state independent, while $\forall x \in X_u$

$$V'(x) = (U^e - U^u)n'(x).$$

Since $n' > 0$, workers prefer higher realizations of x if and only if $U^e > U^u$, which we have shown to be true if and only if $\partial n/\partial y > 0$.[20] If unemployment is the preferred status then workers are happier when unemployment is higher in the contract economy. However, recalling the risk neutral agent's welfare is given by $\pi(x) = k + f[n(x),x] - n(x)w_0 - [1-n(x)]b_0$, we see that $\forall x \in X_u$

$$\begin{aligned}\pi'(x) &= f_2 + [f_1 - w_0 + b_0]n'(x) \\ &= f_2 - \lambda^{-1}(U^e - U^u)n'(x)\end{aligned}$$

Combining this with V' we find

$$V'(x) = \lambda f_2 - \lambda \pi'(x)$$

(compare with $V' = \lambda f_2$ in the representative agent model). This tells us that either the risk neutral agent or the representative worker (or both) will necessarily be better off when x is higher — that is, when employment is higher — in the contract economy.[21]

VI. Summary and Conclusions

We have investigated the nature of unemployment in economies with efficient risk sharing, providing examples of preference specifications that imply the unemployed are worse off in equilibrium than their employed colleagues, and constructing an example where equilibrium unemployment is strictly between 0 and 1. We have analyzed the effects of productivity shocks on the allocation and on welfare, and discussed the similarities and differences between the representative agent and implicit contract versions of the model. We also verified the following general result: the unemployed are worse off if and only if an increase in exogenous income entails an increase in equilibrium employment.[22] For employment to be the preferred status it must be the case that unemployment is an inferior good. Now this is not quite the same thing as saying leisure is an inferior good — our example of the social stigma effect has $U^e > U^u$, and therefore $\partial n/\partial y > 0$, but when hours are allowed to vary it is easily verified that h is independent of y — although it seems close. Whether it is "close enough" to be considered an untenable property of the model is perhaps a matter of opinion.

Some other approaches can be related to this study. For example, the original Azariadis (1975) implicit contract model (and several later versions) arbitrarily ruled out payments to unemployed agents — that is, imposed $b(x) \equiv 0$. With this ad hoc restriction in place, efficient risk sharing across employment status is not possible in general. This makes it more likely that the unemployed will be worse off, and also distorts the employment decision (predictably implying too few layoffs). Models analyzed by Kahn (1985), by Moore (1985), and by Ito with a variety of co-authors (see Ito 1986 and the references contained therein) all assume laid off workers have access to a stochastic opportunity, the outcome of which is private information. This endogenously precludes the efficient allocation of risk.

For example, in one version retained workers receive $u(w)$ while those laid off receive $u(b+r)$, where r is a random variable. Efficient (first best) risk sharing would imply that $u'(w) = u'(b+r)$, and thus $w = b+r$ with probability 1. But since r is not observed by all agents this cannot be implemented — laid off workers would always report the worst possible realization. Ito (1986, Proposition 4.1) demonstrates that the second best outcome has the property that the utility of retained workers is greater than (lower than, the same as) the expected utility of laid off workers if and only if absolute risk aversion is increasing (decreasing, constant). However, in these models leisure typically does not enter the utility function (in Moore's model it enters as a perfect substitute for consumption). Thus, the issue we are concerned with here — whether U_{12} is negative and large enough to imply that the extra income of the employed more than makes up for their loss in leisure — does not really arise.

Of course there are some quite different theories. Efficiency wage models require the unemployed to be worse off because the threat of unemployment is used to discourage workers from "shirking" without monitoring their behavior. These models do not consider risk sharing among workers (who end up being fired essentially randomly in equilibrium). Whether the results will stand up in a general equilibrium context or whether they require ruling out efficient insurance has yet to be seen. In Wright (forthcoming), public unemployment insurance is analyzed as the majority voting equilibrium of a dynamic economy. In that model, the equilibrium UI system can provide incomplete coverage because the median voter (assuming he is employed) can benefit from compensation only in the uncertain future, while he must pay taxes to finance the system today. He will still vote for some insurance if he is sufficiently risk averse but is never willing to accept complete coverage (recall Arrow's 1971 theorem that even very risk averse agents will always take some part of a favorable bet). Hence, in equilibrium agents who suffer layoffs are worse off. Risk sharing is inefficient in this economy because of a political decision, based on redistribution between the employed and unemployed.

While it is obviously possible to have the unemployed worse off in equilibrium when insurance is incomplete, our goal here has been to accomplish this in an economy with first best risk sharing. Rosen (1985) discussed a contract model in which $U(c,1-h) = \varphi[c + m\cdot(1-h)]$, a special case of our utility function with, in his words, "the undesirable prediction that laid off workers fare no worse than employed workers." This led him to conclude that "Therefore incomplete insurance, or more generally some incompleteness in state contingent claims markets, is necessary to get involuntary layoffs into these models." (p. 1154). This is clearly not the case when more general preferences are allowed. Whether the employed or unemployed are better off in equilibria with efficient risk sharing will depend critically on the nature of their utility functions, and is connected in fundamental ways to both the wealth and substitution effects in the economy.

Footnotes

1. Feldstein (1978) provides a representative calculation showing that the net loss in income can be quite small, and thus easily outweighed by the value of leisure, when unemployed. This seems is more likely to be true for workers on temporary layoffs, and unemployment in the models mentioned above is of this variety, in the sense that both retained and laid off agents have an equal chance of employment next period. Frictional (serially correlated) unemployment is not included in those models (but see Greenwood and Huffman 1986, and Grilli and Rogerson 1986).

2. We will try to refrain (as much as possible) from referring to the case where the unemployed enjoy less utility than the employed as "involuntary unemployment," as several authors have done in the past in similar models. Lucas (1977) argues that the profession's preoccupation with this value-laden terminology has hurt more than it has helped our understanding of economic phenomena; an opposing view is provided by Solow (1980), who contends "What looks like involuntary unemployment is involuntary unemployment."

2a. Recently, Greenwood and Huffman (1986) have also provided an example (quite different from ours) where the employed can be better off than the unemployed in an equilibrium with efficient risk sharing. Our analysis differs from theirs in several respects, including our general characterization in terms of income effects, our analysis of the similarities and differences between the representative agent and implicit contract models, and our demonstration that even if unemployment is preferred to employment by individuals this does not mean that an increase in the aggregate unemployment rate increases welfare.

3. More generally, we could represent labor input by $\ell = \ell(n,h)$, so that increasing the number of men at a given level of hours per worker does not necessarily have the same implications as increasing hours for a fixed number of men. We will return to this in Section III.

4. We wish to emphasize that these facts do not (of course) violate the fundamental theorems of welfare economics. Competitive equilibria without lotteries generate Pareto optimal outcomes within the set of non-randomized allocations.

5. This mechanism can be used in a variety of situations. As an extreme example, (at least according to a recent Penthouse magazine) prisoners in overcrowded Brazilian jails have recently taken to holding lotteries in which the "winners" are executed, leaving more room for those who remain. Presumably there is some non-convexity here, probably in preferences (e.g. a chance at a single cell is preferred to the certain prospect of roommates). On the other hand, consider the following story (attributed to Aumann): M pilots make M bombing runs, each with a casualty rate ρ. If only enough fuel for a one way trip was carried the casualty rate would be 1, but since more bombs could be carried, it would be necessary to fly only $N < M$ missions. If the pilots were chosen randomly, the effective casualty rate would be N/M. Although N/M was reported to be less than ρ, lotteries were not considered appropriate in this case.

6. A few comments on this notion of an allocation: The individual probability of employment will equal the number of agents actually employed — hence the notation $n(x)$ — by a version of the law of large numbers (see Judd 1986), and $1 - n(x)$ will equal the number of agents unemployed. Next, since $h(x) \equiv 1$ for all employed workers, $w(x)$ is the contract wage (but not the market wage — see Wright 1986). Finally, $b(x)$ is sometimes referred to as a severance payment.

7. The dual problem is

$$\max E\pi \text{ st } EV \geq V_0. \tag{1"}$$

As we vary V_0 we trace out exactly the same contract curve; however, for investigating the impact of exogenous changes it can matter which problem we solve. For instance, a change in exogenous income will generally change worker consumption and employment in the solution to problem (1′), via a wealth effect, but will have no impact whatsoever on workers in the solution to the dual problem (1"). The change in wealth is completely captured by the risk neutral agent. More generally, comparative static results on the solution to (1") involve no income effects. This is what leads Burdett and Hool (1983), for example, to different predictions about the impact of unemployment insurance, depending on which problem they solve.

8. The equivalence between contract equilibria and competitive market equilibria was first suggested by Barro (1977) and is emphasized in Wright (1986). It is the addition of a risk neutral agent that distinguishes what we call the implicit contract economy from the representative agent economy, and not the mechanism by which trades take place.

9. Feldstein (1976), Baily (1977), Mortensen (1978), Rosen (1985), Bernanke (1986), and Burdett and Wright (1986) each consider one or more of these effects. Other possible ways of getting unemployment into the model include non-concave utility and a job search technology that is less efficient while employed. Note that a necessary condition for unemployment to result from entering n and h as separate arguments in $\ell = \ell(n,h)$ is that an increase in n keeping $n \cdot h$ constant must reduce ℓ. Hence, a sufficient condition for $n = 1$ would be that every "isoquant" $\ell(n,h) = \ell_0$ has a slope at least as steep (pointwise) in (n,h) space as a rectangular hyperbola, which is the isoquant in our special case $\ell = n \cdot h$.

10. The UI system budget is in balance if $t(x) = (1-e)g[1-n(x)]\ \forall x$. Note that also taxing earned income and UI benefits, but at different rates, is another way to get unemployment into the model.

11. Typically in models with divisible hours, either the extensive or intensive margins are used, but not both at the same time. Thus, in high productivity states there will be full employment and hours per worker will vary, while in low productivity states layoffs will occur and hours per worker will remain constant at some minimum level h_0

(see Baily 1977, Mortensen 1978, and Burdett and Wright 1986). It could be the case that layoffs occur with probability 1, so $h(x) = h_0$ $\forall x$. In this case, the equilibrium behavior of the model is observationally indistinguishable from that of an economy with $h(x)$ indivisible and fixed at h_0. However, exogenous changes in the environment will typically change h_0 in the convex economy, and obviously will not in the other.

12. The constraints imply that in the representative agent economy $c(x) = f[n(x),x]$ $\forall x$, while in the implicit contract economy $c(x) = c_0 = Ef[n(x),x]$ $\forall x$. In his survey paper, Azariadis (1981) seems to get this wrong: he claims severance payments should be set to equate total rather than marginal utility (p. 231). However, this does not affect the bulk of his analysis, which proceeds under the restriction that severance payments are zero.

13. The idea for these preferences originated as follows. The utility function

$$U(c,1-h) = \phi[c + m\cdot(1-h)],$$

which is a special case of ours with $a_0 = a_1 = 0$ and $\eta(1-h) = m\cdot(1-h)$ for some $m > 0$, has been used in the past to model unemployment without introducing non-convexities (see Rosen 1985). It works because, in this special case, equating marginal utility is equivalent to equating total utility across employment status, so agents are indifferent between employment or layoffs or worksharing. We have simply perturbed these preferences by introducing the linear terms.

14. On the other hand, in economies where it is sometimes said that the UI system does get exploited (like Britain), it may be the case that fraternizing with one's mates, etc., is made easier by being unemployed.

15. This utility function is concave, and it is strictly increasing in the interior of the consumption set, consistent with the assumptions in Section II. It is not increasing at $h = 0$, since working any positive amount entails a discrete increase in utility when compared to unemployment; this seems an inescapable feature of the social stigma effect, and the same comments apply to the next specification. Note that the social stigma here is similar to the psychic disutility involved in changing jobs or sectors that was used in a dynamic model in Rogerson (1985a).

16. Another way to prove this is to recall that (assuming that $n < 1$) employed workers are better off if and only if $w - b$ exceeds f', and since separability implies $w = b$, this would require $f' < 0$. This means that it is not possible to modify existing models, like Hansen's version of the Kydland-Prescott model, simply by adding the social stigma effect to the additively separable specification. While this would leave the unemployed worse off, it turns out that it leaves no unemployment.

17. It is possible to have employment and therefore output rise while both w and b fall. This can occur if $w > b$, when the increase in output has to be distributed among a larger group of employed workers.

18. This point has been emphasized recently by Rosen (1985) and by Rogerson (1986). On the other hand DeLong and Summers (1984) suggest "it is possible to demonstrate in a variety of implicit contracting models that because of worker's desire for insurance, employment is more stable than it would be if a Walrasian equilibrium were attained every period." (p. 43). This is hard to understand since, given the same underlying environment, the mechanism studied in implicit contract theory generates <u>the same</u> allocation as the competitive mechanism. If what is meant is that the environment studied in implicit contract models (including a risk neutral agent) is different from that studied in representative agent models, then the suggestion is even harder to understand, since in the contract economy the ambiguous wealth effect has been eliminated and this might lead us to expect that employment will be <u>more</u>, not less, responsive to productivity shocks.

19. It is possible for a higher value of x to result in a decrease in both V_e and V_u while V increases, as long as the employment rate increases (and a decrease in V_u or V_e is only possible if $U^e > U^u$, which guarantees $n(x)$ is increasing).

20. This is reminescent of a result in implicit contract models with divisible hours (and, hence, full employment): workers prefer higher realizations of x if and only if an increase in exogenous income leads to an increase in hours per worker — that is, if and only if leisure is non-normal (see, e.g., Rosen 1985). In asymmetric information models, whether leisure is normal or not also has important implications for whether there is overemployment or underemployment; see Chari 1983, Green and Kahn 1983, and Cooper 1983.

21. Notice that our definition of $\pi(x)$ does not correspond to profit in the standard sense of market analysis; that is increasing in x. Also, note that it should be clear somebody's utility will be higher when x is higher, since the production possibility set defined by $f(\cdot,x)$ is contained in the set defined by $f(\cdot,x')$ whenever $x' > x$.

22. The following extension of this result has recently been discovered: in an economy with indivisible hours where layoff unemployment can result because of a discontinuity in the UI benefit schedule (as described in Section III), $U^e > U^u$ if and only if an increase in exogenous income results in a reduction in $\ell = n \cdot h$ (see Wright and Hotchkiss).

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