LABOR CONTRACTS, UNEMPLOYMENT INSURANCE, AND EFFICIENCY

by

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Submitted to the Department of
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ABSTRACT

A model of labor market equilibrium is developed in which private contracting is unconstrained by information or enforcement problems. With Pareto-efficient contracts between firm and worker, it is still possible, indeed likely, that the market equilibrium will not be first best. The cause of this inefficiency is analyzed. It is then shown that an unemployment insurance system which is imperfectly experience rated (i.e., the tax which a firm pays is less than the benefits its workers receive) can result in a partial welfare improvement.

A model of a single firm is then developed to analyze the effect on labor contracts of certain restrictions on private contracting. This has two implications regarding public UI. First, the possibility that UI can improve labor market performance is expanded because of these limitations on private contracts. In addition, the exact manner in which the parameters of the UI system will affect the behavior of firms and workers depends crucially on the private contracts which are negotiated. Since some aspects of UI are perfect substitutes for private employment payments, and vice versa, the ability of firm and worker to negotiate these payments will determine the channels through which the public UI parameters affect the labor market.

It is shown that the presence of informational or other constraints which limit the ability of the firm and worker to set private unemployment payments has distinct implications for the response of the firm's layoff behavior to changes in the UI parameters. These differing responses can be distinguished by the value of a key parameters. The estimation of this parameter provides information on the ability of labor contracts to optimally set private unemployment payments. The results suggest that some constraint (informational or otherwise) prevents contracts from setting private unemployment payments as large as those which would prevail were first-best contracts feasible.

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INTRODUCTION

The existence of public unemployment insurance (UI) provides the government with a set of policy tools to effect improvements in economic performance. UI has its greatest impact on the labor makret. This fact combined with the presence of other, more suitable instruments to affect the distribution of income and macroeconomic fluctuations, implies that concentration on the role which UI can play in improving labor market performance is a logical first step. There are two facets of the labor market given market imperfections which preclude workers from borrowing against and/or insuring their future earnings. Both the allocations of labor and risk must be considered in any discussion of optimal UI.

Related to an investigation into the aspects of optimal UI is an analysis of the channels through which the UI system affects labor market behavior. To determine the features of optimal UI requires an understanding of how the labor market operates. Specifying the channels through which UI affects this market also requires developing a model which captures the salient characteristics of the labor market. Thus, the effects which UI can have (from the perspective of improving welfare) and the effects which UI does have (from a purely descriptive point of view) will both depend upon how, and how well, the labor market works. This provides the motivation for the present study.

The first chapter develops a model of labor market

equilibrium in which private contracting is unconstrained by information or enforcement problems. With Pareto-efficient contracts between firm and worker, it is still possible, indeed likely, that the market equilibrium will not be first best. The cause of this inefficiency is analyzed. It is then shown that an unemployment insurance system which is imperfectly experience rated (i.e., the tax which a firm pays is less than the benefits its workers receive) can result in a partial welfare improvement.

A model of a single firm is developed in chapter two to analyze the effect on contract and the implications for public UI when there are certain restrictions on private contracting. In this partial equilibrium setting, the provisions which can be written into the contract attempt to optimally offset the presence of these restrictions. This has two implications regarding public UI. First, the possibility that UI can improve labor market performance is expanded because of these limitations on private contracts. In addition, the exact manner in which the parameters of the UI system will affect the behavior of firms and workers depends crucially on the private contracts which are negotiated. Since some aspects of UI are perfect substitutes for private employment payments, and vice versa, the ability of firm and worker to negotiate these payments will determine the channels through which the public UI parameters affect the labor market.

In chapter three a simpler version of the partial equilibrium model from chapter two is analyzed to derive

implications regarding the interaction of public UI and private labor contracts which are then tested empirically. It is shown that the presence of constraints on the ability of the firm and worker to set private unemployment payments has distinct implications for the response of the firm's layoff behavior to changes in the UI parameters. There are two cases. Asymmetric information may result in contracts which are unable to set a private payment as high as that which would prevail in a first-best contract. On the other hand, enforcement or institutional constraints may prevent agreements which call for workers on layoff to make payments to the firm (a negative unemployment payment). These two cases along with the case where there is no constraint on private unemploymnet payments can be distinguished by the value of a key parameter which reflects the firm's response to the UI system. The estimation of this parameter provides information on the ability of labor contracts to optimally set private unemployment payments. The results suggest that some constraint (informational or otherwise) prevents contracts from setting private unemployment payments as large as those which would prevail were first-best contracts feasible.

CHAPTER ONE

Search and Fixed Costs: The Inefficiency of Labor Turnover

I. Introduction

The purpose of this paper is to present a simple model of the labor market which focuses on the private incentives for the inter-firm allocation of labor. Workers are assumed to be risk averse, so that the allocation of risk is also an issue. Firms are assumed to be risk neutral. Aggregate demand for labor is constant with intersectoral demand shifts being the only stochastic element. Clearly, a first-best risk allocation entails firms bearing all risk. As the literature on implicit contracts points out, firms and workers can bring about a Pareto-improvement over sequential spot markets by entering into longer-term agreements which allocate risk as well as labor. This response occurs in the absence of complete markets which would enable workers to insure outside the firm. Thus, firms provide insurance and purchase labor services.

The exact nature of these contracts is open to question with different models yielding different implications. One characteristic which is consistently ascribed to such contracts is the breaking of the usual relationship between the wage and the marginal product of labor. This inequality of the wage and marginal product may provide incorrect signals for the allocation of labor across firms (e.g., see Polemarchakis and Weiss 1978 and Holmstrom 1980). The model developed here analyzes the contracts which arise and their effect on the allocation of labor when there are positive

costs of moving from one employment relationship to another.

Mobility costs play an important role in determining the contracts that evolve and their efficiency properties. These costs are of two types: direct financial costs and implicit costs arising from uncertain opportunities, i.e., there are real-time search costs to learning of possible trade opportunities. In the absence of any such frictions there are sequential spot markets for labor which have a constant wage (since the aggregate demand for and supply of labor are constant) and constant employment, thus ensuring the efficient allocations of both risk and labor. Workers would merely move from sector to sector depending on the demand pattern, remaining employed at all times. The coincidence of positive mobility costs and private contracts to allocate risk may sufficiently disrupt the functioning of the labor market to destroy the efficiency that is present in a frictionless world. The causes and nature of any such inefficiency will be of central importance to the model.

The next section presents the model and describes the steady state solution for both the case with zero direct mobility costs and the case where these costs are positive (but finite). Section three analyzes the efficiency properties of equilibrium in each of these cases and shows that the presence of positive, direct mobility costs introduces a fundamental externality, except in a knife-edge situation, which renders the equilibrium inefficient. A fourth section analyzes the relationship between this

externality and a key parameter of the model. Section five introduces an unemployment insurance system and shows that subsidized benefit payments can lead to welfare improvement by partially correcting the externality in the model.

II. The Model A. Structure

Consider the following allocation problem. There are K firms, each of which receives a series of production values, Y, from a known distribution, F(·) (Y gives the flow rate of output which can be produced). The arrival of these values is a continuous time stochastic process governed by the Poisson parameter m. There are enough firms to ensure that the average realized production value (across firms) is equal to the mean of the distribution. In a steady state there are $W < K$ identical workers which must be allocated to these firms. The problem is to allocate workers to the "right" firms, which depends on the pattern of realized production values.

Each firm can hire at most one worker, and production cannot occur without a worker.[1] Whereas firms are infinitely lived, workers die at the exogenous rate r and are replaced by unattached workers. In a steady state the total number of workers is W, a fraction, Ø, of whom are unattached, new entrants.

A firm without a worker will, upon receipt of a production value, attempt to hire a worker. This hiring

(matching) process is driven by the arrival of production values at those firms which have no worker. Each of these firms receives production values at rate m. Upon receipt of this production value an unattached firm instantaneously contacts a random worker, announces its newly drawn production value, and offers to negotiate. (Negotiation is instantaneous.) The contacted worker may be either attached or unattached. If the worker is unattached the firm and worker negotiate a contract and form a match with no mobility cost. (With no fixed cost of entering it is assumed that it is always in the joint interest of an unattached worker and an unattached firm to form a match.) If the contacted worker is attached to another firm the worker will be transferred, at cost C, to the new firm if it is in the joint interest of the three parties: the worker, the worker's existing firm, and the new firm.[2] If the worker is not transferred the unattached firm remains worker-less and must wait for the arrival of another production value before contacting another worker. This "one-shot" nature of the meeting technology generates an arrival process of unattached firms at each worker which is governed by the endogenous Poisson parameter a. (Note that search intensity is fixed and is not a decision variable.)[3] If $\emptyset$ is the steady state fraction of workers that are unattached, then the number of attached firms (which equals the number of attached workers) is $(1 - \emptyset)W$. Thus the number of unattached firms is $K - (1 - \emptyset)W$, each of which receives production values at rate m. The aggregate arrival rate of production

values at unattached firms is then $m(K - (1 - \emptyset)W)$, so that a, the arrival rate per worker is given by

$$a = m(K - (1 - \emptyset)W)/W \quad .$$

Each firm which has a worker under contract is still receiving production values at rate m. As long as these values are above some critical level, R, production continues at the newly drawn level. The reason R is not zero is that workers receive a flow of leisure value, equivalent to the flow payment h, while unemployed and workers supply labor indivisibly. These two facts together imply that for low enough production values it is in the interest of firm and worker for the worker to be laid-off. R will be chosen to make the Pareto-optimal choice between layoff and employment. Production values arrive at rate m which gives: prob(layoff/employment) = mF(R) and prob(recall/on layoff) = m(1-F(R)). Recall, which occurs when the firm with a worker on layoff receives a production value greater than R, takes precedence over attempting to hire a new worker. This is because workers are identical and recall gives the firm a worker with probability one, whereas search has uncertain results. Also, there is no direct cost of recalling a worker.[4]

When an attached firm finds that its worker has transferred to another firm which has just arrived with a better deal, the now unattached firm must wait for the arrival of a new production value before contacting a worker, as

described above. Likewise, the firm which has its worker die becomes unattached and must wait for a new production arrival.

The hiring, transfer, and layoff/recall processes place firms and workers in one of three positions, respectively. The positions for the firm are: P--having a worker and producing; T--having a worker that is under contract and on temporary layoff; and N--not having a worker (unattached). Those for the worker are: E--under contract and employed (producing); L--under contract and on layoff; and U--not under contract (unattached). Positions P and T for the firm and E and L for the worker are the "attached" positions. Movements among these positions occur from layoff/recall decisions, the death of the worker, or from the formation of new matches, either by the meeting of an unattached firm and an unattached worker or by the transfer of a worker from one firm to another.[5] Firms and workers are each ex ante identical, so no matching problem in the usual sense exists. However, once firms have received production values, it is desirable for workers to be producing at the firms with the highest realized production values (given the allocation technology described above).

B. Contracts

The transfer, acceptance, and layoff/recall decisions of the individual agents which solve the dynamic programming problem faced by each agent will depend upon the contract

which is negotiated between firm and worker. The form of the negotiated contract will in turn depend upon the decision to be taken by each agent when faced with the possibility of a change in position. Thus the solution to the dynamic program and the provisions of the optimal contract would seem to be jointly determined. The following argument reveals that the form of the optimal contract can be deduced separately as a solution to the two-person bargaining game between firm and worker, and given this, the solution to the dynamic programming problem facing each agent can then be determined.

The presence of both direct and implicit mobility costs generates a surplus, in the form of future streams of quasi-rents, to each agent of being in an existing match (contract). This surplus is the difference between the value of the agent's existing position and the value of the agent's next best alternative. The mobility costs imply that this difference is strictly positive. A firm and a worker negotiating a contract are in a bilateral monopoly situation because of the positive surplus. The bargaining theory assumed is that each agent has a threat point which is equal to that agent's next best alternative. The negotiated settlement will split the surplus between the agents so that each is strictly better off than at its threat point (each gets a positive share of the surplus).

Following Mortensen (1978) the value of this surplus is endogenous to the two-person bargaining game, the solution of which yields the contract between firm and worker.

Specifically, it is the contract provisions governing the transfer (separation) of the worker when a new firm arrives and offers to negotiate that affect the value of the surplus. There are two possibilities for this separation decision: 1) the worker can decide to transfer to the new firm based only on his share of the surplus; or 2) the transfer decision can be based on the total surplus of the existing match. In case (1) the worker's decision to transfer will impose a capital loss on its former firm equal to that firm's share of the lost surplus. Mortensen argues that a decision rule of type (1) will lower the ex ante value of the total surplus of the existing match and thus lower the expected utility of the worker's position as well. Mortensen shows that a decision rule of type (2), using a Pareto-criterion for the transfer decision (i.e. compensating the losing firm with an amount at least equal to its capital loss), maximizes this surplus and will be agreed upon when the contract is negotiated. In other words, the worker agrees ex ante to take account of the firm's interest in any future transfer decision, because if the worker plans to heed only his own interests then the total surplus of the existing match is reduced and the utility to the worker of being in the match is reduced (wage payments will be lower) by more than what the worker could gain with a selfish decision rule. With the ex ante surplus of an existing match maximized by the agreement on the efficient transfer rule, the method of dividing this surplus can now be addressed.

Workers are risk averse, firms are risk neutral, and there is no outside insurance market because of monitoring problems. As a result, firms and workers will enter into long-term contracts to bring about a Pareto-improvement with regard to risk allocation. Such a contract will optimally allocate risk by smoothing the payment to the worker across all states of the world. The flow wage payment while employed, w, will be set as a constant function of the production value, $w(Y) = w$. The level of w will depend upon the specific fraction of the surplus going to each agent. In addition, the firm will pay the worker a constant flow UI benefit, b, while the worker is on layoff. (b could also depend on Y given observability, though a constant b is optimal in any case.) A first-best risk allocation requires marginal utilities to be equated across states of the world. Noting that the worker receives the equivalent of the flow payment h from leisure while on layoff, this condition is $U'(w) = U'(b + h)$, where $U(\cdot)$ is the worker's utility over flow payments, which yields $w = b + h$.

It is certainly efficient for workers' marginal utility flows to be smooth not only within a single contract but also across contracts as the worker moves from match to match. Risk averse workers would prefer <u>ex ante</u> to sign lifetime contracts with a forever constant marginal utility flow, than signing sequential contracts (a new contract after each transfer) which results in varying wage payments across contracts (given the same expected wage over the worker's lifetime). The argument is just that any stochastic payment

stream is dominated, in the view of a risk averse agent, by a constant stream of payments at a level slightly below the expected value of the stochastic stream. A risk neutral firm would also prefer to pay out such a constant stream since the firm is only concerned with expected values. How can such a Pareto-improvement be achieved <u>across</u> contracts in the present case?

Given the surplus-maximizing transfer rule, which is based on the total value of the existing surplus, the worker and firm would both prefer a contract which calls for the firm to "trade" the worker to any new firm which arrives with a better opportunity, with the provision that the new firm must continue the same wage and benefit payments to the worker. The transfer cost, C, will be borne by the firms since any diminution of the worker's flow payment entails an inefficient risk allocation. The initial firm prefers this since it can extract a premium in the form of a lower wage for providing this insurance. The worker prefers this since lifetime expected utility will be increased by having a constant marginal utility flow at all times. It is important that this provision to stabilize the wage not affect the transfer decisions, else the streams of wage payments from sequential contracts and lifetime contracts would not be comparable. In fact, the transfer decision depends only on the total surplus (as demonstrated below) and not on its division. Therefore a lifetime contract with this trading provision will dominate sequential contracts since the firm pays a lower wage, the

worker receives a higher lifetime expected utility, and the pattern of worker transfers is unaffected and thus remains privately efficient.

To summarize, a contracting equilibrium is a Nash equilibrium in that each pair of firm and worker negotiate a contract, which is the joint wealth (surplus) maximizing solution to the two-person game involving the separation decisions, given all other contracts in the market. The search environment is such that unattached firms may arrive at any matched pair and offer to negotiate. The pair has three contract choices: 1) the worker privately decides whether to transfer and then negotiates with the new firm; 2) the worker transfers if it is in the joint interest of the three parties, the losing firm is at least compensated for its capital loss, and the worker negotiates with the new firm; or 3) the worker is traded to the new firm if it is in the three agents' joint interest, the worker's wage and benefit payments remain constant, and the two firms share the value from the trade net of the transfer cost C (i.e., the losing firm is at least compensated for its capital loss). A contract of type (2) maximizes the surplus of an existing match and thus dominates type (1). The future pattern of inter-firm worker transfers will be the same with either a type (2) or a type (3) contract since only total surplus matters (note that the losing firm is compensated in either case, hence the Pareto criterion governs the transfer decisions). The argument that a non-constant payment stream is dominated (by reason of an improved risk

allocation) by a constant stream at a level slightly below the expected value of the non-constant stream when one agent is risk averse, is thus applicable and shows type (3) to be the dominant contract.[6] Thus the solution to the full dynamic programming problem facing each agent can be determined given the joint wealth maximizing solution to the two-person game which defines the form of the optimal contract.

C. Value Equations

The steady state positions of firm and worker can be expressed using asset value equations to depict the dynamic programming problem facing each agent given the form of the optimal contract derived above.[7] Let V_L, V_E, V_U be the optimized expected present discounted lifetime utility (EPDU) the worker receives if he is currently on layoff (L), employed (E), and unattached (U), respectively.[8] Let V_T, V_P, V_N be the maximized expected present discounted value (EPDV) the firm receives if it currently has a worker on temporary layoff (T), is producing with an employed worker (P), and has no worker (N), respectively. The lifetime contracts are negotiated when an unattached firm (position N) with a newly arrived production value, Y, contacts an unattached worker (position U). Such a new match is allowed to begin in either the production state or the temporary layoff state depending on the value of Y.[9] The initial value which demarcates entry to production and entry to layoff so as to maximize the match

value is just R, the critical level for any layoff/recall decision. When a firm contacts an unattached worker (all firms which search to contact a worker are unattached firms) the production value with which the match will begin is known. The surplus of the match will depend on this initial production value, and given the surplus-splitting rule, the wage (and thus the benefit) will depend on this initial value as well. The worker's contract, then, will be indexed by the initial production value.[10] (Since workers have only one lifetime contract, workers can be thought of as indexed as well.) Hence, $V_L = V_L(S)$ and $V_E = V_E(S)$ are, respectively, the EPDU of a worker currently on layoff whose contract began with production value S and the EPDU of a worker currently employed whose contract began with production value S. Lucky unattached workers happen to be contacted by firms with high production values. $V_L(S)$ and $V_E(S)$ are not functions of the current production value since to any worker all layoff positions are identical as are all employed positions (the wage and benefit payments to a worker never vary). The EPDU of the unattached position, V_U is the same for all workers.

Turning to the firm side, the EPDV of a firm with a worker on temporary layoff, V_T, will depend on the production value which indexes the worker's contract, S, since the benefit payment to the worker will depend on this S, hence $V_T = V_T(S)$. $V_T(S)$ does not depend on the current production value since no production occurs with the worker on layoff. By similar arguments the value of a firm which is producing,

V_P, will depend on both the index, S, of its worker's contract (since this affects the wage payment) and on the current production value, Y (since this affects profits), thus $V_P = V_P(Y,S)$. The value of the unattached position, V_N, is the same for all firms. V_N does not depend on any production value since if the firm receives a value, contacts a worker, and is successful in forming a match (all of which occurs instantaneously) the firm will not be unattached. In addition, the gain to the unattached firm from receiving a transferred worker depends on the total surplus of such a move and is independent of the worker's index S, which only affects the division of this surplus. This implies that V_N will not depend on the distribution of these index values across attached workers.

The following six equations give the interest rate, i, times the asset value of a position equal to the flow benefits of the position plus the expected capital gains from a change of position:

$$(1)\quad iV_U = U(h) + aF(R)[V_L(R) - V_U] + a\int_R^e [V_E(z) - V_U]dF(z) - rV_U$$

$$(2)\quad iV_L(S) = U[B(S) + h] + m[1-F(R)][V_E(S) - V_L(S)] + a[1-F(X_L)][V_E(S) - V_L(S)] - rV_L(S)$$

$$(3)\quad iV_E(S) = U[w(S)] + mF(R)[V_L(S) - V_E(S)] - rV_E(S)$$

$$(4)\quad iV_T(S) = -b(S) + m\int_R^e [V_P(z,S) - V_T(S)]dF(z) + r[V_N - V_T(S)] +$$

$$+ na \int_{X_L}^{e} [V_P(z,S) - V_T(S) + - C]dF(z)$$

$$(5) \quad iV_P(Y,S) = Y - w(S) + mF(R)[V_T(S) - V_P(Y,S)]$$

$$+ m \int_{R}^{e} [V_P(z,S) - V_P(Y,S)]dF(z)$$

$$+ r[V_N - V_P(Y,S)]$$

$$+ na \int_{X_E(Y)}^{e} [V_P(z,S) - V_P(Y,S) - C]dF(z)$$

$$(6) \quad iV_N = m\emptyset\{F(R)[V_T(R) - V_N] + \int_{R}^{e} [V_P(z,z) - V_N]dF(z)\}$$

$$+ (1-n)(1-\emptyset)mJ(R) \int_{X_L}^{e} [V_P(z,S) - V_T(S) - C]dF(z)$$

$$+ (1-n)(1-\emptyset)m \int_{R}^{e} \int_{X_E(y)}^{e} [V_P(z,S)$$

$$- V_P(y,S) - C]dF(z)dJ(y) \quad .$$

$F(\cdot)$, with support $[d,e]$, is the distribution from which production values arrive. $J(\cdot)$, with support $[R,e]$, is the induced steady state distribution of attached workers (and thus of matches) over the possible production values, ($J(R)$ represents that fraction of matches which are in the layoff state by virtue of having a production value no greater than R). A worker on layoff will be transferred to a newly arrived firm which has a production value greater than the critical value X_L. Likewise a worker employed in a match producing Y will be transferred to a newly arrived firm with a production value greater than $X_E(Y)$. X_L and $X_E(Y)$ will be the transfer

rules that meet the Pareto-criterion (i.e., transfer at these values just breaks even for the three parties involved). Finally, n is the share of the surplus from transferring a worker to a more productive firm net of the transfer cost C, which is paid lump-sum to the firm losing the worker. Note that n = 0 is the case of just compensating the firm for the capital loss of becoming unattached.

Now for an explanation of what each equation says. Equation (1) has the interest rate times the EPDU of being an unattached worker equal to the utility flow from leisure value, h, plus the expected capital gain of entering a contract--either to the layoff position or to the employed position, less the capital loss of death. All contracts which begin in the layoff positon will be indexed by the same value, R. Note that there is no fixed cost of entering a contract. This is assumed for simplicity, but does not alter the results provided any such fixed cost is not so large as to make entry into some contracts unattractive.[11] Equation (2) has the interest rate times the EPDU of being a worker on layoff in a contract indexed by S equal to the utility of the flow payments (both private UI benefit and leisure) plus the expected capital gain from being recalled plus the expected capital gain from being transfered to a more productive firm less the capital loss of death. Equation (3) is the analogous equation for the employed worker indexed by S, where the utility flow is from the wage and there are expected capital losses from layoff and death. Note that the transfer of an

employed worker has no effect on the worker since the wage remains constant.

For the firm, equation (4) has the interest rate times the EPDV of being a firm with a worker indexed by S on temporary layoff equal to the benefit payment to the worker plus the expected capital gain from recalling the worker less the capital loss of the worker's death plus the firm's share, n, of the expected capital gain from transferring the worker to a more productive firm. Likewise, equation (5) gives the interest rate times the value of a firm which is producing the flow output Y with a worker indexed by S equal to the flow product net of the wage plus the expected capital loss from laying-off the worker plus the expected gain from receiving a new production value greater than R and continuing production less the capital loss from the worker's death plus the share of the capital gain from transferring the worker. Equation (6) for the unattached firm has three terms representing the expected capital gains from arriving at a worker in each of the possible positions--unattached, on layoff, employed--respectively, (there is no flow payment or receipt for an unattached firm).

D. Solution

The worker's contract yields a constant marginal utility flow meaning $U'[b(S) + h] = U'[w(S)]$ for each S, which implies $b(S) + h = w(S)$. Using this with equations (2) and (3) we

obtain

$$(7)\quad V_E(S) = V_L(S) = \frac{U[w(S)]}{i+r} = \frac{U[b(S)+h]}{i+r} \quad .$$

As expected, the worker receives the utility flow [U(w(S)] capitalized at i + r. The probability of death, r, acts like a discount rate since a higher r makes any future flows less valuable. Equations (1) and (7) imply that the EPDU of an unattached worker is

$$V_U = \frac{U(h)}{i+a+r} + \frac{a}{(i+a+r)(i+r)}\{U[w(R)]F(R) + \int_R^e U[w(s)]dF(s)\}$$

which, noting w(S) = w(R) for $S \leq R$ (all contracts beginning in the layoff state have the same wage), can be rewritten as

$$(8)\quad V_U = \frac{U(h)}{i+a+r} + \frac{a}{(i+a+r)(i+r)}\{\int_R^e U[w(s)]dF(s)\} \quad .$$

The second term is just the expected flow utility over the possible contracts properly capitalized (a is the instantaneous probability of the arrival of an unattached firm at any worker).

There are decisions to be made with regard to each of the following three activities: (i) layoff/recall; (ii) transfer of a worker on layoff; and, (iii) transfer of an employed worker. The Pareto-criterion is invoked by the parties to each decision. This gives the following equations which implicitly define the private break-even rules R, X_L, and $X_E(Y)$ for any index S:[12]

(9) $V_L(S) + V_T(S) = V_E(S) + V_P(R,S)$

(10) $V_L(S) + V_T(S) + V_N = V_E(S) + V_N + V_P(X_L,S) - C$

(11) $V_E(S) + V_P(Y,S) + V_N = V_E(S) + V_N + V_P[X_E(Y),S] - C$

The left side of each equation gives the combined values of each agent's position for one decision choice (layoff, no transfer from layoff, and no transfer from employment) and the right side gives the analogous combined values for the other decision choice. Equations (9) - (11) define the same values of R, X_L, and $X_E(Y)$ for each possible index value. The reason these critical values are independent of S is that only the total surplus from any pair of match positions matters when comparing any two matches, and S only affects the division of this surplus. Noting that $V_E(S) = V_L(S)$ and cancelling the common terms, (9) - (11) become

(9A) $V_T(S) = V_P(R,S)$

(10A) $V_T(S) = V_P(X_L,S) - C$

(11A) $V_P(Y,S) = V_P[X_E(Y),S] - C$

Equations (4) - (6) and (9A) - (11A) can be solved simultaneously to obtain the values of the three firm positions $V_L(S)$, $V_E(Y,S)$, and V_N and the decision rules R, X_L, and $X_E(Y)$. Analytic solutions are possible only in the case of n = 0. This implies that the firm losing a transferred worker is just compensated for its capital loss. Section four

contains a further discussion of the parameter n and its importance to the model. For now, assume that n = 0.

First the solutions to the decision rules will be given:

$$(12) \qquad R = h$$

$$(13) \qquad X_L = h + (i + r + m)C$$

$$(14) \qquad X_E(Y) = Y + (i + r + m)C$$

With these the EPDV's of each of the firm's positions are

$$(15) \quad V_T(S) = \frac{1}{i+r}\left[-b(S)\frac{i+r}{i+r+m} + \frac{m}{i+r+m}Q(S) + rV_N\right]$$

$$(16) \quad V_P(Y,S) = \frac{1}{i+r}\left[(Y-w(S))\frac{i+r}{i+r+m} + \frac{m}{i+r+m}Q(S) + rV_N\right]$$

$$(17) \quad V_N = \frac{(i+r)m\emptyset}{i(i+r+m\emptyset)(i+r+m)}\left\{\int_R^e [z-w(z)dF(z) - b(R)F(R) + \frac{m}{i+r}\left[\int_R^e Q(z)dF(z) + Q(R)F(R)\right]\right\}$$

$$+ \frac{m(i+r)(1-\emptyset)}{i(i+r+m\emptyset)}J(h)\int_{h+(i+r+m)C}^{e}\left[\frac{z-h}{i+r+m} - C\right]dF(z)$$

$$+ \frac{m(i+r)(1-\emptyset)}{i(i+r+m\emptyset)}\int_h^e\int_{y+(i+r+m)C}^{e}\left[\frac{z-y}{i+r+m} - C\right]dF(z)dJ(y)$$

where $Q(S) = \int_h^e zdF(z) - w(S)[1-F(h)] - b(S)F(h)$.

(15) and (16), the values for an attached firm, are presented as depending on the unattached value, V_N, for expositional clarity.

Equation (12) means that the worker is laid-off when output net of forgone leisure value, h, is zero. (13) and

(14) state that for the transfer of a worker to be profitable, production at the new firm must exceed production with the old firm (either leisure or output) by an amount sufficient to amortize the transfer cost, C (in an expected sense). If C = 0, then the only requirement is that output increase. Note that $X_E(h) = X_L$.

Equation (15) has the EPDV of a firm with a worker of index S currently on temporary layoff depending on three things, each appropriately discounted or capitalized by the factors which involve i, r, and m. The firm pays its laid-off worker the benefit b(S). The firm will receive a new production value with instantaneous probability m. Q(S) is the expected flow of net output to the attached firm with a worker of index S at a point in time (expected value of output less the expected payment to the worker). V_N is of course the value of the firm if its worker dies and it becomes unattached. The transfer of the worker has no effect on $V_T(S)$ since exact compensation is paid (i.e, n = 0).

The EPDV of a firm which is currently producing with a worker of index S (equation 16) differs from the same firm with its worker on layoff only by the current flow. The producing firm receives the output Y and pays the wage w(S). It faces the same probabilities of receiving a new production value or of having its worker die as does a firm with a laid-off worker; thus the similarity of (15) and (16). Additional insight can be gained by considering the difference: $V_P(Y,S) - V_T(S) = [Y - (w(S) - b(S))]/(i + m + r)$, (where $w(S) - b(S) = h$,

independently of S) which is just the difference in the current flow of net receipts capitalized at i + m + r. The arrival rate, m, and the rate of worker death, r, act like discount rates since m and r represent independent, instantaneous probabilities of "moving" from the firm's current situation and thus 1/(m + r) is the expected length of time the firm remains in any particular attached position. Larger values of m or r mean the firm will be "moving" between positions more rapidly, thus the smaller the gap between the values of any two positions at any instant. Again, note that $V_P(h,S) = V_T(S)$.

Equation (17) gives the EPDV of a currently unattached firm. This is composed of the expected gains from receiving a production value, contacting a random worker, and entering into an attached position. (With C = 0 the expected gain from contacting an attached worker is increased.) This can occur in one of three ways--contact an unattached worker, receive the transfer of a laid-off worker, or receive the transfer of an employed worker--corresponding to the three terms in (17). The gain to the firm from receiving a transferred worker is indeed independent on the worker's index ($V_P(z,S) - V_T(S)$ is independent of S), thus the use of the arbitrary S. (If the firm contacts a worker with a high index then wage and benefit payments will be higher but the compensation paid the losing firm is lower, offsetting the higher payments to the worker. This continues to hold when n is positive.)

This describes the equilibrium of the model, with C

either zero or positive, except for the determination of the wage level (since $b(S) = w(S) - h$) which depends on a particular bargaining assumption about the fraction of the surplus which goes to each agent. Assume that the surplus is split evenly when an unattached firm and an unattached worker form a new match. This implies the following two equations which implicitly define the wage function $w(S)$, with $S \geq R$:

$$(18) \quad V_L(R) - V_U = V_T(R) - V_N$$

for contracts which begin in the layoff state (defining $w(R)$); and

$$(19) \quad V_E(S) - V_U = V_P(S,S) - V_N$$

for contracts which begin in production (defining $w(S)$ for $S > R$).[13] Private incentives lead to lifetime contracts which generate privately optimal turnover decisions. The next sections analyze the social efficiency of this pattern of labor turnover.

III. Efficiency Properties

The question of whether the allocation of workers in the above model is efficient revolves around the decision rules R, X_L, and $X_E(Y)$. Two cases will be considered separately--zero transfer costs and positive transfer costs. The analysis is still focused on the case $n = 0$ (exact compensation to the losing firm in a transfer).

When transfer costs, C, are zero the above equilibrium is indeed constrained efficient. The risk associated with being in a contract (output fluctuates randomly) is allocated in a first-best manner, i.e., it is borne completely by the risk-neutral firm. The efficiency of the risk allocation is constrained since unattached workers would prefer to insure themselves against the risk of entering a low-indexed contract and thus receiving a lower expected lifetime utility. There is no institution to provide such insurance and behavior is not altered by unattached workers having to bear this risk, thus the risk allocation is constrained (by this missing market) efficient.

Turning to the efficiency of the labor allocation, the possibility of a tradeoff between allocating risk and labor must be considered. With binding labor contracts expected output can be maximized and then distributed in whatever manner best allocates risk, hence there is no tradeoff in this case. Were workers suddenly able to break contracts (e.g., professional baseball's Reserve Clause fails a court test), then some workers (those transferring to high production value firms) could raise their utility by obtaining more output at the expense of a varying marginal utility stream. The above equilibrium would then unravel. If contracts are not binding, then the allocations of risk and labor are intertwined by the action of private incentives, and discussing constrained (by the prohibition of binding contracts) efficiency is problematic.

The efficiency of the equilibrium when C = 0 depends, then upon the maximization of expected output. This can be treated as a control problem where the decision rules, R, X_L, and $X_E(Y)$ are chosen to maximize the EPDV of aggregate value, A. The approach here will be somewhat less direct. There are three logical steps as follows: 1) given $X_L = R$ and $X_E(Y) = Y$, prove R = h maximizes A; 2) show that $X_L = R$ and 3) that $X_E(Y) = Y$ maximize A. A, the EPDV of steady state value (per capita) is

$$(20) \quad A = \int_0^{\infty} e^{-it}[\emptyset h + (1-\emptyset)\int_0^{R} h dJ(y) + (1-\emptyset)\int_R^{e} y dJ(y)]dt$$

In a steady state a random worker can be in one of three positions: unattached, with probability $\emptyset$, and receiving leisure value h; attached and on layoff, with probability $(1 - \emptyset)J(R)$, and receiving leisure value h; or attached and employed producing output Y with probability governed by $(1 - \emptyset)J(Y)$. Again, A, is unrelated to the distribution of index values because only total output matters, not its division between workers and firms. Substitution for J(Y) and rearranging gives

$$(21) \quad A = \frac{1}{i}\{\emptyset h + (1-\emptyset)h\,\frac{F(R)(r+m)}{a(1-F(R)) + r + m} + (1-\emptyset)\int_R^{e} \frac{y(a+r+m)(r+m)F'(y)}{[a(1-F(y)) + r + m]^2}\,dy\}$$

Maximizing (21) by choice of R implies[14]

$(1 - \emptyset)h - (1 - \emptyset)R^* = 0 \Rightarrow R^* = h.$

This gives step (1) above.[15]

For step (2) consider the following two situations. A firm with a worker on layoff has just received a new production value and must decide whether to recall the worker or not. In another instance, a firm without a worker has received a production value, arrived at a worker on layoff, and offered to negotiate, necessitating a decision on transfer. From society's viewpoint these two situations are identical with C = 0. In either case if the decision is affirmative (recall/transfer) a producing match is created and the distribution of firms without workers is unchanged (since in the latter case one firm merely replaces the other), and the distribution of match values, J(Y), will be the same regardless of why the new match is created. Thus whatever decision rule is socially optimal for the recall decision, R, should also be the decision rule for the transfer of a worker on layoff, X_L; hence $X_L = R$ and step (2) is satisfied.

The rule $X_E(Y) = Y$ gives the Pareto-optimal decision for the three agents involved in transferring a worker from a match producing Y to another producing match. This rule will be socially optimal as well unless there is an externality which has a non-zero value at the margin for such transfers. If this externality value is not zero for a transfer which just breaks even for the three parties involved, then failure to account for this externality distorts the replacement decision at the margin, and the privately optimal decision rule is not efficient.

Any such externality will occur by altering the distribution of opportunities which are available to the other agents in the economy. The transfer of a worker from one producing match to another only affects the distribution of matches across production values, J(Y). The distribution of unattached firms stays the same since the losing firm replaces the firm which receives the worker. Unattached workers are unaffected as well. With J(Y) altered the opportunities open to an unattached firm are changed.

Since any unattached firm that receives a new production value prefers to contact a worker in a match with a low production value (the lower the production value the greater the net surplus from transferring the worker and the greater the receiving firm's gain), there is an (negative) externality value to unattached firms of replacing one producing match with another of greater value. Meetings occur randomly, which implies that the externality to unattached firms of transferring a worker in a match with production value Y to a match with production value X > Y, E(Y,X), is the probability of a firm's arrival, a, times the difference in expected surplus from meeting the X-value match and the Y-value match (from equation(6)):

$$(22) \quad E(Y,X) = a \int_{X_E(X)}^{e} [V_P(z,S) - V_P(X,S)]dF(z) - a \int_{X_E(Y)}^{e} [V_P(z,S) - V_P(Y,S)]dF(z)$$

$$= -a \int_{X_E(Y)}^{X_E(X)} [V_P(z,S) - V_P(Y,S)]dF(z)$$

$$- a[1 - F(X_E(X))][V_P(X,S) - V_P(Y,S)]$$

$$= -a \int_{Y}^{X} [\frac{z-Y}{i+r+m}]dF(z)$$

$$-a[1 - F(X)][\frac{X-Y}{i+r+m}] \leq 0$$

since $X_E(X) = X$, $X_E(Y) = Y$. Noting that a break-even transfer satisfies $V_P(X,S) = V_P(Y,S)$ so that $X = Y$, gives

$$E[Y,X_E(Y)] = E(Y,Y) = 0$$

Thus, the negative externality vanishes at the margin, the privately optimal decision rule is efficient, and step (3) is satisfied. The equilibrium when transfer costs, C, are zero meets the requirements of steps (1) - (3) and is thus constrained efficient.

The presence of positve transfer costs causes this externality value not to vanish for a break-even transfer hence the equilibrium with $C > 0$ is inefficient. The transfer of a worker from a producing match with production value Y to a match with production value $X > Y$ yields the externality value:

$$(23) \quad E(Y,X) = a \int_{X_E(X)}^{e} [V_P(z,S) - V_P(X,S) - C]dF(z)$$

$$- a \int_{X_E(Y)}^{e} [V_P(z,S) - V_P(Y,S) - C]dF(z)$$

$$= -a \int_{X_E(Y)}^{X_E(X)} [V_P(z,S) - V_P(Y,S) - C]dF(z)$$

$$- a[1 - F(X_E(X))][V_P(X,S) - V_P(Y,S)]$$

Evaluating (23) at the break-even value, $X = X_E(Y) = Y + (i + r + m)C$, gives (using (15) and (16)

$$(24) \quad E[Y, X_E(Y)] = -a\int_{Y+(i+r+m)C}^{Y+2(i+r+m)C} [\frac{z-Y}{i+r+m} - C]df(z)$$

$$- a[1 - F(Y + 2(i+r+m)C)]C < 0 \quad .$$

From (24) the externality value of the marginal transfer has two components. The first term represents the expected surplus of those transfers which are precluded because the cost C cannot be amortized. The second term represents the expected savings from not having to pay a second transfer cost on those transfers which will occur in any case. At the margin the negative externality does not vanish, hence private decisions are inefficient.

The same reasoning can be used to determine the externality value, $E_L(X)$, of transferring a worker from a match which is in the temporary layoff state to a producing match with production value X. This gives:

$$(25) \quad E_L(X) = -a\int_{X_L}^{X_E(X)} [V_P(z,S) - V_T(S) - C]dF(z)$$

$$-a[1 - F(X_E(X))][V_P(X,S) - V_T(S)]$$

Evaluating this at the break-even value $X = X_L = R + (i + r + m)C$ gives

$$(26) \quad E_L(X_L) = -a\int_{h+(i+r+m)C}^{h+2(i+r+m)C} [\frac{z-h}{i+r+m} - C]df(z)$$

$$- a[1 - F(h + 2(i+r+m)C)]C < 0 \quad .$$

Again the negative externality does not vanish. (Note that $E(R,X_E(R)) = E_L(X_L)$.[16]

Likewise, the externality value of recalling a worker to produce in a match with production value Y is:

$$(27) \quad E_R(X) = -a \int_{X_E(X)}^{e} [V_P(z,S) - V_P(X,S) - C]dF(z)$$

$$-a \int_{X_L}^{e} [V_P(z,S) - V_T(S) - C]dF(z) = E_L(X)$$

The break-even value for a recall is X = R. Plugging into (27) yields (note $X_E(R) = X_L$):

$$(28) \quad E_R(R) = -a \int_{X_L}^{X_L} [V_P(z,S) - V_T(S) - C]dF(z)$$

$$-a[1 - F(X_L)][V_P(R,S) - V_T(S)] = 0$$

(since $V_P(R,S) = V_T(S)$ by definition) which does disappear.

The presence of this negative externality at the margin for the two transfer decisions results in too much replacement of low-valued matches by higher valued matches. The layoff/recall decision, however, does not generate an externality ($E_R(R) = 0$), which highlights the role of the positive mobility cost C in causing inefficiency. The intuition is as follows. With C = 0 all of the transfers which yield a positive incremental output flow (higher value of Y) are completed, given the pattern of firm arrivals at workers. When C is positive this is no longer true. Suppose

$(i + r + m)C = 4$ and there is an existing match with $Y = 10$. If a new firm arrives with a value of 15 a transfer will occur. If another new firm with $Y = 18$ arrives at this same worker immediately thereafter, no transfer will occur. Clearly, for a small enough expected time between firm arrivals it pays to wait and obtain the incremental flow of 3 (= 18 - 15). Inefficiency occurs because private turnover decisions do not take account of this value of waiting. When exact compensation is paid to the losing firm in a transfer (i.e., when $n = 0$) the increase in surplus from waiting to make another, more profitable transfer in the near future would accrue completely to the firm which will arrive in the future. However, this future firm is not a party to the current transfer decision, and thus its gain is not internalized.

In conclusion, the efficiency analyses can be simplified. Private decisions which are Pareto-optimal will generate efficient outcomes as long as there are no externalities present at the margin of such decisions. There are no such externalities when transfer costs are zero and efficiency prevails. In the case of positive costs these externalities do not vanish at the margin, hence inefficiency.

IV. A Firm-Firm Bargaining Rule ($n \neq 0$)

The analysis up until now has been made with the assumption that the losing firm in a transfer is exactly

compensated for its capital loss, i.e., n = 0. At first glance this may seem reasonable. However, with the lifetime contracts which guarantee workers a constant marginal utility flow, workers are indifferent (at the time of transfer, i.e., given the contract provisions) about any possible transfer. A transfer, then is essentially a trade of a worker from one firm to another firm which can employ the worker more productively. As such, these two firms are in a bilateral bargaining situation. It is unreasonable to assume that one firm (the new firm) will be able to extract the entire surplus from the transfer, which is what the n = 0 case assumes. Analysis of this more general model gives additional insight into the source of the externality which renders the equilibrium with positive transfer costs inefficient.

Unfortunately the model is much less tractable with a non-zero n. Neither the value equations nor the two transfer decision rules can be solved analytically.[17] It is instructive, however, to consider the two equations which implicitly define the transfer rules X_L and $X_E(Y)$:

$$(29)\quad X_L = h + (i+r+m)C + na\{\int_{X_L}^{X_E(X_L)} [V_P(z,S) - V_T(S) - C]df(z) + [1 - F(X_E(X_L))]C\}$$

$$(30)\quad X_E(Y) = Y + (i+r+m)C + na\{\int_{X_E(Y)}^{X_E(X_E(Y))} [V_P(z,S) - V_P(Y,S) - C]dF(z)$$

$$+ [1 - F(X_E(X_E(Y)))]C\}$$

With a positive n there is a third (positive) term added to the decision rules which reflects the expected value of waiting for a more profitable transfer in the future.[18] Compare this third term to the equations defining the externality values of the break-even transfers (analogous to (26) and (24) above):

$$(31) \quad E_L(X_L) = -a(1-n)\int_{X_L}^{X_E(X_L)} [V_P(z,S) - V_T(S) - C]dF(z)$$
$$-a(1-n)[1 - F(X_E(X_L))]C$$

$$(32) \quad E[Y,X_E(Y)] = -a(1-n)\int_{X_E(Y)}^{X_E(X_E(Y))} [V_P(z,S) - V_P(Y,S) - C]dF(z)$$
$$-a(1-n)[1 - F(X_E(X_E(Y)))]C \quad .$$

The expected surplus value from waiting for a better transfer either accrues to the parties participating in a transfer and is thus rolled into their decision rules, or it accrues to a non-participating agent and is ignored.

This relationship between the externality values and the value-of-waiting term in the decision rules reveals the crucial role which n, the share of the net surplus from a transfer going to the losing firm, plays in affecting the magnitude of the externality. Viewing (31) and (32) it appears that the externality vanishes when n = 1 and, furthermore, that the two externality values are linear in n. The former observation is true, but the latter is not because

the decision rules and the EPDV's, which are on the right-hand side of (31) and (32), are themselves functions of n.

Returning to the case n = 1, the vanishing of the externality, which restores the efficiency property, is perfectly understandable. In this case, the firm losing the worker in a transfer receives the entire net surplus from making the transfer. As such, this firm will completely internalize the expected value of waiting for a more profitable transfer, thus the decision rules X_L and $X_E(Y)$ will be socially optimal. Alternatively, with n = 1, an unattached firm receives no gain from contacting and receiving the transfer of any attached worker (see equation (6)--the second and third terms are zero), so that there is no value to making a future transfer which is not completely accounted for by the parties involved in a given transfer, hence no inefficiency.

One other interesting result regarding the behavior of the externality values, $E(Y,X_E(Y))$ and $E_L(X_L)$, as functions of n can be obtained. The values are each continuous in n. This implies that as n -> 1 the values approach zero. If the bargaining share, n, could be controlled by fiat, then setting n very close to one would mean that the externality would be close to zero, thus making the equilibrium "almost" efficient.

V. Unemployment Insurance

The efficiency properties of the model with direct mobility costs (i.e., c > 0) depend on the three decision rules for moving a worker--R, X_L and $X_E(Y)$-- and through these

rules on the parameter n--the share of the net surplus from transferring a worker to a more productive match which accrues to the firm losing the worker. When n is anything other than one, X_L and $X_E(Y)$ are set too low, ignoring that share of the surplus from a possibly more profitable transfer which would accrue to the firm receiving the worker, and an inefficient labor turnover pattern results. There will be too many transfers of workers since each transfer imposes a diseconomy on all other unattached firms which is ignored by the parties to the transfer.

The equilibrium could be rendered efficient by directly setting $n = 1$. However, the parameter n reflects the relative bargaining strengths of the two firms involved in a transfer and thus is essentially impossible to control. (Henceforth, assume $0 < n < 1$.) Since efficiency depends on n as it affects the decision rules X_L and $X_E(Y)$ there is the possibility of improving efficiency by affecting these rules in a less direct manner. Efficiency requires that X_L and $X_E(Y)$ be raised to fully incorporate the total net gain from transferring a worker to a more productive match. The efficient decision rules ensure that the benefits from waiting for a possibly more profitable transfer are properly taken into account when any decision on a given transfer is made. An unemployment insurance (UI) system provides a policy tool to indirectly affect these private decisions and possibly bring about an efficiency gain.

If the UI system is designed so that the total value of

the layoff positions of a match (V_L for the worker and V_T for the firm) is increased relative to the producing positions, then the reservation values for transitting from layoff to production (either by recall or transfer) will be raised. In particular, suppose that the government makes a flow payment B to all workers on layoff, the payment being financed by a lump-sum tax not specifically modeled here (i.e., the payments are fully subsidized since there is no experience rating). This implies that the (optimized) EPDU of a worker with index S currently on layoff is given by:

$$(33) \quad V_L(S) = \frac{U[b(S)+B+h]}{i+r}$$

It is still the case that $V_L(S) = V_E(S)$ (the worker is indifferent between employment and layoff) since private contracts will have $w(S) = b(S) + B + h$ to optimally allocate risk. (Again $w(\cdot)$ will be set to split equally the surplus from entering a match.) The decision rules governing the exit from layoff, R and X_L, will be determined by the joint wealth maximizing (Pareto) conditions:

$$(34) \quad V_L(S) + V_T(S) = V_E(S) + V_P(R,S)$$

$$(35) \quad V_L(S) + V_T(S) + V_N = V_E(S) + V_N + V_P(X_L,S) - C.$$

Noting that $w(S) - b(S) = B + h$ these imply that

$$(36) \quad R = B + h$$

$$(37) \quad X_L = B + h + (i + r + m)C.$$

Thus a (fully subsidized) UI benefit flow payment will raise the values of R and X_L by the amount of the benefit.

There are two things to notice at this point. First, the imposition of these benefit payments has no effect on $X_E(Y)$, the decision rule governing the transfer of a worker employed in a match producing Y, $(X_E(Y) = Y + (i + r + m)C)$. This is because the probability of entering layoff, conditional on being engaged in production, is the same for all matches and thus the potential benefit receipts from any future layoffs are valued equally by any producing match. The payment of UI benefits does not change the difference in values between any two producing matches which is the relevant criterion for a transfer decision. Second, it is not the payment of UI benefits <u>per se</u> but the subsidization of these payments which affects R and X_L.[19] If the benefit B were paid and partially financed by a tax, $t = \theta B$ with $0 < \theta < 1$, levied on those firms which have a worker on layoff then the decision rules would become:

(36A) $R = (1- \theta)B + h$

(37A) $X_L = (1 - \theta)B + h + (i + r + m)C$.

$(1 - \theta)B$ is then the subsidy to layoffs implicit in the UI system.

UI will raise the value of R and X_L (noting $X_L = R + (i + r + m)C$) by the amount of this subsidy. This implies that an imperfectly experience rated ($\theta < 1$) UI system can be

used to alter the equilibrium pattern of labor turnover in the model of the previous section. The problem of designing the UI system so as to effect an efficiency gain can now be addressed.[20]

Aggregate output in the model without UI can be increased by raising X_L and $X_E(Y)$. The UI subsidy raises R and X_L. Clearly a first-best solution is not achievable using public unemployment insurance. The possibility of a partial welfare improvement exists if efficiency and thus aggregate output can be increased. Increasing X_L so that a firm and worker in the layoff positions require any newly arrived firm to possess a larger production value before consenting to transfer the worker will increase aggregate output since a portion of the external diseconomy is effectively internalized. On the other hand, increasing the critical value, R, for the layoff/recall decision will diminish aggregate output since the choice of R in the absence of UI is efficient by virtue of there being no external diseconomy for the marginal decision.[21] It is the inter-firm allocation of labor which is inefficient whereas the intra-firm allocation is first best. An imperfectly experience rated UI system will change both of these allocations and thus determining the optimal level of the UI subsidy is a problem of the second-best.

The argument here will only show that a positive subsidy is optimal.[22] Equations (36) and (37) imply $\frac{dR}{dB} = 1$ and $\frac{dX}{dB}L = 1$ (with $\theta = 0$ so that the benefit is fully subsidized). A break-even transfer of a laid-off worker generates a

negative externality, hence an infinitesimal increase in X_L will raise the expected present discounted value of aggregate output, A. Since A is maximized by the private choice of R when there is no UI subsidy, then application of the envelope theorem implies that the change in R which is induced by an infinitesimal UI subsidy will not affect aggregate output. The combined effects on R and X_L of an infinitesimal subsidy will cause aggregate output and thus welfare (since the risk allocation remains optimal) to increase. Hence the second-best optimal unemploymment insurance system will have a positive subsidy.

A caveat concerning the sensitivity of the above result to the assumptions on initial contract entry is warranted. The maintained assumption has been that all attached positions are strictly preferred by worker and firm to remaining unattached. If this is not true then there will be some decision rule (defined analogously to R, X_L, and $X_E(Y)$) which will delineate desirable initial contracts from those dominated by remaining unattached. Entry into the marginal contract which just breaks-even for the firm and worker involved will impose a negative externality on all unattached firms since the distribution of workers which these firms face has been worsened.[23] Just as with the transfer of workers, there will be an inefficient amount (too much) of contract entry. The imposition of an UI system with a positive subsidy will increase inefficient contract entry since the UI subsidy

raises the value of all attached positions relative to being unattached (assuming UI benefits are only paid to laid-off workers). Thus while the UI subsidy decreases the external diseconomy generated by the transfer of attached workers, the subsidy also worsens the externality created by contract entry. Without the assumption that all contracts are strictly desirable nothing can be said about the optimal UI subsidy.

The results to this point can be stated as the following three things: 1) Even with unrestricted (and thus privately optimal) contracting, externalities in the search and allocation process can render the labor market equilibrium inefficient; 2) This defines a possible efficiency-improving role for public unemployment insurance; and, 3) The relevant control variable for the UI system is the subsidy and not the level of benefits or taxes per se. Further investigation will concentrate on the implications for efficiency and for the role of UI in improving labor market performance when private contracting is restricted by observability and other enforcement problems. Both the risk and labor allocations may be inefficient in such a model, thus expanding the possible channels through which UI can improve welfare. Understanding just how the UI system parameters affect labor turnover, as well as the allocation of risk, and whether it is only the UI subsidy that matters in more realistic contracting environments are crucial to determining the features of an optimal unemployment insurance system and to unearthing the effects which the current UI system has on turnover. After

all, if an empirical investigation suggests that UI has little effect on labor turnover then the theoretical issues involved in designing optimal UI may well be moot.

VI. Conclusion

This paper has developed a model of the labor market characterized by uncertain opportunities for trade which require agents to search for each other. The model is simple to allow the analysis to concentrate on the effect which positive mobility costs, other than the implicit costs of search, have on the inter-firm allocation of labor. It was argued that workers and firms prefer to enter lifetime contracts to improve the allocation of risk. The steady state equilibrium was then derived and shown to exhibit an inefficient pattern of labor turnover, despite these privately efficient contracts, caused by an externality from the transfer of a worker from one firm to another. This externality arises because the parties to a possible transfer do not take full account of the expected value of waiting for a more profitable transfer. This exernality disappears if direct mobility costs are zero since, at the margin, there is then no value to waiting for a more profitable transfer--all profitable transfers will be made with no mobility cost to amortize. The externality also vanishes if the total expected value of waiting for a better transfer accrues to the parties involved in any given transfer. This occurs when the bargaining share

parameter n is exactly equal to one. Furthermore, the magnitude of this externality is a continuous function of n, which facilitates movement of the equilibrium arbitrarily "close" to efficiency, if n is controllable. The imposition of an imperfectly experience rated unemployment insurance system will internalize a portion of this externality thus leading to a partial welfare improvement.

APPENDIX

A. Derivation of Asset Value Equations

The fundamental recurrence relation imbedded in Bellman's Principle of Optimality implies that the problem of an expected-discounted-utility-maximizing worker, who has index S and is employed at time t, over the short interval [t,t+ Δt] can be represented as:

$$\begin{aligned}(A1)\quad V_E(S,t) = {} & (1+i\,\Delta t)^{-1}\{U[w(S)]\,\Delta t \\ & + m\,\Delta t F(R)(1-r\,\Delta t)V_L(S,t+\Delta t) + r\,\Delta t \cdot 0 \\ & + (1-r\,\Delta t)[1-m\,\Delta t F(R)]V_E(S,t+\Delta t)\}\end{aligned}$$

where $V_E(S,t)$ is the maximized expected discounted utility at time t of an employed worker with index S, $V_L(S,t+\Delta t)$ is the analogous value for a worker on layoff at time t+ Δt, and zero is utility given death. This can be simplified by dividing by the discount factor $(1+i\,\Delta t)^{-1}$ and expanding the optimized utility functions about the point (S,t). This yields:

$$\begin{aligned}(A2)\quad V_E(S,t)(1+i\,\Delta t) = {} & U[w(S)]\,\Delta t + m\,\Delta t F(R)V_L(S,t) \\ & + o(\Delta t) + [1-r\,\Delta t - m\,\Delta t F(R)]V_E(S,t) \\ & + o(\Delta t) + V_{Et}(S,t)\,\Delta t\end{aligned}$$

where V_{Et} represents partial differentiation with respect to t, and $\frac{o(\Delta t)}{t} \to 0$ as $\Delta t \to 0$. Subtracting the common $V_E(S,t)$ term, dividing (A2) by Δt, then taking the limit as $\Delta t \to 0$ gives:

$$(A3)\quad iV_E(S,t) = U[w(S)] + mF(R)V_L(S,t) - rV_E(S,t)$$

$$- \; mF(R)V_E(S,t) + V_{Et}(S,t) \quad .$$

In a steady state the optimized utilities are time-independent. Thus (A3) can be rewritten as:

$$(A4) \quad iV_E(S) = U[w(S)] + mF(R)[V_L(S) - V_E(S)] - rV_E(S)$$

which is the same as equation (3) in the text. Analogous derivations give equations (1), (2), and (4) (6).

B. The Distribution J(Y)

The layoff/recall, transfer, match formation, and worker death processes yield the following for the distribution of attached workers across production values when C = 0.

$$J(Y) = \begin{cases} \dfrac{F(Y)(r+m)}{a[1-F(R)] + r + m}, & Y \in [d,R] \\ \dfrac{F(Y)(r+m)}{a[1-F(Y)] + r + m}, & Y \in (R,e] \end{cases}$$

Note that J(·) is continuous at R (provided F(·) is). Note also, that were there no arrivals of unattached firms, i.e., a = 0, then J(Y) = F(Y) as would be expected.

NOTES

[1]Because of this one-to-one relationship it is perhaps better to interpret "firms" as "jobs", then $K > W$ is understandable.

[2]The cost C is meant to represent actual moving costs from one firm to another (e.g., in a different city) as well as retraining costs. This raises questions about the assumptions that there are no costs to entering an initial contract and that all matches are desirable when compared to the unattached positions. The assumptions are made to simplify the model in order to concentrate on the inter-firm labor allocation. See notes 11, 13 and 16 for further discussion of the importance and implications of these assumptions.

[3]The one-shot search process with no intensity decision is assumed to simplify the analysis. The inefficiency result would seem to only be exacerbated by the addition of a private intensity decision, given the nature of the externality involved. However, extension along these lines may give additional insight.

[4]The structure of the fixed costs is then: forming a new match--zero, recalling a worker--zero, transferring a worker--C.

[5]Transfers occur when the worker will produce at the new firm. No worker is transferred directly into layoff.

[6]The ability to commit to such a contract requires that workers be allowed to enter servitude arrangements and that firms are not subject to bankruptcy restrictions (because of the possiblity of repeated low production draws).

[7]See the appendix for the derivationn of asset value equations from the fundamental recurrence relation of dynamic programming.

[8]Utility is assumed to be intertemporally additive, with a concave, instantaneous utility function over income flows, and with a subjective discount rate for future utility flows equal to the interest rate.

[9]Were entry into layoff prohibited, firms and workers would react by entering into some producing contracts with "too low" values; just as firms "over-employ" workers if private UI is prohibited in the standard implicit contract models. This second-best response is obviated by allowing first-best contract entry.

[10]Note that, ex ante, contracts differ only in these

initial production flows since all future production values have the same expected magnitude and arrival probabilities. The difference in the lifetime wage stream that a worker would receive from any two contracts is merely his share of this initial flow spread over his expected lifetime. Thus the differences among contracts in lifetime utility offered are small relative to the utility received from any one contract.

[11]The results depend only on the assumption that entry into all initial contracts (an unattached worker and firm) is not a marginal decision. This just means that any employment is strictly preferred to being unattached. The presence of fixed costs of entry is not important per se. See also notes 13 and 16.

[12]These rules will maximize the surplus from each of these decisions. E.g., the expected gain from transferring a laid-off worker with index S to a match producing Y is $V_E(S) + V_P(Y,S) + V_N - V_L(S) - V_N - V_T(S) - C$ which is maximized by $Y = X_L$.

[13]For all initial contracts to be strictly preferred over the unattached positions it must be that $V_T(R) + V_L(R) > V_U + V_N$ or with fixed costs of entry $V_T(R) + V_L(R) - C > V_U + V_N$.

[14]See the appendix for the distribution $J(\cdot)$ in the case $C = 0$.

[15]Choice of the optimal steady state is the appropriate criterion since steady states can be indexed by R and movement across steady states is instantaneous and costless. Were it the case that movement to a new steady state occurred along a transition path, the analysis would be more complex.

[16]If initial contract entry entailed fixed costs and were a marginal decision, then a similar externality effect would occur from this initial entry. By assuming that entry is strictly preferred to remaining unattached this effect has no efficiency implications, (technically the private surplus from entry must be greater than the value of the externality imposed on other unattached firms).

[17]It is still the case that $R = h$, however.

[18]This is exactly analogous to a standard search model where the reservation wage is set to optimally trade-off accepting now and waiting for something better.

[19]Only the subsidy affects R and X_L provided that the public benefit, B, is not set so high as to drive the optimal private benefit, b, to a corner, $b = 0$.

[20]Being concerned with the efficiency of the labor allocation is not as narrow as it may appear. With unrestricted private contracting the risk allocation is constrained efficient. Also, there is no scope in this model for UI to redistribute income or stabilize aggregate shocks.

[21]This is true for both of the cases $C = 0$ and $C > 0$.

[22]This is sufficient for the purposes of this paper which include determining when a UI subsidy is welfare improving and analyzing the channels through which the UI system affects turnover decisions. In addition, calculating the second-best optimum would be quite difficult and, given the stylized nature of the model, does not seem worth the effort in terms of insight gained.

[23]This is true whether there are fixed costs, C, of entering a contract or not.

CHAPTER TWO

Restrictions on Contracting and The Role for Unemployment Insurance

I. Introduction

The model of the previous chapter assumed that there were no restrictions on the ability of firms and workers to negotiate contracts. The present chapter develops a model in which firm and worker are unable to negotiate such a first-best contract because of observability and enforcement problems. Specifically, if the firm and the worker cannot each observe the value of the other's position after a layoff has occurred, then the provision of private unemployment payments is infeasible. Also, that portion of the contract which governs the acceptance of new job offers by the worker on layoff will not be enforceable if the worker can make the decision privately without the firm having recourse.

The purpose of this chapter is to analyze the effect which public unemployment insurance (UI) will have on individual contracts when there are certain restrictions on contracting. With the focus on a single contract the analysis is essentially partial equilibrium. In the previous chapter, which investigated labor market equilibrium, the presence of unrestricted contracting implied that there was an efficiency-improving role for UI only if fixed mobility costs together with the search process generated an externality from the inter-firm transfer of a worker. In the present chapter the inability of firm and worker to include certain provisions in the employment contract implies that public UI can have salutary effects on individual contracts by helping to offset

the presence of these restriction on contracting.

The next section describes the model when contracting is unrestricted. The first-order conditions for an optimal contract are derived and discussed. In the third section the model is then recast in a contracting environment which precludes private unemployment payments. The first-order conditions for a (constrained) optimal contract are derived. It is then shown that introducing fully experience-rated UI benefits will increase the value of the contract. In fact, the optimal contract from section one can be restored by a fully experience-rated UI system. The fourth section presents the model when the decision of the laid-off worker to accept another job is made by the worker alone rather than specified in the contract (and thus reflecting the interests of both the firm and worker). If the laid-off worker's decision to accept another job imposes a loss on the firm, then the payment of a public UI benefit will raise the worker's reservation wage, thereby helping to prevent such a loss, which increases the value of the contract. A final section summarizes the implications of the results for the design of an UI system. The analyses of sections three and four reveal two separate channels through which public UI can possibly improve contract performance when there are restrictions on contracting.

II. Unrestricted Contracting

Consider a three-period model with a firm selling its output in a competitive market buffeted by demand shocks from

period to period. For simplicity, assume that the price is high (p_1) in the first and third periods and low ($p_2 < p_1$) in the second period.[1] The firm produces via the production function $g(\cdot)$ using labor as the only variable factor, with $g'(\cdot) > 0$ and $g''(\cdot) < 0$. The firm will choose a workforce, E_1, at the beginning of period one. The labor market in this first period, due to the absence of outside insurance or capital markets, is a market for three-period (lifetime) contracts which clears at the expected utility level, $\bar{V}$. A contract offer includes the wage paid to employed workers in each period, w_1, w_2, and w_3; a fraction, r, of the workforce to be retained when demand is low (the workforce in period two is rE_1); and a private unemployment payment, b, made to workers remaining on layoff in period two.[2] Recall of all laid-off workers occurs in the third period with certainty.

It is assumed that these contracts are always binding on the firm and are binding on employed workers. The labor market re-opens in the second period and workers on layoff receive one offer from the exogenous distribution $F(\cdot)$.[3] The offer is a contract for employment in the two remaining periods. If an offer x is accepted, then the worker receives the expected discounted utility V(x) over the two periods, where x is an index of contract value, with $V'(x) > 0$. A worker who remains on layoff receives the (certain) utility $U(h + b) + DU(w_3)$; where $U(\cdot)$ is the one period, concave utility function over income, D is a discount factor

$(D = 1/(1 + i))$, and h is the income value of leisure. The employment contract will also include a reservation value for the acceptance of a new offer by the laid-off worker. The contract will specify an A such that all offers $x > A$ are accepted and all offers $x \leq A$ are rejected. In the third period, a spot market for labor will clear at the wage w' (from this single firm's perspective in period one, w' is exogenous and certain). In period three the firm will again choose a workforce, E_3, consisting of all those employees under contract from period one (retained or successfully recalled) and paid w_3, plus any new hires the firm may make at the wage w'.

The problem facing the firm in period one is to maximize the present value of its expected profits, W_1, given by

$$(1) \quad W_1 = p_1 g(E_1) - w_1 E_1 + D\big(p_2 g(rE_1) - w_2 rE_1 - bF(A)(1 - r)E_1\big) + D^2\{p_1 g(E_3) - w'E_3 + (w' - w_3)E_1\big(r + (1 - r)F(A)\big)\}$$

subject to providing each member of its workforce, E_1, with an expected utility level, V_1, at least as great as $\bar{V}$:

$$(2) \quad V_1 = U(w_1) + rD\big(U(w_2) + DU(w_3)\big) + (1 - r)D\{\int_A^e V(x)dF(x) + F(A)\big(U(h + b) + DU(w_3)\big)\} \geq \bar{V} \quad .$$

$(w' - w_3)$ is the premium which must be paid to newly hired workers in period three. The expected workforce from period one which remains in period three is $E_1\big(r + (1 - r)F(A)\big)$. For w' sufficiently high (relative to $\bar{V}$) the firm would

prefer to employ recalled workers instead of new hires (i.e., when w_3 is chosen such that $w' > w_3$).[4]

Employing the Lagrange multiplier, y, the firm's task in period one can be expressed using (1) and (2), as[5]

$$(3) \qquad \underset{\{w_1,w_2,w_3,b,A,E_1,r,y\}}{MAX} \quad L = W_1 + y(V_1 - \bar{V}) \quad .$$

The first-order conditions for an interior solution of (3) can be written as

$$(4) \quad E_1 = yU'(w_1)$$

$$(5) \quad E_1 = yU'(w_2)$$

$$(6) \quad E_1 = yU'(w_3)$$

$$(7) \quad E_1 = yU'(h + b)$$

$$(8) \quad V(A) = U(h + b) + DU(w_3) + U'(w_1)\left(D(w' - w_3) - b\right)$$

$$(9) \quad p_1 g'(E_1) - w_1 + D\left(rp_2 g'(rE_1) - w_2 r - bF(A)(1 - r)\right) + D^2(w' - w_3)\left(r + (1 - r)F(A)\right) = 0$$

$$(10) \quad E_1 p_2 g'(rE_1) - w_2 E_1 + bF(A)E_1 + D(w' - w_3)E_1(1 - F(A)) + y\{U(w_2) + DU(w_3) - {}_A\int^e V(x)dF(x) - F(A)\left(U(h + b) + DU(w_3)\right)\} = 0$$

$$(11) \quad V_1 = \bar{V} \quad .$$

(4) - (7) imply that the worker under contract receives a constant payment (including leisure value), $w_1 = w_2 = w_3 = h + b$. The condition (8), which determines A, includes the effects

on both the firm and worker of the worker moving to a new job. This ensures that the separation decision maximizes the value of the contract (i.e., maximizes W_1 given $\bar{V}$). Using (4) - (8), condition (10) for the choice of r can be written as

$$(10') \quad p_2 g'(rE_1) = h + \frac{\int_A^e [V(x) - V(A)]dF(x)}{U'(w_2)}$$

which says that the marginal revenue product in the low-demand period is equated to the dollar value of leisure (which is the difference, $w_2 - b$, in the payments the firm makes to employed and laid-off workers) plus the expected gain in expected utility for the worker over the breakeven level V(A) (which includes the premium $w' - w_3$) from accepting another job, normalized by the worker's marginal utility.

The contract smooths the payments to the worker under contract, which is optimal given that $U(\cdot)$ is concave. The choice of A allows the firm and worker to optimally exploit the gain available from the re-opened labor market while taking into account the firm's desire to employ recalled workers in period three if $w' > w_3$ (and vice versa). The inability of the contract to set either b or A will alter these conclusions and have distinct implications for the effect of public UI.

It is worth noting how UI will affect the provisions of the present contract.[6] The inclusion of a UI system which makes a benefit payment, B, to workers remaining on layoff, which is financed by a tax on the firm of θB per worker

receiving benefits (where θ is the experience rating parameter and $\theta = 1$ means full experience rating) alters W_1 and V_1 as follows:

$$(1') \quad W_1 = p_1 g(E_1) - w_1 E_1 + D\big(p_2 g(rE_1) - w_2 rE_1 - (b + \theta B)F(A)(1 - r)E_1\big) + D^2\{p_1 g(E_3) - w'E_3 + (w' - w_3)E_1\big(r + (1 - r)F(A)\big)\}$$

$$(2') \quad V_1 = U(w_1) + rD\big(U(w_2 + DU(w_3)\big) + (1 - r)D\{{}_A\int^e V(x)dF(x) + F(A)\big(U(h + B + b) + DU(w_3)\big)\} \geq \bar{V} \quad .$$

Obviously, a subsidized (i.e., when $\theta < 1$) increase in B from zero will increase the firm's profits for any $\bar{V}$.[7] However, when the UI system is fully experience rated ($\theta = 1$), public benefits, B, and private payments, b, are perfect substitutes. Thus any fully experience-rated change in public benefits will be exactly offset by a change in private payments (provided b is not at a corner) with no effect on the contract's value or any other choice variable. This is analogous to the result in chapter one where only changes in the UI subsidy ($S = B(1 - \theta)$) affected the behavior of the choice variables other than b.

III. No Private Unemployment Payments

Consider an alternative contracting regime where private unemployment payments are infeasible because of observability problems or transactions costs, thus $b = 0$. It is still the case that the reservation acceptance value, A, is specified in the contract.

The firm's problem is now to

$$\begin{aligned}(3A)\qquad \underset{\{w_1,w_2,w_3,A,E_1,r,y\}}{MAX} \quad L \;=\; & p_1 g(E_1) - w_1 E_1 \\ & + D\left(p_2 g(rE_1) - w_2 rE_1\right) \\ & + D^2\{p_1 g(E_3) - w'E_3 \\ & + (w' - w_3)E_1\left(r + (1 - r)F(A)\right)\} \\ & + y\{U(w_1) + rD\left(U(w_2) + DU(w_3)\right) \\ & + (1 - r)D\left({}_A\int^e V(x)\,dF(x)\right. \\ & \left. + F(A)\left(U(h) + DU(w_3)\right)\right) - \bar{V} \quad .\end{aligned}$$

The first-order conditions for (3A) are given by

$$(4A)\qquad E_1 = yU'(w_1)$$

$$(5A)\qquad E_1 = yU'(w_2)$$

$$(6A)\qquad E = yU'(w_3)$$

$$(8A)\qquad V(A) = U(h) + DU(w_3) + U'(w_1)D(w' - w_3)$$

$$\begin{aligned}(9A)\qquad & p_1 g'(E_1) - w_1 + D\left(rp_2 g'(rE_1) - w_2 r\right) \\ & + D^2(w' - w_3)\left(r + (1 - r)F(A)\right) = 0\end{aligned}$$

$$\begin{aligned}(10A)\qquad & E_1 p_2 g'(rE_1) - w_2 E_1 + D(w' - w_3)E(1 - F(A)) + \\ & + y\{U(w_2) + DU(w_3) - {}_A\int^e V(x)\,dF(x) - F(A)\left(U(h)\right. \\ & \left. + DU(w_3)\right)\} = 0\end{aligned}$$

$$(11A)\qquad V_1 = \bar{V} \quad .$$

(4A) - (6A) imply that the worker receives a constant wage in this contract, $w_1 = w_2 = w_3$. With private unemployment payments infeasible the worker receives a lower utility, U(h),

while remaining on layoff, assuming $\bar{V}$ is such that $w_1 > h$. The reservation value A, determined by (8A), again guarantees that the separation decision takes into account the interests of both the firm and the worker.

The condition (10A) for the choice of the retention fraction r can be written as

$$(10A') \quad p_2 g'(rE_1) = w_2 - \frac{U(w_2) - u(h)}{U'(w_2)} + \frac{\int_A^e \left(V(x) - V(A)\right) dF(x)}{U'(w_2)}$$

Comparing this to (10') we see that again the firm equates marginal revenue product in the low-demand period to the difference in the payments it makes to employed and laid-off workers (note, b = 0) plus the expected gain in expected utility for the worker over the breakeven level V(A) from accepting another job. There is, however, another term in (10A') which captures the decrement to the worker's utility caused by moving from employment to layoff.[8] The first two terms of (10A)--$\{w_2 - \left(U(w_2) - U(h)\right)/U'(w_2)\}$--have a downward impact on the low-demand marginal revenue product, relative to the case where b can be paid, implying upward pressure on r. This is the result of the early implicit contracting literature (see Baily 1974) which found that firms would "over-employ" workers as a second-best means of providing income insurance.

The introduction of a public UI system, even with full experience rating, will increase the value of the contract (increase profits for any $\bar{V}$). Recall that fully experience-

rated UI benefits are perfect substitutes for private unemployment payments. If the b = 0 constraint binds, then such benefits provide a means to circumvent this constraint thereby increasing the firm's profits, given $\bar{V}$.

Including a UI system implies that the Lagrangian to be maximized in (3A) becomes

$$\begin{aligned}(12A)\quad L = {} & p_1 g(E_1) - w_1 E_1 + D\big(p_2 g(rE_1) - w_2 rE_1 \\ & - \theta B F(A)(1 - r)E_1\big) + D^2\{p_1 g(E_3) - w'E_3 \\ & + (w' - w_3)E\big(r + (1 - r)F(A)\big)\} + y\{U(w_1) \\ & + rD\big(U(w_2) + DU(w_3)\big) + (1 - r)D\big({}_A\!\int^{e} V(x)\,dF(x) \\ & + F(A)\big(U(h + B) + DU(w_3)\big)\big) - \bar{V}\} \quad .\end{aligned}$$

The effect on profits of an infinitesimal increase in B from zero is given by (using the envelope theorem)

$$(13A)\quad \big(-\theta E_1 + yU'(h)\big)(1 - r)DF(A) \quad .$$

The expression in (13A) is positive when $yU'(h) > \theta E_1$. The interesting case is full experience rating ($\theta = 1$), since an increase in subsidized benefits always raises profits. Profits will be increased by the introduction of fully experience-rated UI benefits if $yU'(h) > E_1$, which is true when $\bar{V}$ is high enough to imply $w_2 > h$, using (6A). This just says that when $\bar{V}$ is high enough so that the b = 0 constraint binds, then the introduction of fully experience-rated UI benefits, which are perfect substitutes for private payments, will help to loosen this constraint and raise profits. Moreover, the unrestricted contract of section II can be

replicated by a fully experience-rated UI system where the benefit, B, is set equal to the level of the private payment, b, which would be chosen if such payments were feasible (i.e., set $B = B(w_1) = w_1 - h$ and set $\Theta = 1$).

IV. The Worker Chooses A

Now consider a contracting regime where the worker on layoff privately decides whether or not to accept the new job offer x, without regard to the incumbent firm. Private unemployment payments will be assumed feasible, so that the analysis can concentrate on one contract restriction at a time. The firm will be affected by the worker's choice of A. As such, the firm's choice of the (constrained) optimal contract for a given $\bar{V}$ will reflect the impact certain of the contract provisions have on the worker's choice of A. Specifically, the greater the utility the worker receives from remaining on layoff the less likely he will be to accept another job. The contract provisions which affect the utility of a laid-off worker are the private unemployment payment, b, which he receives and the wage, w_3, which he will receive when recalled in period three. The introduction of public UI will also affect the worker's acceptance decision.

Formally, the firm's problem is to

$$(3B) \qquad \underset{\{w_1,w_2,w_3,b,E_1,r,y\}}{MAX} \quad L = p_1 g(E_1) - w_1 E_1 + D\big(p_2 g(rE_1) - w_2 rE_1 - bF(A)(1 - r)E_1\big) + D^2\{p_1 g(E_3) - w'E_3 + (w' - w_3)E_1\big(r + (1 - r)F(A)\big)\} + y\{U(w_1) + rD\big(U(w_2) + DU(w_3)\big) + (1 - r)D\big({}_A\int^e V(x)\,dF(x) + F(A)\big(U(h + b) + DU(w_3)\big)\big) - \bar{V}\} .$$

The worker will choose A to maximize

$${}_A\int^e V(x)\,dF(x) + F(A)\big(U(h + b) + DU(w_3)\big)$$

which gives the following implicit equation for A

$$(8B) \quad V(A) = U(h + b) + DU(w_3)$$

Hence $A = A(w_3,b)$ with $A_1 > 0$ and $A_2 > 0$ since $V'(A) > 0$. Given the equation for A, the first-order conditions for (3B) can be written as

$$(4B) \quad E_1 = yU'(w_1)$$

$$(5B) \quad E_1 = yU'(w_2)$$

$$(6B) \quad \big(-b + D(w' - w_3)\big)(1 - r)DE_1 f(A)A_1 + \big(-E_1 + yU'(w_3)\big)D^2\big(r + (1 - r)F(A)\big) = 0$$

$$(7B) \quad \big(-b + D(w' - w_3)\big)(1 - r)DE_1 f(A)A_2 + \big(-E_1 + yU'(h + b)\big)DF(A)(1 - r) = 0$$

$$(9B) \quad p_1 g'(E_1) - w_1 + D\big(rp_2 g'(rE_1) - w_2 r - bF(A)(1 - r)\big) + D^2(w' - w_3)\big(r + (1 - r)F(A)\big) = 0$$

$$(10B)\quad E_1 p_2 g'(rE_1) - w_2 E_1 + bF(A)E_1 + D(w' - w_3)E_1(1 - F(A)) + y\{U(w_2) + DU(w_3) - {}_A\int^e V(x)dF(x) - F(A)\left[U(h + b) + DU(w_3)\right]\} = 0$$

$$(11B)\quad V_1 = \bar{V} \quad .$$

(4B) and (5B) imply the wage is constant over the first two periods, $w_1 = w_2$. Both condition (6B) for w_3 and condition (7B) for b include the effect these contract provisions have on the worker's choice of A. (6B) and (7B) can be rewritten using (4B) as

$$(6B')\quad \frac{U'(w_3)}{U'(w_1)} = 1 - \frac{\left(D(w' - w_3) - b\right)(1 - r)f(A)A_1}{\left(r + (1 - r)F(A)\right)D}$$

$$(7B')\quad \frac{U'(h + b)}{U'(w_1)} = 1 - \left(D(w' - w_3) - b\right)A_2\frac{f(A)}{F(A)} \quad .$$

Thus $D(w' - w_3) - b > 0$ implies $w_3 > w_1$ and $b + h > w_1$. This is the case where w' is large enough, given $\bar{V}$, to result in a loss being imposed on the firm when the worker accepts another job. The firm loses if the discounted payment required to replace the worker with a new hire, Dw', is greater than what the firm would pay this worker if he did not accept another job, $b + Dw_3$. In this case, the payments to the worker are skewed away from a perfectly smooth pattern in an attempt to raise A and lessen the expected loss imposed on the firm by the worker's acceptance decision. In comparing the relative magnitudes of w_3 and $h + b$, (6B) and (7B) can be combined to yield

$$-E_1D(1 - r)F(A)\left(U'(h + b) - U'(w_3)\right)$$
$$+ DrU'(h + b)\left(-E_1 + yU'(w_3)\right) = 0 \quad .$$

In the case $D(w' - w_3) + b > 0$, this implies, using (4B) - (6B), $h + b > w_3 > w_2 = w_1$. Alternatively, $D(w' - w_3) + b < 0$ implies $w_1 = w_2 > w_3 > h + b$. In skewing these payments to a laid-off worker the firm realizes that the third period wage is also paid to those workers who were retained in period two and thus do not need any incentive to remain with the firm. Thus the firm makes the more extreme payment, $h + b$, directly to those workers whose separation decision can be influenced.

Now to analyze the firm's choice of the retention fraction fraction r. Using (5B) and (8B), (10B) implies

$$(10B') \quad p_2g'(rE_1) = w_2 - b - \frac{U(w_2) - U(h + b)}{U'(w_2)}$$
$$+ \frac{A\int^{e}\{V(x) - V(A) - U'(w_1)\left(D(w' - w_3) - b\right)\}dF(X)}{U'(w_2)} \quad .$$

Comparing this to (10') for the first-best contract reveals two things. With $w_2 \neq b + h$ there is a difference in the payment streams for employment and layoff. The first three terms of (10B') include the effects of this difference on both firm and worker in the choice of r. If payments were constant then $w_2 = b + h$ and these three terms would collapse to h which is the first term in (10'). Substituting the relevant expression for V(A) into the integral terms in (10')

and (10B') (substitute (7) into (10') and (7B) into (10B')), we see that these two terms are equal with a numerator of

$$\int_A^e \{V(X) - U(h+b) - DU(w_3) - U'(w_1)\left(D(w' - w_3) - b\right)\}dF(X).$$

Thus, in either contracting environment, the firm is able to set r based on the expected joint gain (or loss) which the firm and worker experience from the acceptance of a new job.

To summarize, compare the provisions of this contract with those of the fully optimal contract in section two. The firm makes a private unemployment payment, b, and a third period wage, w_3, which attempt to influence the worker's choice of A to the firm's benefit. The unemployment payment is a more effective (or less costly) instrument for affecting A since w_3 is received by all workers and b is received only by those who actually choose an A. Each worker, then, receives an uneven payment stream throughout his contract. The firm's choice of a retention fraction, r, recognizes this uneven payment pattern.

It is interesting to examine the source of the inefficiency in this model before analyzing the impact which public UI will have. The inability of the firm and worker to include the choice of the reservation acceptance value A in the contract results in the worker's private decision on A not balancing all of the gains and losses from accepting a new job. The worker's decision essentially imposes an externality on the firm which is either negative or positive depending on the sign of $D(w' - w_3) - b$. Since the firm

makes payments to the laid-off worker (both while on layoff and after recall) it would seem that A could be indirectly controlled to mimic the unrestricted contract. This is not the case. The concavity of $U(\cdot)$ implies that an optimal contract has equal payments (including leisure) to the worker. The firm is thus constrained in its attempt to control A by the need to smooth the worker's payments and a full optimum cannot be achieved. In the parlance of external effects, the method of making side payments is also the method of allocating risk, hence the second-best solution for the contract.[9]

When choosing a contract the firm must trade-off making smooth payments to the worker and indirectly affecting A through the payments b and w_3. If the firm's solution to this problem results in the firm incurring a loss when a laid-off worker accepts another job (i.e., w' is high enough that the choices of w_3 and b imply $D(w' - w_3) - b > 0$), then public UI can bring about a partial improvement in the contract. The payment of public UI benefits in an attempt to influence the choice of A, will be beset by the same problems involving the desire to smooth the worker's income when $U(\cdot)$ is concave, which again precludes the attainment of a full optimum.

As shown in section two, the introduction of fully experience-rated UI benefits will merely substitute for a portion of the private payment b, without affecting any other choice variable or firm profits (for a given $\bar{V}$). The analysis will assume there to be no experience rating (i.e.,

$\theta = 0$), hence all public UI benefits will be fully subsidized. The payment of a UI benefit, B, will only enter the maximization in (3B) through the utility in period two of the worker remaining on layoff--$U(h + b + B)$. B will also affect the worker's choice of A given implicitly by

$$(7B') \quad V(A) = U(h + b + B) + DU(w_3)$$

which implies $\frac{dA}{dB} > 0$. UI benefits increase the utility of remaining on layoff and thus increase the reservation value for accepting a new job while on layoff.

The effect on profits, given $\bar{V}$, of introducing an infinitesimal UI benefit with no experience rating is given by

$$(12B) \quad \left(\frac{dL}{dB}\right)_{B=0} = \left(\frac{\partial L}{\partial B}\right)_{B=0} + \frac{\partial L}{\partial A} \cdot \left(\frac{dA}{dB}\right)_{B=0}$$

$$= y(1 - r)DF(A)U'(h + b)$$

$$+ \left(-b + D(w' - w_3)\right)(1 - r)DE_1 f(A)A_2$$

using (7B') and the fact that B and b affect A in the same way. The first term is the direct effect of paying a subsidized benefit, which is positive. The second term represents the effect which B has on the worker's choice of A and thus indirectly on the firm's profits (provided $D(w' - w_3) \neq b$). If the firm incurs a loss from the worker's separation (when $D(w' - w_3) - b > 0$), then the UI benefit will lessen the likelihood of such a loss by raising the acceptance value A. This looks conspicuously like a Pigovian subsidy. Note, however, that the firm can make its

own payment to the worker on layoff which should preclude the need for any other corrective action, according to Coase's theorem. The problem here is the confounding of the side payment and the risk allocation.

The introduction of a subsidized UI benefit gives a free dollar to the contract. Being given to the laid-off worker, B causes A to rise. Because the firm cannot freely make side payments there is a trade-off between affecting A and skewing the worker's payments. The UI benefit raising A will improve the contract (increase profits given $\bar{V}$) when the result of this trade-off has the firm still losing from the worker's separation. Note, however, that the expression in (12B) is equal to (from (7B)) $DF(A)(1 - r)E_1$, which is just the expected number of workers remaining on layoff multiplied by the discount factor D. This implies that the effect of paying the subsidized benefit, B, is no different (on a per worker basis) than any other subsidized payment. The worker's choice of A is affected nonetheless, so B does have an incentive effect.[10] A full optimum cannot be achieved since the worker's incentive to separate and the risk allocation are not independently controlled.

V. Conclusion

When the ability of the firm and worker to negotiate a contract is restricted, the possibility that public UI can improve market performance is expanded. It was shown in

sections two, three and four that the inability to include unemployment payments or a separation decision provision in contracts, results in the firm and the worker altering those provisions which can be written into the contract (e.g., the retention fraction or the wage in period three) in an attempt to offset the constraints imposed by the limitations on contracting. To the extent that public UI can substitute for the "missing" contract provisions, these distortions will be lessened and the value of the contract (firm profits, given $\bar{V}$) will rise.

There are two channels through which UI can increase the value of the contract. In section three where private unemployment payments were precluded, public UI could substitute directly for private payments thereby loosening the constraint $b = 0$. In fact, a fully experience-rated UI system could replicate the unrestricted contract from section two. In section four it was shown that a subsidized UI benefit could lessen the likelihood of the firm suffering a loss from an inefficient separation. A full optimum cannot be achieved since there is no way to affect the worker's separation decision without affecting the risk allocation. Public UI, including both subsidized and fully experience-rated benefits, can help to alleviate the distortions of private behavior caused by limitations on contracting. however, the proper design of the UI system and the manner in which it affects private decisions, including labor turnover, depends crucially on the private contracting environment.

A worthwhile next step would be to combine the equilibrium analysis of chapter one with the restricted contracting regimes discussed here. Though quite complicated, this would give better insight into how an optimal UI system should be designed for a second-best labor market.

NOTES

[1]Thus the demand pattern is known with certainty.

[2]A first-best contract would have two payments to laid-off workers: b_L to workers remaining on layoff and b_A to workers accepting another job. It is assumed here that such a payment b_A is not feasible. In any case with workers choosing whether to accept the new job or not it seems quite likely that the optimal b_A is negative which would not be enforceable.

[3]The exogeneity of $F(\cdot)$ is obviously crucial to the validity of a partial equilibrium approach (see note 6). In addition, the offers from $F(\cdot)$ are assumed to represent expected marginal revenue products to avoid the issues involved with bargaining over surplusses and externalities of the search process which arose in chapter one.

[4]w' is meant to capture the higher wage which must be paid to attract a trained worker, or the wage and training costs of hiring an inexperienced worker to replace a worker who cannot be recalled. Thus w' reflects the match specific captial which accrues to the firm from its initial workforce. It must be mentioned that if the distribution $F(\cdot)$ is "good enough" and w' is high, then a worker may find it in his interest to not enter a contract in period one. However, one can imagine the labor markets in periods two and three for inexperienced labor as being different from those for experienced workers. It is assumed that $\bar{V}$, w' and $F(\cdot)$ are such that all workers enter a contract in period one.

[5]The firm will choose E_3 in period three, after the number of successful recalls is known. It is assumed that $E_3 \geq rE_1 + R$, where R is the number of laid-off workers who are successfully recalled by virtue of not taking an alternative job. Note that with binding contracts this condition is a constraint on the firm. Thus $E_3 = rE_1 + R$ when $p_1 g'(rE_1 + R) \leq w'$ and $E_3 > rE_1 + R$ when $p_1 g'(rE_1 + R) > w'$.

[6]The partial equilibrium analysis implicitly assumes that the introduction of a UI system will not have an effect on the market equilibrium as reflected by $\bar{V}$, $F(\cdot)$, and w'. This does not seem likely. The justification for this approach rests on the logic of proceeding one step at a time. The end product should couple the equilibrium approach of chapter one with the second-best contracting of this chapter.

[7]This is true since $\left(\frac{dL}{dB}\right)_{B=0} = \left(\frac{\partial L}{\partial B}\right)_{B=0} =$ $- D\theta F(A)(1 - r)E_1 + y(1 - r)DF(A)U'(h + b) > 0$, provided $\theta < 1$ and using (6), for an infinitesimal level of public benefits.

[8]Note that when the level of $\bar{V}$ implies $w_2 = h$, (10A') and (10') are identical. Indeed at this $\bar{V}$ the solutions to (3) and (3A) are the same since the optimal choice of b is zero, hence the constraint $b = 0$ has no effect.

[9]If $U(w) = w$ so that the pattern of payments is unimportant, then a full optimum can easily be achieved when the worker chooses A. This suggests that it is the inability to separate the side payments from the risk allocation which precludes attaining a full optimum.

[10]A full resolution of this seeming paradox regarding the effects of B will require a complete comparative statics analysis of the endogenous variables.

CHAPTER THREE

Observability, Private Contracts, and the Implications for Unemployment Insurance

I. Introduction

The one firm-one worker nature of the model in chapter one renders the analysis of a firm's layoff decisions problematic. In particular, such a models is unsuitable for generating implications concerning how layoff behavior is affected by public unemployment insurance (UI). This paper presents a simpler version of the model in chapter two to this end. Again, only a single firm is considered, thus largely ignoring market equilibrium. Of primary interest will be the implications for the effect of UI on layoff behavior when there are certain restrictions on the ability of the firm to make private unemployment payments to its laid-off workers.

The next section describes the model and derives the first-order condition for determining the level of private unemployment payments. Section three analyzes the two ways in which this first-order condition can fail to hold and gives examples of each. A method for distinguishing empirically between these two cases when the condition fails, which also distinguishes when the condition holds is then derived. This method relies on the fact that the firm will react differently to changes in fully experience-rated UI benefits, which are perfect substitutes for private unemployment payments made to workers remaining on layoff, depending on if and how the firm's ability to make such private payments is constrained. A fourth section empirically estimates the important parameter

defined in section three and discusses its implications for the nature of the private contracting environment. The final section summarizes the implications of this and the earlier chapters for the role that public UI can play in improving labor market performance.

II. The Model

Consider a two-period model with a firm selling its output in a competitive market buffeted by demand shocks from period to period. For simplicity, assume that the price is high (p_1) in the first period and low ($p_2 < p_1$) in the second period.[1] The firm produces via the production function $g(\cdot)$ using labor as the only variable factor, with $g'(\cdot) > 0$ and $g''(\cdot) < 0$. The firm will chose a workforce, E, at the beginning of period one. The labor market in this first period, due to the absence of outside insurance or capital markets, is a market for two-period (lifetime) contracts which clears at the expected utility level, $\underline{V}$. A contract offer by the firm consists of a wage, w_1, to be paid when demand is high (period one); a wage, w_2, paid to employed workers when demand is low (period two); a fraction, r, of the workforce to be retained when demand is low (the workforce in period two is rE); and a private unemployment payment, b, made to laid-off workers in period two.

It is assumed that these contracts are always binding on the firm and are binding on employed workers. The labor market re-opens in the second period and workers on layoff

find and accept another job with exogenous probability q. This new job pays the worker a wage X, thus providing utility U(X); where U(·) is the one period, concave utility function over income. If the worker remains on layoff (this occurs with probability 1 - q) the worker receives utility U(h + b + B); where h is the income value of leisure and B is the public UI benefit.[2] The emphasis here is on the features of the contract which the firm will offer. As it is described, the model differs from the standard implicit contract model only by allowing some worker mobility in the second period.

The problem facing the firm in period one is to maximize the present value of its expected profits, W_1, given by

$$(1) \quad W_1 = p_1 g(E) - w_1 E + D[p_2 g(rE) - w_2 rE - b(1 - r)(1 - q)E - \theta B(1 - r)(1 - q)E]$$

subject to providing each member of its workforce, E_1, with an expected utility level, V_1, at least as great as $\underline{V}$:

$$(2) \quad V_1 = U(w_1) + D\{rU(w_2) + (1-r)[qU(X) + (1-q)U(h+b+B)]\} \geq \underline{V}$$

where $D = 1/(1+i)$ is a discount factor. θ is the degree of experience rating of the UI system, hence $\theta B(1 - r)(1 - q)E$ gives the firm's expected UI tax payments (θB dollars per worker receiving benefits).

Employing the Lagrange multiplier, y, the firm's task in period one can be expressed using (1) and (2), as

(3) $\underset{\{E,r,w_1,w_2,b,y\}}{MAX}$ $L = W_1 + y(V_1 - \underline{V})$.

The first-order conditions for an interior solution of (3) can be written (after some rearrangement) as

(4) $p_1 g'(E) - w_1 + D[rp_2 g'(rE_1) - w_2 r - b(1 - r)(1 - q) - \theta B(1 - r)(1 - q)] = 0$

(5) $[Ep_2 g'(rE) - w_2 E + b(1 - q)E + \theta B(1 - q)E] + y\{U(w_2) - qU(X) - (1 - q)U(h + b + B)]\} = 0$

(6) $E = yU'(w_1)$

(7) $E = yU'(w_2) \Rightarrow U'(w_1) = U'(w_2)$

(8) $E = yU'(h + b + B) \Rightarrow U'(w_1) = U'(h + b + B)$

(9) $V_1 = \underline{V}$.

(6), (7) and (8) imply that the worker receives a constant payment (including leisure value), $w_1 = w_2 = h + B + b$.

Equation (8) is the condition for an interior solution of the private unemployment payment, b. It may be the case, however, that there is some constraint which prevents the firm from setting b to satisfy (8). The next section analyzes the condition in (8) and discusses circumstances under which it may not hold.

III. Restrictions on Private Unemployment Payments and the Implications for UI

There are two possibilities for the first-order condition concerning the private unemployment payment, b, if (8) is not satisfied:

$$(8A) \quad U'(w_1) > U'(h + B + b^*)$$

$$(8B) \quad U'(w_1) < U'(h + B + b^*)$$

where b* is the actual private payment made by the firm. If (8A) is true then the firm would prefer to make a lower payment, given h, B, and w_1, but is somehow prevented from doing so. This case would occur if h and B were great enough, relative to V, that the level of b which satisfies the equality condition in (8) is negative, and if such negative payments were unenforceable. This is the case of public UI benefits being large enough, given the other variables in the model, that the payment of a positive private unemployment payment is unnecessary, hence b* = 0 in (8A). Thus, in this case, the constraint which prevents (8) from being satisfied is the inability of contracts to include a provision for laid-off workers to pay their former employer when UI benefits are overly generous.

When (8B) is true the constraint on the private payment b is binding from above. The firm would prefer a higher level of b given w_1, h, and B, but for some reason does not pay it. It is difficult to imagine any constraint which would directly

limit the size of b. However, consider the following adaptation of the model from the previous section, where a restriction on the ability of the firm to observe the behavior of its laid-off workers can lead to a contract with (8B) true.

Assume that the firm cannot observe whether a given worker on layoff has taken another job. Thus any private unemployment payment cannot be made contingent on the worker remaining on layoff. Let b' represent this payment, which must now be paid to all laid-off workers. In contrast, it is assumed that the government can observe job-taking behavior and pays B only to those workers on layoff.[3] With all other aspects of the model unchanged the firm's problem is now

$$\text{(10)} \quad \underset{\{E,r,w_1,w_2,b',y\}}{\text{MAX}} \; p_1 g(E) - w_1 E + D[p_2 g(rE) - w_2 rE - b'(1 - r)E - \theta B(1 - r)(1 - q)E + y\{U(w_1) + DrU(w_2) + D(1 - r)[qU(X + b') + (1 - q)U(h + B + b')] - \underline{V}\} \quad .$$

The first-order conditions for b' and r are

$$\text{(11)} \quad U'(w_1) = qU'(X + b') + (1 - q)U'(h + B + b')$$

$$\text{(12)} \quad [Ep_2 g'(rE) - w_2 E + b'E + \theta B(1 - q)E + y\{U(w_2) - qU(X + b') - (1 - q)U(h + b' + B)]\} = 0.$$

With this restriction on observability, the private unemployment payment will be set according to equation (11). Maintaining the assumption that the alternative job is lucrative enough so that $X > w_1$ prevails, (11) implies

$U'(x + b') < U'(w_1) < U'(h + B + b')$.[4] Hence, (8B) is true with $b^* = b'$. This is the case where the high alternative wage, X, and the probability of finding this wage, q, coupled with the firm's inability to observe the worker's post-layoff employment status, implies that the private unemployment payment is constrained below the level which would be chosen were contingent payments possible.

To summarize, the three possibilities for the choice of the contingent payment b are 1) the firm is able to pay the level of b it desires, thus (8) is true; 2) the firm cannot set b as low as it would like, hence (8A) is true; or 3) the firm cannot pay as large a b (or perhaps any b) as it desires, thus (8B) is true. A plausible reason for the second possibility was shown to be a generous public UI benefit coupled with the inability to enforce a negative b. The third possibility might occur when the firm can only make a non-contingent payment, b', to laid-off workers and the possible alternative wage, X, is high. It turns out that these three possibilities regarding how the contingent payment b is constrained (if at all) can be empirically distinguished by observing how the firm reacts to changes in the UI parameters, B and θ.

Since the government is assumed to be able to monitor the employment status of workers, fully experience-rated UI benefits (i.e., $\theta = 1$) are perfect substitutes for contingent private unemployment payments. Thus the manner in which the firm responds to changes in θ and B which leave the UI subsidy

($S = B(1 - \theta)$; this is the subsidy per worker receiving benefits) unchanged, will imply which of (8), (8A), or (8B) is true. The intuition is as follows. If the firm is able to pay the level of contingent payments, b, it desires ((8) is true), then a change in fully experience-rated UI benefits will be exactly offset by a change in b with no other choice variable affected. This case has provided the basis for empirical work which has regressed some aspect of firm behavior (e.g., layoff rates) on a measure of the UI subsidy (see Topel 1982a). However, if the firm cannot make the payment b at the level it desires, then such an offset will not occur and other choice variables (e.g., the retention fraction r) will be affected by these changes in fully experience-rated benefits. When the firm would like to pay a lower b ((8A) is true), an equal increase in UI benefits and taxes per worker is equivalent to an increase in b which the firm views as "bad" (profits decline given $\underline{V}$) and tries to avoid by altering its other decisions (e.g., by raising r to partially avoid the changes in UI). On the other hand, when the firm would like to pay a higher (contingent) payment ((8B) is true) the equal increase in benefits and taxes is beneficial to the firm and it takes actions to exploit this, such as lowering r, thereby capturing more of these fully-experience rated benefits.

Now to formalize somewhat the effects of changes in the UI parameters on the retention fraction r, and thus on the layoff rate, given by $1 - r$. Changes in B and θ which

maintain the amount of the subsidy (to first order) satisfy $(1 - \theta)dB - Bd\theta = 0$. Alternatively, defining $T = \theta B$ as the unemployment insurance tax which the firm pays for each worker receiving benefits, changes in B and T which maintain the subsidy satisfy $dB - dT = 0$.[5] Thus $\frac{dr}{dB} + \frac{dr}{dT}$ represents the total effect on the retention fraction of a change in UI benefits and taxes which leaves the UI subsidy unchanged. Comparative statics results for B and T from the models above can be shown to imply that $\frac{dr}{dB} + \frac{dr}{dT} \gtrless 0$ as $U'(w_1) \gtrless U'(h + B + b^*)$, where b^* is again the actual payment (whether contingent or not) the firm makes.[6] This says that an increase in fully experience-rated UI benefits will alternately increase, have no effect on, or decrease the retention fraction as the firm's actual private unemployment payment is above, equal to, or below the level of the contingent payment b which it desires to pay. For the purpose of analyzing the effects of UI when b is possibly constrained from the level which satisfies (8), define $A = B - zT$, where z is a descriptive parameter which will capture the difference in the responses of the choice variables to changes in B and T, respectively. Hence $z = -\frac{dr/dT}{dr/dB}$. A, which is a generalization of the actual subsidy S, is, in effect, the "parameter" of the UI system which affects firm behavior. However, z is not constant but is determined by the firm as it responds to changes in B and T.[7] The comparative statics results also imply $\frac{dr}{dB} < 0$ and $\frac{dr}{dT} > 0$ as expected. Note that the firm behaves as if only

changes in B and T which change A have an effect on r.[8] From the definition of z and the result above it is apparent that z $\gtrless$ 1 as $U'(w_1) \gtrless U'(h + B + b^*)$. Thus, when the firm desires a lower b, z is greater than one and "taxes matter more", and when the firm would like to pay a higher b, z is less than one and "benefits matter more".

Anticipating the empirical work in the next section, the regression analysis will attempt to infer how the firm's layoff rate, 1 - r, is affected by changes in B and T while at the same time allowing z to be estimated. The estimate of z will provide information on the contracting environment of firm and worker. An estimate significantly less than one implies that there are constraints (informational or otherwise) which prevent the payment of (at least the desired level of) contingent private unemployment payments. An estimate significantly above one implies that public UI benefits (given UI taxes) are more than sufficient to fill the role of private unemployment payments and that a non-negativity constraint is binding on these payments. And if z is insignificantly different from one, this implies that contingent private unemployment payments are at the desired level given the existing public UI system. Thus not only can the simple effects of UI be determined but information on the nature of the constraints affecting the payment of private unemployment payments can be obtained.[9]

IV. Empirical Results

The implications of the theoretical model for an empirical investigation of the effects of public unemployment insurance on layoff behavior can be summarized in three points. 1) Using the UI subsidy, S as an explanatory variable in the equation describing layoff rates will give an inconsistent estimate of the subsidy's effect unless private unemployment payments are unconstrained and can be set optimally (i.e., unless $z = 1$). 2) The correct equation for the layoff rate includes B and T separately which allows the parameter z, reflecting the differential impact of UI benefits and taxes on layoffs, to be estimated. 3) The magnitude of the estimate of z provides information about the nature of the constraints on private contracting, with $\hat{z} > 1$ (< 1) implying that contingent private unemployment payments are constrained from below (above). This paper will present and compare the results of using the variables S and A to explain layoff rates, respectively, concentrating on the estimates of z and what these reveal about the private contracting environment.[10]

The equation to be estimated derives from the reduced form solution to the systems of first-order conditions for the firm's maximization problems given above in (3) and (10).[11] All of the data are aggregated to the two-digit SIC industry level. The regressions are essentially cross-section (by states) as the vast majority of variation in UI parameters occurs across states, though monthly data for the years 1961

and 1962 are used.[12] The layoff rate, LRATE, is equal to one minus the retention fraction, r. Define LRATE = 1 - r as the dependent variable for the estimation. The explanatory variables need to capture the effects of demand shocks and the alternative opportunities for laid-off workers as well as the effects of UI.[13] Demand shocks should drive the firm's layoff behavior being filtered through the effects of the UI system and the opportunities open to workers on layoff. An index of industrial output production, IP, is the variable used to represent demand fluctuations.[14] The search opportunities available to laid-off workers are measured, albeit crudely, by unemployment rates, UR.

The unemployment insurance parameters of interest are the level of benefits received, B, and the amount of taxes paid, T, per laid-off worker. UI taxes are actually levied as a payroll tax and are experience rated by changing the tax rate over time in response to the amount of benefits received by a firm's laid-off workers. Benefit payments are made weekly up to a maximum duration (in weeks). Considering these two institutional facts leads to the following specification of the UI variables. The payroll tax aspect is represented by the variable, TAX, which is the current UI tax rate times the wage base per worker upon which the tax is levied. Thus TAX represents the tax payments saved by laying-off a worker. The benefit level is measured by the maximum weekly benefit amount, WBA, and the maximum duration of payments in weeks, DUR. Experience rating is measured by the expected present

value, PV, of future tax increases caused by laying-off an additional worker, assuming static expectations about the UI tax schedule.[15]

The UI subsidy is the difference between benefits received and taxes paid from laying-off a worker. Thus, S = WBA - PV is the UI subsidy.[16] Whereas use of the variable A = WBA - z·PV, allows the parameter z to be estimated. The problem is to estimate the parameters of the function L(·) which gives the layoff rate as a function of these six variables:

$$LRATE = L(IP,UR,TAX,WBA,PV,DUR)$$

Estimates were derived using the two different specifications S and A for WBA and PV. The key point is what the estimates of z reveal about private contracts, given that the other parameter estimates seem reasonable.

The variables other than the UI subsidy variable can be expected to have the following effects on the layoff rate. Industrial production, IP, should have a negative effect since it takes less workers to produce less. The unemployment rate, UR, should also have a negative effect since a higher UR implies that X is lower (and perhaps q lower), hence there is less "insurance" to be gained by engaging in layoffs. The payroll tax portion of UI, TAX, should positively affect layoffs as would any payroll tax. The benefit duration variable, DUR, is more interesting though perhaps ambiguous. An increase in duration raises both the benefits received and

taxes paid from laying-off an additional worker. Expected benefit and tax payments are raised by the same proportion as DUR increases. The effect of DUR on the layoff rate should depend on whether $z \gtrless 1$, with the effect positive when $z < 1$ (more benefits and taxes increase layoffs) and the effect negative when $z > 1$.

Regressions were run for each of 15 two-digit manufacturing industries and then the data were pooled with fixed industry effects. Table 1 gives the results from ordinary least squares regressions using the actual subsidy, S (thus constraining $z = 1$). The subsidy variable was included in both linear and quadratic terms (S and S^2) as this significantly (at the 5% level) improved the fit in ten of the industries and also facilitates a better comparison with the estimates using A. The results give broad support to the theoretical implication that the UI subsidy increases layoff rates. Nine of the twelve industries in which the variables measuring the subsidy (DUR, S, and S^2) are jointly significant, exhibit a significant, positive response of the layoff rate to changes in the subsidy (either S or S^2).[17] In addition, the payroll tax, TAX, and demand shock, IP, variables generally perform well, though the alternative opportunities variable, UR, does poorly. The estimates derived from pooling the industries (including fixed industry effects which were significant) also generally support the hypothesis concerning the UI subsidy and layoff rate. Again the three variables measuring the subsidy are jointly

significant, though the individual coefficients for S and S^2 are imprecisely estimated. This is perhaps due to constraining these coefficients to be equal across all industries, since the pooling can be strongly rejected (the F-statistic is 8.07 which should be distributed as F(84,5103) having a critical value at the 1% level of about 1.6).

Using the variable A, instead of the subsidy, S, allows the parameter z to be estimated, from which inferences can be drawn about the efficacy of private contracting. Again separate regressions were run for each of the 15 industries and then the data were pooled with fixed industry effects. The equations, which include both A and A^2, were estimated using non-linear least squares in order to obtain estimates of z.[18] Table 2 gives the results of these regressions.

Again, the estimates tend to support the implications regarding the UI variables. It is interesting and instructive to compare the estimates from using A, with those based on the subsidy, S. In eleven of the fifteen industries, the estimate of z is significantly different from one. In these industries, constraining z to equal one yields inconsistent estimates of the effect of UI on layoff rates.

Aside from the implications for consistently estimating UI's effect, the estimates of the z's imply that private contracting is not very adept at reaching the Pareto frontier. The estimates of z are significantly less than one in eight industries. This indicates that these industries are somehow constrained from making private unemployment payments which

would benefit both firm and worker. In addition, with $z < 1$, the effects of increases in the subsidy caused by an increase in benefits are significantly larger than those estimated using the variable S in Table 1. Of the eleven industries with estimates of z significantly different from one, only three are greater than one, and one of these has the anomaly that the coefficients of A and A^2 are both negative.[19] An estimated z above one implies that the UI system is more than sufficient at providing a conduit for firms to pay their laid-off workers. In fact, negative private payments would be desired, if feasible. It is somewhat puzzling that the estimate of z from the pooled regression (with fixed industry effects) is significantly greater than one, given that most of the industries exhibit the opposite result. The pooling can be rejected quite strongly, however.

Further evidence of the inefficiency of private contracting is presented by the estimates of the parameters analogous to z from the other reduced form equations. The level of employment, EMP, is also an endogenous variable of the model. Define z' as the negative ratio of the effects on employment of changes in the UI tax, T, and benefit, B, parameters. Thus $z' = -\frac{dE/dT}{dE/dB}$, analogous to z. From the comparative statics results it can be shown that z and z' are both either greater than, equal to, or less than one. Thus z' has the same implications for the efficiency of private unemployment payments as does z. Table 3 presents the estimates of z' as well as those of z (from Table 2). Though

nine of the twelve industries for which convergence of the estimation procedure was achieved exhibit estimates of z' differing significantly from one, the comparison is less than encouraging. Only six of these twelve industries possess estimates of z' bearing the same relation to one as does the estimate of z for that industry. This is no better than if z and z' were each randomly distributed both above and below one.

In conclusion, the primary result of the empirical work implies that theoretical and empirical models which assume Pareto-efficient labor contracts may be woefully incorrect. Given that the model here generated reasonable estimates for the UI variables as well as the control variables the estimates of the z's, which imply that inefficient contracting is rampant, should be heeded. However, this enthusiasm for a belief in inefficiencies is tempered by the poor comparisons of the results from the two reduced form equations.[20]

This work is only a first step toward modelling labor market activity. It is encouraging that there appears to be an alternative to assuming whether contracts really work or not. These preliminary results indicate that they do not, at least concerning private unemployment payments. As always, the results are quite sensitive to the model. In particular, firms are beset by aggregate demand shocks which may induce permanent layoffs. There seems to be little understanding of how labor contracts are affected by these aggregate-demand-shock induced permanent separations. Such an understanding is

crucial to determining the proper role for UI. It is also not clear that firms are indeed risk neutral with respect to such shocks. More general models need to be built and tested before efficient contracting is ignored. It would seem, at least with public UI, which when fully experience-rated substitutes perfectly for private payments given observability, there will always be a way to test whether the implications of these more sophisticated models are in accord with private efficiency or not.

V. Conclusion

This paper has shown that the inability of firms to observe the job-acceptance behavior of workers on layoff may constrain private unemployment payments from being set at the first-best level. On the other hand, public unemployment insurance provisions may be sufficiently generous that the binding constraint on these private payments is the infeasibility of negative payments. The implications for the design of an UI system will be quite different depending upon which of these is the binding constraint. If, in fact, neither constraint is binding then only the UI subsidy, $S = B - T$, will affect labor turnover.

In the third section the variable A was introduced which captures the full impact on layoff behavior of changes in the UI parameters, B and T, regardless of which if any constraint is binding on the choice of b. This approach to measuring the

effects of UI on layoffs allows the determination of the parameter z which reflects the differential effects of benefits and taxes. It was then shown that $z > 1$ (< 1) implies that the contingent private payment, b, is above (below) the Pareto-optimal level. Empirical estimation of the parameter z for fifteen different two-digit manufacturing industries for the years 1961-1962 gave eleven estimates which differed significantly from one. Of these eleven, eight were below one implying that a fully experience-rated increase in benefits would be Pareto-improving in these industries. The results then, offer some support to the notion that private contracts are beset by many constraints which preclude reaching a first-best optimum.

Each of the chapters in this thesis has analyzed the possible role for public UI in improving labor market performance. The manner in which UI is able to affect behavior is intimately related to the nature of private contracts. First-best contracts relegate UI to the Pigovian function of correcting externalities in the labor allocation process, though such externalities may be rampant. In this case only the UI subsidy will affect behavior. The inability to negotiate first-best contracts because of constraints on the contracting environment implies larger opportunitites for UI to be beneficial. UI benefits, even when fully experience rated, can help to alleviate the distortions of private behavior, induced by the contracting constraints, which lead to inferior sets of possible bargaining solutions.

This is a crucial distinction. The existence of first-best contracts implies that UI can only improve the allocation of labor between contracts and that only the UI subsidy matters, since equal changes in UI benefits and taxes are exactly offset by private payment provisions. On the other hand, the allocation of labor within a single contract can be improved by UI when there are constraints on these private unemployment payments, and both the benefit and tax parameters will be important in determining the extent of this improvement. A method for distinguishing these two contract settings empirically was developed and implemented. The preliminary results favor (not surprisingly) the case against first-best contracting.

TABLE 1

Industry	Constant	TAX	IP	UR	DUR	S	S^2	R^2	SER	n
Foods**	120.6	.002	-.84	-7.6	.84	-.66	.001	.05	30.2	360
	(53.5)	(.001)	(.41)	(2.4)	(1.04)	(.91)	(.02)			
Textiles*	15.4	.002	-.52	.008	1.16	-.64	.016	.27	14.7	312
	(26.3)	(.001)	(.24)	(1.17)	(.51)	(.55)	(.008)			
Apparel	60.0	.003	-1.14	.78	.82	.13	-.002	.25	15.4	384
	(23.5)	(.00006)	(.21)	(.90)	(.46)	(.52)	(.009)			
Lumber*	87.0	-.0007	-.86	-.51	-.6	2.69	-.05	.13	17.8	360
	(22.1)	(.0007)	(.16)	(1.21)	(.5)	(.92)	(.02)			
Furniture &Fixtures	27.6	.0004	-.64	-.39	.82	1.55	-.029	.10	14.7	324
	(46.6)	(.0007)	(.41)	(2.83)	(.49)	(.91)	(.016)			
Paper* & Allied Products	118.1	.0033	-.62	.49	-3.42	1.40	-.026	.29	17.0	408
	(25.8)	(.0005)	(.24)	(1.09)	(.49)	(.49)	(.008)			
Printing* & Publishing	-4.4	.0001	.016	-.06	.46	-.20	.004	.03	5.02	348
	(15.5)	(.0002)	(.17)	(.49)	(.16)	(.18)	(.004)			
Chemicals*	-21.4	-.0004	.33	1.20	.29	.07	-.007	.09	10.4	360
	(23.1)	(.0004)	(.25)	(1.05)	(.29)	(.41)	(.008)			
Leather*	-53.7	.0025	.25	2.02	-.23	3.20	-.093	.18	13.1	252
	(20.5)	(.0006)	(.17)	(.89)	(.55)	(1.11)	(.026)			
Stone,* Clay&Glass	153.0	.0013	-1.03	-4.90	-.37	-2.23	.054	.21	16.5	384
	(22.7)	(.0006)	(.15)	(1.27)	(.45)	(.64)	(.012)			
Primary* Metals	45.2	.0016	-.48	.32	.34	-1.35	.022	.11	15.4	408
	(15.7)	(.0004)	(.10)	(.85)	(.45)	(.46)	(.008)			

TABLE 1 (cont.)

Industry	Constant	TAX	IP	UR	DUR	S	S^2	R^2	SER	n
Fabricated* Metal Products	84.7 (39.7)	.0007 (.0004)	-1.08 (.38)	-2.68 (1.93)	.48 (.40)	1.05 (.42)	-1.37 (.072)	.19	13.6	360
Machinery exc. Elec.	99.2 (21.6)	-.0007 (.0005)	-1.03 (.28)	1.90 (1.00)	-.26 (.34)	.04 (.41)	-.001 (.007)	.08	12.5	360
Electrical* Machinery	26.0 (25.2)	-.00005 (.0004)	-.19 (.27)	.88 (1.40)	.01 (.39)	-.86 (.39)	.016 (.007)	.04	12.4	324
Transport* Equip.	193.6 (63.8)	-.0025 (.0017)	-.93 (.49)	3.64 (3.65)	-6.41 (1.39)	6.90 (1.92)	-.12 (.04)	.17	44.0	264
All Ind.* Pooled	85.1 (7.7)	.0010 (.0002)	-.65 (.06)	-.59 (.36)	-.36 (.15)	.323 (.169)	-.005 (.003)	.14	19.4	5208

Ordinary least squares regressions with LRATE as the dependent variable.

The pooled regression included industry fixed effects which were significant at the 1% level.

*An F-test of the joint hypothesis that DUR, S, and S^2 do not affect LRATE was rejected at the 1% significance level.

**An F-test of the joint hypothesis that DUR, S, and S^2 do not affect LRATE was rejected at the 5% significance level.

TABLE 2

Industry	Constant	TAX	IP	UR	DUR	A	A^2	z	SER	n
Foods	111.8 (57.2)	.0017 (.0012)	-.84 (.41)	-7.7 (2.4)	1.62 (1.43)	-.79 (1.56)	.0003 (.02)	.59 (.44)	30.3	360
Textiles*	38.5 (32.1)	.0023 (.0008)	-.51 (.24)	-.03 (1.17)	1.10 (.53)	-2.03 (1.41)	.036 (.019)	.53 (.15)	14.6	312
Apparel*	102.2 (30.5)	.0023 (.0006)	-1.12 (.21)	.54 (.88)	.49 (.51)	-1.76 (1.27)	.029 (.017)	.084 (.099)	15.1	384
Lumber*	78.5 (21.1)	-.0001 (.008)	-.86 (.15)	-.26 (1.16)	.90 (.54)	2.33 (.66)	-.062 (.013)	1.68 (.12)	16.9	360
Furniture &Fixtures	28.2 (46.8)	.0004 (.0007)	-.64 (.41)	-.39 (2.39)	.88 (.57)	1.50 (.93)	-.028 (.016)	1.06 (.35)	14.7	324
Paper* & Allied Products	285.1 (28.0)	.0015 (.0005)	-.56 (.21)	-.03 (.95)	-2.04 (.50)	-6.35 (.86)	.052 (.009)	.66 (.11)	14.7	408
Printing* & Publishing	52.4 (18.3)	-.00004 (.0001)	.02 (.16)	-.04 (.47)	.18 (.19)	-3.30 (.61)	.051 (.009)	.33 (.04)	4.8	348
Chemicals*	-38.5 (22.7)	-.0005 (.0004)	.30 (.25)	1.17 (1.03)	1.20 (.41)	-.13 (.12)	-.006 (.005)	3.09 (.88)	10.2	360
Leather*	-25.2 (23.3)	.0025 (.0006)	.25 (.16)	1.96 (.88)	-.48 (.56)	.96 (1.40)	-.045 (.035)	1.37 (.39)	13.0	252
Stone Clay&Glass*	147.5 (22.5)	.0015 (.0007)	-1.03 (.15)	-4.86 (1.27)	-.62 (.51)	-1.63 (.67)	.046 (.013)	1.23 (.20)	16.5	384

TABLE 2 (cont.)

Industry	Constant	TAX	IP	UR	DUR	A	A^2	z	SER	n
Primary* Metals	84.6 (29.3)	.0011 (.0004)	-.48 (.10)	.27 (.85)	.67 (.49)	-3.53 (1.45)	.049 (.019)	.38 (.14)	15.4	408
Fabricated* Metal Products	81.2 (38.6)	.0006 (.0004)	-1.10 (.36)	-2.65 (1.88)	1.54 (.45)	.44 (.24)	-.012 (.005)	2.21 (.32)	13.2	360
Machinery exc. Elec.	64.1 (25.9)	-.0006 (.0004)	-1.10 (.26)	-1.95 (.99)	-.63 (.40)	2.74 (1.12)	-.036 (.015)	.18 (.12)	12.4	360
Electrical** Machinery	59.7 (30.7)	-.0002 (.0004)	-.17 (.27)	.92 (1.40)	.34 (.45)	-3.12 (1.22)	.045 (.016)	.39 (.11)	12.4	324
Transport* Equip.	-184.1 (108.3)	-.001 (.002)	-.95 (.48)	3.73 (3.57)	-7.66 (1.74)	30.4 (6.4)	-.46 (.09)	.42 (.05)	43.0	264
All Ind.* Pooled	84.2 (7.7)	.0010 (.0002)	-.65 (.06)	-.59 (.36)	-.12 (.17)	.15 (.11)	-.0040 (.0021)	1.97 (.41)	19.4	5208

Non-linear least regressions with LRATE as the dependent variable.

The pooled regression included industry fixed effects which were significant at the 1% level.

*An (approximate) F-test of the joint hypothesis that DUR, S, and S^2 do not affect LRATE was rejected at the 1% significance level.

**An (approximate) F-test of the joint hypothesis that DUR, S, and S^2 do not affect LRATE was rejected at the 5% significance level.

TABLE 3

Industry	z	z'
Foods	.59 (.44)	*
Textiles	.53 (.15)	1.30 (.24)
Apparel	.084 (.099)	5.97 (4.71)
Lumber	1.68 (.12)	.61 (.03)
Furniture & Fixtures	1.06 (.35)	1.27 (.04)
Paper & Allied Prods.	.66 (.11)	1.30 (.10)
Printing & Publishing	.33 (.04)	2.39 (.18)
Chemicals	3.09 (.88)	1.57 (.08)
Leather	1.37 (.39)	1.93 (.15)
Stone, Clay & Glass	1.23 (.20)	1.37 (.03)
Primary Metals	.38 (.14)	.88 (.22)
Fabricated Metal Prods.	2.21 (.32)	*
Machinery exc. Elec.	.18 (.12)	*
Electrical Machinery	.39 (.11)	2.20 (.29)
Transport Equipment	.42 (.05)	.30 (.01)
All Industries Pooled	1.97 (.41)	1.45 (.07)

*Estimation procedure did not converge.

APPENDIX

A. Comparative Statics

Begin with the case of contingent payments, b. If there is an interior solution (i.e, $b^* = b$) then equal changes in B and T are equivalent to changes in b and will be exactly offset by changes in b (i.e., $\frac{db}{dB} + \frac{db}{dT} = -1$), hence $\frac{dr}{dB} + \frac{dr}{dT} = 0$. If $b \leq 0$ so that $b^* = 0$, then $\frac{dr}{dB} + \frac{dr}{dT}$ can be calculated from the maximization in (3) for the variables E, r, w_1, y (since $w_1 = w_2$). Applying Cramer's rule to the matrix of second derivatives of (3) with respect to these four choice variables (the bordered Hessian) gives

$$(A1) \quad \frac{dr}{dB} + \frac{dr}{dT} = K_1 \cdot [-E_1 + yU'(h + B)] + K_2 \cdot J$$

where $K_1, K_2 < 0$ and sign (J) = sign $[-E_1 + yU'(h + B)]$.

The bracketed term is negative because the first-order condition for b has a corner solution.

$$[-E_1 + yU'(h + B)] < 0 \Rightarrow U'(w_1) > U'(h + B) \text{ using (b).}$$

The bracketed expression cannot be positive when there is no upper limit on b. This establishes the comparative statics when contingent payments are possible.

The result when only non-contingent payments, b', are feasible is more algebraically cumbersome but analogous to the case above. $\frac{dr}{dB} + \frac{dr}{dT}$ is calculated from the maximization in (10) over the variables E, R, W_1, b', y (again, $w_1 = w_2$). The fact that b', and thus b*, will vary with B and T complicates

the computation. If b' is at a corner, hence b* = 0, the analysis proceeds as above, though either $[-E_1 + yU'(h + B)] \lessgtr 0$ is possible. With b' > 0 and b* = b', (8B) is true--

$U'(w_1) < U'(h + B + b^*) \Rightarrow -E_1 + yU'(h + B + b^*) > 0$.

Applying Cramer's rule in this case gives $\frac{dr}{dB} + \frac{dr}{dT} < 0$ which establishes the result.

B. Data Appendix

The variables unrelated to the UI system are defined in a simple manner. The primary dependent variable is the layoff rate, LRATE. This series was obtained from a tape provided by the Bureau of Labor Statistics (BLS). The data consisted of layoffs per 100 employees for each of the 21 two-digit SIC industries within manufacturing (codes 19-39) for each state for each month. All data are for the years 1961-62 and are not seasonally adjusted. Only the 15 industries listed in the text were used because of sample size (too small) or heterogeneity--miscellaneous manufacturing (code 39) was not used.

Employment, EMP, was also used as a dependent variable in the second reduced form equation. This series was taken from the 1961 and 1962 issues of th BLS publication Unemployment Insurance Tax Rates by Industry. The data consisted of annual levels of employment for each two-digit industry in each state. (The employment data were actually employment covered by UI, but the coverage rate in each industry used was in excess of 97%.)

The unemployment rate, UR, used was just the national unemployment rate for each month. This series was obtained from the Handbook of Labor Statistics. State-specific unemployment rates are not available for this time period. However, a state rate can be calculated from data on statewide employment and unemployment which is covered by UI. These rates, while somewhat suspect, were used in earlier regressions and fared no better than the national rate.

The industrial production indices, IP, were obtained from a publication of the Federal Reserve. Again, the data consisted of monthly figures for each two-digit industry. There was no state-specific breakdown, however.

Now for the variables measuring the UI parameters. All of the states used in the sample have the reserve-ratio type of experience rating. This gives the firm's tax rate in period t as a function of its reserve-ratio--the accumulation of taxes paid by the firm less benefits received by its laid-off workers prior to period t as a percentage of its taxable payroll (taxable wage base multiplied by number of employees). This function--the UI tax schedule--varies from state to state and, to a much lesser extent, within a state over time. This schedule is piecemeal linear, typically with a (negatively) sloped middle portion and flat portions at minimum and maximum tax rates. The firm's tax rate is re-calculated annually.

Industry specific tax rates were obtained for each state from the aforementioned BLS publication. The payroll tax paid per worker, TAX, was calculated as this tax rate multiplied by

the taxable wage base per employee (from the same publication). Using this tax rate and detailed knowledge of the tax schedules for each state, obtained from the BLS publication Comparison of State Unemployment Insurance Laws, the expected present value of future tax payment increases which results from the layoff of an additional worker, PV, was calculated (using the interest rate on Moody's AAA bonds for discounting) in the following way. The firm's tax rate, t, is a (decreasing) function of the firm's reserve ratio, R, which is accumulated tax payments less benefits received by former employees divided by taxable payroll, K, (taxable wage base times number of employees). Thus $t = t(R)$ and total UI taxes per period are tK. Thus the present value of the expected increase in taxes for the next period from one more layoff, L, is $t'(R) \frac{dR}{dL} \cdot K/(1 + i)$ (the change in current taxes is $t \cdot \frac{dK}{dL}$). Summing this over all future peiods (with static expectations) gives $PV = \frac{t'}{i + t'} WBA$, which is less than WBA only because the UI system calculates reserves in nominal terms not because t' may be less than one. The weekly benefit amount, WBA, (which was also used to calculate PV) was obtained from the Comparison as the maximum benefit allowed in each state. The maximum, mean, and minimum weekly benefits allowed were highly correlated in each state. No information was available on actual benefit payments at the appropriate level of disaggregation. Since UI benefits are not subject to income tax or Social Security tax the benefit variables were adjusted using average marginal federal and state income tax

rates and the Social Security tax rate. The maximum duration in weeks over which UI can be collected in each state was obtained from the Comparison for the variable DUR.

Table A1 gives the means for each variable used. The data are given for each industry and pooled for all industries in the sample.

TABLE A1

MEANS OF VARIABLES

Industry	LRATE	EMP	IP (1967=100)	UR	TAX	WBA	PV	DUR	S
Foods	27.3	26400	82.1	6.1	5074	36.6	.57	26.1	16.1
Textiles	17.8	47851	73.8	6.1	6420	38.2	.48	25.6	20.0
Apparel	18.8	20959	83.9	6.1	7710	38.4	.48	26.3	20.2
Lumber	21.7	22314	80.3	6.1	6636	37.3	.56	26.1	16.7
Furniture & Fixtures	16.8	11071	74.8	6.1	6206	37.9	.56	26.4	16.9
Paper & Allied Prods.	16.6	12436	74.0	6.1	5483	37.8	.50	26.3	19.5
Printing & Publishing	6.8	11304	72.6	6.2	3928	37.6	.54	26.1	17.1
Chemicals	10.8	17836	62.5	6.1	4426	37.1	.57	26.1	16.2
Leather	17.7	16229	91.0	6.1	7432	37.2	.57	25.9	15.7
Stone, Clay & Glass	19.3	11558	81.1	6.1	5865	38.2	.58	26.1	16.0
Primary Metals	15.9	16037	73.7	6.1	6203	38.5	.50	26.3	19.6
Fabricated Metal Prods.	20.7	18675	72.3	6.1	6564	39.3	.48	26.3	20.6
Machinery exc. Electrical	16.0	22364	58.7	6.1	6690	38.7	.48	26.1	20.5
Electrical Mach.	12.0	39025	59.0	6.1	6882	39.8	.46	26.2	21.8
Transport Equipment	38.5	46794	66.3	6.1	7356	38.0	.53	26.5	17.8
All Industries	18.2	21961	73.7	6.1	6142	38.1	.52	26.2	19.7

NOTES

[1]Thus the demand pattern is known with certainty. The inclusion of demand uncertainty does not alter the important results.

[2]A first-best contract would actually have two payments to laid-off workers: b_L to workers remaining on layoff and b_A to workers accepting another job. For $X < w_2$ the optimal contract would have $b_A > 0$. This is the case where a worker is moved to a low-paying job, an event which the old firm can (and will) provide insurance against. It will be assumed here that $X \geq w_2$ and that $b_A < 0$ is infeasible. The re-opened labor market is assumed to operate as follows. There are a relatively small number of openings which pay a high wage X. These jobs are allocated by some search process whereby "lucky" unemployed workers find them. For a large enough X the assumption of q being exogenous does not matter. Workers who remain employed cannot break their contract to search for the wage X. It is necessary, however, to ensure that it is not in a worker's interest to sit at home in period one and then try and obtain X in period two. This will be the case when $V_1 > U(h) + D[qU(X) + (1 - q)U(h)]$. This will hold for a small enough q. To summarize, the assumptions are that X is large enough (relative to $\underline{V}$) and q is small enough that all workers enter a contract in period one which pays a wage $w_2 < X$.

[3]This primarily reflects the government's greater ability to penalize a worker caught "cheating". A strategy which would take advantage of the government's greater monitoring ability is the following. The firm could state that a laid-off worker can receive his private unemployment payment only after showing the firm his public UI benefit (check). This would allow the firm to make contingent private payments without being able to directly monitor the worker. Such an ingenius ploy would imply that contingent payments are always feasible and thus (anticipating the results below) it must be that $z \geq 1$.

[4]See note 2 for a discussion of the assumptions underlying $X > w_2 \ (= w_1)$.

[5]Assuming the control parameters of the UI system to be T and B is equivalent to using θ and B, where θ is the UI tax paid <u>per dollar</u> of benefits, since θ and T bear a one-to-one relationship, given B.

[6]Consider the case with contingent payments, b. If $b > 0$ then $b^* = b$ and $\frac{dr}{dB} + \frac{dr}{dT} = 0$. If the desired $b \leq 0$ then $b^* = 0$

and $\frac{dr}{dB} + \frac{dr}{dT} > 0$. $\frac{dr}{dB} + \frac{dr}{dT} < 0$ is not possible when contingent payments can be made. Now consider the case where only non-contingent payments, b', are allowed, then $b' > 0 \Rightarrow b^* = b'$ and the discussion above shows $U'(w_1) < U'(h + B + b^*)$, which gives $\frac{dr}{dB} + \frac{dr}{dT} < 0$, even though b', and thus b*, varies with B and T. If desired $b' \leq 0$, then $b^* = 0$, and either $U'(w_1) > U'(h + B)$ or $U'(w_1) < U'(h + B)$ depending on whether B is sufficient, given h, to preclude even the payment of contingent payments. (If B is large enough to imply $b' \leq 0$, then $b \gtrless 0$ is possible, though $b > b'$ must hold since $X > w_1$.) In any case the sign of $\frac{dr}{dB} + \frac{dr}{dT}$ will be as given. The comparative statics essentially rely on whether the firm is able to set its actual payment b* equal to the desired contingent payment b, or some constraint forces b* away from b. See the appendix for a more formal derivation.

[7]Again z is meant only to describe the firm's response. The firm does not choose z directly. The expression which defines z is given and discussed below.

[8]Note $dA = 0 \Rightarrow dB = zdT$. Thus $[\frac{dr}{dB} + \frac{dr}{dT}]_{dA=0} = -\frac{dr}{dT} + \frac{dr}{dT} = 0$. This generalizes the result that only changes in the actual subsidy, S, matter, when the desired contingent payment, b, is made.

[9]It might seem that the efficiency implications of UI could be discussed here in terms of whether (8), (8A), or (8B) is true. This relates to private efficiency only, whereas any analysis of UI and efficiency must be couched in terms of social efficiency which requires a market equilibrium model, as in the earlier chapters.

[10]This is equivalent to comparing regressions with z alternatively constrained to equal one and estimated freely.

[11]Estimation of the reduced form is the proper approach as the comparative statics results, particularly concerning the parameter z, derive from these equations.

[12]The data are described more fully in the appendix.

[13]Other inputs to the production process are endogenous, though held constant here. These variables, such as capital, having been ignored in the theoretical model will receive no consideration here, either.

[14]Modelling this as exogenous to the layoff decision implicitly assumes that the firm's optimization occurs in two steps: how much to produce, then what inputs to use.

[15]There is some question as to whether the payroll tax aspect and the future increase in taxes should be included together to properly determine a net PV. It seems that it is only the future tax increases which capture the effects of experience rating. The theoretical model needs to be adjusted to conform to the institutional details to completely resolve this issue. It is quite important to the correct interpretation of z, however.

[16]This is the subsidy per week of benefits received (PV depends on WBA and the UI tax schedule). An alternative measure would include the duration variable multiplicatively to measure the total subsidy available. This was done and the results seem unaffected. In addition, including the DUR variable separately allows a better interpretation of the results.

[17]Such "conditional testing" is not meant to be rigorous, merely suggestive.

[18]The explanatory variables include $a1(WBA - z \cdot PV) + a2[(WBA - z \cdot PV)^2]$. Non-linear least squares gives consistent estimates of a1, a2, and z. Note that z is the same in both the A and A^2 terms. The question of whether specifying WBA and PV in A and A^2 is better than a set of general second order terms is interesting. The former implies that z is a constant which can easily be compared to one. The latter implies that z will depend on WBA and PV which affords a more general test of z = 1 though a particular sample point must be chosen for calculating the test statistic. It is unclear which aproach is better and as a next step the robustness of the estimates of z to this more general specification could be analyzed. It should be noted that the result regarding the ability of firms to make unconstrained private payments requires that z = 1 everywhere.

[19]This is not to say that the estimate of z for this industry is wrong. It does seem, however, that something different is occurring here compared to the other industries.

[20]There is another conflicting bit of evidence. James Brown (1980) found that the labor market in U.S. manufacturing from 1954-76 seemed to behave as if some form of labor contracts existed. Wages were quite unresponsive to short run fluctuations in measured marginal products, but over the longer-term these were close to equal. The standard risk-sharing arguments give such behavior as a result of labor contracting. Given this finding of one type of behavior consistent with efficient contracting, the fact that this

paper reveals evidence that contracts are unable to optimize regarding private unemployment payments implies that the contracting environment of the labor market will require further scrutiny before a judgement as to efficiency can be made.

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