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IMPLICIT CONTRACTS: A SURVEY

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ABSTRACT

Implicit contracts resolve the distribution of uncertainty and utilization of specific human capital between risk averse workers and less risk averse firms. Incomplete contracts are required to yield involuntary layoffs in contract markets: otherwise, contracts are efficient and pareto optimal by construction. There is a close relation between contract theory and neoclassical labor market theory. Contracts smooth consumption, but increase the volatility of labor supply and labor utilization to demand disturbances, because contractual insurance eliminates the income effects of socially diversifiable risks. This result is similar to the intertemporal substitution hypothesis. However, the price mechanism in a contract is substantially different. Contracts embody a nonlinear two-part pricing scheme. The lump sum part allocates the income-consumption consequences of risks and the marginal pricing part allocates production and labor utilization. This implicit pricing mechanism is in all respects "flexible," though the observed average hourly wage combines both parts and may give the outward appearance of rigidity. Furthermore, the observed average wage rate in a contract does not reflect marginal conditions necessary for structural econometric estimation. Indivisibilities appear necessary to account for the split between work-sharing and layoffs. Contracts with private information are also considered in the nonlinear pricing context.

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I. INTRODUCTION

The ideas associated with implicit contracts originate in the work of Martin Baily (1974), Costas Azariadis (1975) -- who apparently coined the term -- and Donald F. Gordon (1974) though certain pre-Keynesian views of the labor market such as the remarkably enduring work of John R. Hicks (1932), and later analyses by Armen Alchian (1969) and others are important predecessors. This line of research has been extremely active in the past decade and is notable for bringing microeconomic theory to bear on the problem of unemployment and employment fluctuations. Forty years ago Franco Modigliani (1944) identified the workings of the labor market as the weak link in understanding macroeconomic fluctuations. The promise of implicit contract theory lies in taking a step toward repairing that deficiency. Practical interest in this theory also has been promoted by a search for alternatives to the Phillips' Curve approach to labor market equilibrium, which was criticized for its inconsistencies with microtheory by Milton Friedman (1968) and Robert Lucas (1973), and which failed empirically in the inflationary environment of the 1970s.

The speed with which the term <u>implicit contracts</u> has entered the economics vocabulary is slightly astonishing, but perusal of the literature reveals considerable controversy and strongly held differences of opinion on the meaning of the term and its implications. It is natural enough that passions tend to be aroused by any model purporting to analyze employment security and stability, and professional disagreements in this area undoubtedly are not made less intense by intellectual tensions in the field of macroeconomics today. These debates will not be joined here. My goal is limited to presenting some elementary versions of the theory with sufficient clarity to reveal its main content and its relationship with more conventional ways of thinking about labor markets. For these reasons as well as the fact that research in this area is proceeding at a rapid pace, it is inevitable that this survey is incomplete. Additional material may be found in the surveys by Azariadis (1979), Azariadis and Joseph Stiglitz (1983), Oliver Hart (1983), Takatoshi Ito (1983) and Aba Schwartz (1983), which differ in style and perspective from what is presented here.

The following serves as a summary and overview.

(1) Viewing labor market exchange in terms of contracts represents an interesting and novel methodological departure from conventional models in which market wage rates decentralize impersonal and unilateral labor demand decisions by firms on the one hand and labor supply decisions by workers on the other. In contrast, contracts are inherently bilateral negotiations between partners that are disciplined by external opportunities, making analysis of the labor market more akin to the marriage market than to the bourse. Contract markets are supported by frictions and specificity of employment relationships that tend to insulate contracting parties from short-run external shocks and which take current wage rates "out of competition" in allocating labor resources.

(2) A contract is a voluntary ex-ante agreement that resolves the distribution of uncertainty about the value and utilization of shared investments between contracting parties. The contract precisely specifies the amount of labor to be utilized and the wages to be paid in each state of nature, that is, conditional on information (random variables) observed by both parties. Wage payments in a contract reflect both allocative production decisions and risk-sharing and income transfer decisions jointly determined by both parties.

(3) Contract theory neither resolves nor illuminates questions of Keynesian unemployment based on nominal wage and price rigidities, money illusion and nonmarket clearing. Explanations for "sticky" wages and prices that impede efficient labor utilization must be sought in other quarters. Contracts allocate resources through a subtle and "flexible" nonlinear pricing mechanism, which sometimes gives the outward appearance of rigidities in observed real wages and prices. But these observed rigidities signal little about market failure.

(4) The most important empirical implications of contract theory follow from the hypothesis that contract wages embody implicit payments of insurance premiums by workers in favorable states of nature and receipt of indemnities in unfavorable states. Contractual income transfers smooth consumption, which interacts with labor utilization by eliminating income effects. The prominence of substitution effects promotes an elastic labor utilization response to socially diversifiable external shocks. Contracts tend to increase the volatility of employment, but these effects are difficult to detect in structural econometric models because observed wages reflect more than production/labor supply efficiency margins in contract markets.

(5) Only socially diversifiable risks are contractually insurable. Complete contracts and full risk-shifting imply that all ex post aspects of contracts, including possible layoffs and unemployment, are "voluntary:" laid-off workers in a firm are no worse off than those remaining employed, distinctly non-Keynesian. Nondiversifiable and uninsurable risks, risk aversion of firms, information asymmetries and other costs that make contracts incomplete are needed to create ex post involuntary aspects into contract terms. Incomplete risk shifting qualifies the main empirical implications of contracts because income effects play a more prominent role under those circumstances:

Consumption varies more and labor utilization varies less in response to demand shocks than when contracts are complete, similar to conventional theory.

The paper is organized as follows: The next section presents some background and contextual discussion of labor market contracts. An elementary contract is analyzed in section III, where employment is modeled as an all-or-nothing affair. This model has some simple properties, but its special features obscure the relations between contract theory and conventional theories of labor markets. Section IV presents a more familiar model which clarifies these relationships. Section V takes up the distinction between layoffs and worksharing viewed as choices at the extensive and intensive margins. Section VI sketches some extensions to intertemporal problems and the relation between contract theory and intertemporal substitution theory. The models in sections II-VII are based on common information assumptions. Much research in this area has investigated asymmetric information models as sources of market failure. Discussion of that work necessarily requires more advanced methods and appears in section VII. Conclusions are found in section VIII.

II. BACKGROUND

The first substantial treatment of the effects of unemployment on a labor market is Adam Smith's discussion of equalizing wage differences on unemployment risk. Smith recognized that workers exposed to such risks, e.g., bricklayers, would require higher wages while employed to compensate for less regular work patterns and to sustain consumption during periods of slack demand. An extra premium might be needed to compensate risk averse workers for bearing earnings risk.

Refined development of this idea has occurred only in recent years, beginning with the work of Michael Todaro (1969), John Harris and Todaro (1970), Arnold Harberger (1971) and Jacob Mincer (1976), which is notable for analyzing the effects of market controls and minimum wages on unemployment, viewed as an equilibrium phenomenon. Workers array their search activities across markets to equate expected earnings in each. If wages are constrained as a clearing mechanism, something else must do the job and that is the probability of finding employment. In equilibrium workers queue up for high wage jobs in the regulated sector: greater unemployment and smaller job finding probabilities are observed in those markets where wages are highest to enforce the equilibrium supply condition. These models have had some success in explaining urban unemployment in less developed economies.

Robert Hall (1970) incorporated some novel inventory theoretic ideas into models of this type to account for persistent spatial differences in unemployment. Cities with greater equilibrium unemployment rates must pay wage premiums to attract workers. Higher wages support longer unemployment spells and more frequent transitions between jobs, and represent the implicit prices that firms must pay for the privilege of drawing on an inventory of ready labor. The advantage of this reserve army of the unemployed, as it were, lies in greater flexibility and quicker responses of employment decisions by firms facing shifting and uncertain demands. Robert Topel (1984) extended the argument to incorporate intermarket mobility and found evidence of equalizing differences on local unemployment rates when unemployment insurance is properly accounted for. A full market equilibrium analysis in this vein was attempted, but incompletely realized by Hall (1979).

The most complete micro-analysis of equalizing differences in the Smithian mode so far is by John Abowd and Orley Ashenfelter (1981, 1984), based on utility theory and rationing constraints on hours availability. This and related work by Robert Hutchens (1983) and Stephen Bronars (1983) find small, but persistent equalizing wage rate difference effects on average hours of work restrictions and layoff rate differences among jobs, but insignificant, if not perverse effects on the variability or risk elements. Small effects for mean differences might be expected when the value of leisure is taken into account, but the unsubstantial effects of risk are not consistent with this theory.

The literature reviewed here concentrates much more on the contractual features of labor market exchange than on implicit risk attributes of jobs. However, an important link between the two is provided in an unpublished paper by H. Gregg Lewis (1969) and more recently by Tomio Kinoshita (1985). Lewis analyzed a deterministic market in which both employers and employees care about hours worked per employee. The equilibrium that emerges out of this analysis looks much different than that of a traditional market: a single wage does not clear the market. Instead, each firm offers fixed wage-hours packages, insisting that its employees work a fixed number of hours in exchange for a fixed income or seek employment elsewhere. A nonlinear equalizing wage-hours locus across firms serves as the equilibrium concept. There is an important sense in which implicit contract theory extends these ideas to incorporate uncertainty, since a contract specifies wage-work package deals for each state of nature.

Professional interest in contract theory has been stimulated by a number of recent empirical observations on labor market institutions. Many features of labor markets bear little resemblance to impersonal Walrasian auction markets. Chief among them is the remarkable degree of observed worker-firm attachment. Martin Feldstein's (1975) surprising finding that over 70 percent of layoffs are temporary, with most laid-off workers ultimately returning to their original employers, was confirmed on similar aggregate data by David Lilien (1980) and by much different methods on micro-panel data in a recent study by Lawrence Katz (1985). The typical adult male worker spends twenty years or more on a single job (Hall, 1982) and the probability of job turnover is a sharply declining function of job tenure (e.g., Mincer and Boyan Jovanovic, 1981 and William Randolph, 1983). Most job changes in a worker's life occur at younger ages, and a person who has persisted in the same job for a few years is likely to continue employment in it for a long time to come. If tenure is *de jure* in academia, it is *de facto* in much of the labor market at large. These findings can be explained by search theory through "job shopping" (William Johnson, 1979) or searching for the best "match" between a worker and a firm (Jovanovic, 1979).

The rationale for observed employment continuity ultimately rests on Gary Becker's (1964) concept of firm-specific human capital, which formed the basis of the earlier quasi-fixed cost theory of employment fluctuations originated by Walter Oi (1962). Robert Hart (1984) presents an up-to-date discussion and prior references. Quasi-fixed cost theory and implicit contract theory share many of the same features and assumptions, as demonstrated in the recent book by Arthur Okun (1981), who attempted an integration of the two. Charles Schultze (1985) pursues this line. Fixed costs, firm-specific investments or match-specific capital create the equivalent of market frictions that render significant value to enduring employment relationships. Maintenance of existing employment attachments creates shared rents which introduce a wedge between the value of a current job and outside opportunities. Rents relax momentary arbitrage constraints between current wages, current fortunes of the firm, and general labor market conditions, as in the economics of marriage (Becker, 1973). Under these circumstances it is expected present values of wages that matter to firms and workers, not necessarily the current wage. Wage income is in part an installment payment on specific-investments (Hall, 1980. J.R. Miller, 1971 presents an interesting early model along these lines which deserves to be pursued).

Fixed cost theory focuses on quantity adjustments of labor inputs to changing demand conditions. Implicit contract theory potentially provides a more complete description of wage adjustments as well. For if firm-specific investments are an important component of labor market exchange, employment specificity implies that the worker is effectively a partner in his enterprise. But the return on specific capital embodied in workers is inherently stochastic and its joint ownership raises deep questions of how this capital is utilized and how its risks are shared. An ex ante agreement or contract resolves these issues of utilization and risk sharing.

Theoretical research on contracts has been propelled by recent developments in the economics of uncertainty and information. Feldstein's (1976) and Baily's (1977) analyses of the U.S. unemployment insurance system showed the practical relevance of applying insurance principles to certain labor market activities. Economists' increasing understanding of state-contingent claims theory (Kenneth Arrow, 1964 and Gerard Debreu, 1959) has played its part as well.

However, the idea of implicit contracts goes back to Frank Knight's s1921) views of the entrepreneur as a residual income recipient and bearer of risk. Knight's entrepreneur makes contractual commitments to input suppliers and earns a risky return on the difference between stochastic receipts and fixed contractual and other costs (Friedman, 1962). Contracts with workers are supported by human capital specificity. Occupational selection suggests that entrepreneurs are less risk averse than the average person (Richard Kihlstrom and Jean-Jacques Laffont, 1979, 1983). Modern analysis also shows that entrepreneurs shift some of these risks to the capital market. Nonetheless, a firm's owners may have comparative advantage at risk management through portfolio diversification, whereas a worker's main wealth is nonmarketable human capital. Specialized human capital, and firm-specific human capital in particular, is not diversifiable and does not collateralize consumption loans in modern economies. Furthermore, there are practical limitations, from moral hazard and adverse selection, on private unemployment insurance markets, because workers and employers share employment and wage decisions in any state of nature. The insurance features of contracts therefore manifest the gains from trade between effectively more and less risk averse agents, and, since employment and earnings decisions are internalized at the firm level, partially avoid direct monitoring by third parties. It is these risk-shifting gains from trade that intermingles insurance and productive efficiency considerations in observed contract wages, and which determines how risks on shared investments are allocated.

Casting employment arrangements in contractual terms leads to a fundamentally different analysis conceptually from that of a standard competitive market. In traditional theory the worker is presented with a market-determined wage and decides how much labor to supply to the market at large at that wage. The firm decides how much impersonal labor services to buy. A contract specifies, up front, exactly how much labor the worker must supply and exactly what the wage will be in various circumstances at some particular firm. When the state of nature is actually realized there is no further scope for free choice at some external market-determined wage rate. Instead, the worker supplies precisely the agreed upon quantity of labor (possibly none) at the previously agreed-upon wage payment, even though he might ex post prefer something different. Sometimes the agreement even transfers the rights of employment and hours determination to the complete discretion of a specific employer. These aspects of ex ante bilateral negotiation and agreement inherent in a contract system have no counterpart in an idealized decentralized competitive market in which all decisions are impersonal and unilateral. This difference is well expressed by Okun's (1981) felicitous characterization of a contract market as the "invisible handshake" rather than the invisible hand.

An employment relationship represents a complex interaction of authority, delegation, personal interactions and monitoring, so complex that remarkably few provisions are actually written down.[1] Yet the economic analysis of implicit contracts amounts to working out the details of an explicit contract concerning wages and employment under uncertainty. Hence an implicit contract must be interpreted in the "as if" sense of an explicit one, as a mutual understanding between worker and employer that the invisible handshake implies, as in commercial contracts. At one level applying this as-if principle is no different from most theorizing in economics. At another, we know that contracts do not contain all contingencies because many of them cannot be foreseen and there are so many possibilities that contracting costs are prohibitive. The extent to which formal consideration of these costs and benefits affects any as-if model which ignores them is an open question that can be answered only by the empirical usefulness of the simpler theory.

III. CONTRACTS WITH LAYOFFS

The literature on implicit contracts has introduced some new language and technical paraphernalia that sometimes makes the fundamental ideas difficult to grasp. This section sets out a simple one-period model aimed at clarifying the essential concepts. Models of this timeless type were first introduced by Azariadis (1975) and much of the subsequent literature has followed in this vein.

The basic set-up is this: The firm contracts with a group of workers, for simplicity assumed to be identical in talents and preferences, and produces an output with a production function that depends on the utilized labor of its contract employees. This production function has conventional properties, except that it is shocked by a random variable θ. The stochastic disturbance θ is meant to reflect demand uncertainty and shocks to technology or other input supplies that are produced by external forces not controlled by contracting parties. The term "common knowledge" refers to the assumption that all relevant information is available to all parties. The probability distribution function of θ and the actual ex post realization of θ is costlessly observed and agreed upon by all contracting parties. This assumption carries great force, for it implies that the contract can be conditioned on the realization, that is, on the "state of nature" that actually materializes ex post.

The contract is a set of conditions such as: "if θ turns out to have the value θ_i then the worker agrees to supply exactly xxxx units of labor in exchange for exactly xxxx dollars." Statements of this form cover every possible realization of θ. This, and the fact that information is complete means that there is no economic rationale for any ex post renegotiation of terms (no "new" information comes in). Of course, nature is random, so contracting parties might well regret certain ex post realizations, similar to the way a poker player might have ex post regret, though there is nothing to be done about it then. These informational assumptions seem severe, to be sure, but they are exactly the same as the Arrow-Debreu contingent claims market model. Much work has been and continues to be done on models in which information is not common in this sense. However, the basic ideas are most easily seen in the simpler common information models.

The key simplifying assumption in Azariadis's model is specifying worker preferences in the form $u = U(C + mL)$, where C is consumption, L is the fraction of time devoted to leisure, and m is a constant. Normalize L so that $0 \leq L \leq 1$. The worker is assumed to be risk averse: $U' > 0$ and $U'' < 0$. This utility function has linear indifference curves: C and L are perfect substitutes, with constant marginal rate of substitution m. Alternatively, imagine the worker dividing his available unit of time between market work and the production of an equivalent but nonmarketable good with production function mL. Here m is the marginal product of time in producing nonmarket goods. In either case, m is the unique reservation price of time supplied to market work. The conventional labor supply problem has a very simple solution in this case: either the worker supplies his entire endowment of time to the market or to leisure. This feature carries over to a contract as well. It is natural to identify a contractual provision which stipulates $L = 1$ in some state of the world as a layoff in that state.

The firm's production function is assumed to be of the form $x = \theta f(N)$, where N is utilized labor services and $f'(N) > 0$ and $f''(N) < 0$: positive and decreasing marginal product of labor. Capital is ignored. The random variable θ is distributed with known distribution function $G(\theta)$ and density function

$G'(\theta) = g(\theta)$. Its mean is $E\theta = \mu$, known at the time the contract is struck (alternatively, μ may be random, but the contract is conditioned on it). Since the contract will specify either $L = 0$ or $L = 1$ for workers with preferences such as these, write $N = \rho n$, where n is the fixed number of workers under contract, ρ is the proportion of them who work, and $1 - \rho$ is the proportion who don't work or the layoff rate. Furthermore $0 \leq \rho \leq 1$. Given some realization of θ, the contract specifies a wage payment C_1 to those employees instructed to work and possibly a layoff payment C_2 to those who are laid off. Work or nonwork assignments are drawn by lot, represented by the employment probability, ρ. Thus, the contract specifies a set of three numbers (C_1, C_2, ρ) for each possible outcome θ. Another way to describe it is by three functions of the outcomes: $C_1(\theta)$, $C_2(\theta)$ and $\rho(\theta)$.

An employed worker ($L = 0$) receives no nonmarket goods and obtains utility $U(C_1(\theta))$ under the contract. This occurs with probability $\rho(\theta)$. A laid off worker ($L = 1$) produces m units of the nonmarket good and has contracted for $C_2(\theta)$ of market goods, so utility is $U(C_2(\theta) + m)$. This occurs with probability $(1 - \rho(\theta))$. Therefore the ex ante expected utility of a worker in this firm is

$$Eu = \int[U(C_1(\theta))\rho(\theta) + U(C_2(\theta) + m)(1 - \rho(\theta))]dG(\theta). \quad (1)$$

The contract $\{C_1(\theta), C_2(\theta), \rho(\theta)\}$ maximizes the worker's expected utility (1) subject to an expected profit or utility constraint for the firm. It is pareto optimal by construction.[2] In state θ the firm produces output of value $\theta f(\rho(\theta)n)$ and incurs contractual costs of $n\rho(\theta)C_1(\theta)$ paid to employed workers and costs of $n(1 - \rho(\theta))C_2(\theta)$ paid to laid-off workers. The managers of the firm have utility function v(.) defined over profits, so the expected utility of the firm is

$$Ev = \int v(\pi(\theta))dG = \int v(\theta f(\rho(\theta)n) - n\rho(\theta)C_1(\theta) - n(1 - \rho(\theta))C_2(\theta))dG(\theta) \tag{2}$$

The equilibrium contract maximizes (1) subject to $Ev = \bar{v}$ and corresponds to one point on the Pareto frontier between Eu and Ev.

Think of an economy composed of many such firms with the disturbance θ independently distributed among them, so many in fact that the mean $E\theta = \mu$ is realized with the probability 1 (the entire distribution $G(\theta)$ is realized across firms ex post -- otherwise feasibility requires the contract to be conditioned on the sample mean). To justify the solution of the constrained maximum problem as a description of the observed contract, think of firms competing for contract workers and making their joint investments (not modeled in this literature) at the beginning of the period. Firms compete for workers by offering favorable contract terms, given investments, and in devising these terms manager/owners diversify their risks by trading residual profit claims on an asset market. Possible risk aversion of firms is justified by some incompleteness in risk markets. For example, there may be bankruptcy possibilities or agency problems between owners and managers that make complete managerial diversification undesirable. If managers' reservation utility level is $\bar{v}$ and they are supplied elastically, then the equilibrium contract transfers rents to workers and the proposed solution follows as a competitive market equilibrium.

Associating a negative-valued multiplier λ (from Pareto optimality) with constraint (2), setting up the Lagrangian function and differentiating yields the first order conditions for C_1, C_2, and ρ, respectively:[3]

$$U'(C_1) = -\lambda n v'(\pi)$$

$$U'(C_2 + m) = -\lambda n v'(\pi) \tag{3}$$

$$\rho(1 - \rho)[U(C_1) - U(C_2 + m) - \lambda n v'(\pi)(\theta f'(\rho n) - C_1 + C_2)] = 0$$

The arguments C_1, C_2, ρ and π (profits) in (3) should be understood as functions of θ, but this functional notation is supressed to save space. The term in $\rho(1 - \rho)$ in the third condition takes care of the constraint $0 \leq \rho \leq 1$.[4]

The first two conditions determine optimal risk sharing among risk averse agents as in Karl Borch (1962), Arrow (1971), and Robert Wilson (1968): marginal utilities between agents are proportional in all possible realizations; or $U'(C_1(\theta)) = U'(C_2(\theta) + m)$, which in turn implies $C_1(\theta) = C_2(\theta) + m$ and $U(C_1(\theta)) = U(C_2(\theta) + m)$. Therefore, when the firm provides layoff pay (C_2) contracts make no ex post utility distinctions between employed and unemployed workers for any given value of θ. Of course workers attached to firms with favorable realizations of θ are better off ex post than workers attached to firms with unfavorable realizations of θ (if the firm is risk averse and not all risk is shifted), but all workers in the same firm get the same ex post utility independent of employment status. Layoffs are voluntary in this sense, though workers attached to a low θ firm may envy those in a larger θ firm ex post.

The third condition in (3) determines $\rho(\theta)$ according to

$$\rho(\theta)(1 - \rho(\theta))[\theta f'(\rho(\theta)n) - m] = 0 \tag{4}$$

since $U(C_1) - U(C_2 + m) = 0$ and $C_1 - C_2 = m$ from the first two conditions. If θ is such that $0 < \rho < 1$, then $\rho(\theta)$ is determined so that the marginal product of a unit of labor equals its social opportunity cost: $\theta f'(\rho n) = m$. However, this marginal condition does not hold with equality at the corners. When θ turns out to be very large, the firm would like to employ a great deal of labor, but has contracted with only n workers. In this case $\rho = 1$ and $\theta f'(n) > m$. Similarly, when θ is small enough, the marginal value product of labor falls short of its opportunity cost, in which case the firm shuts down its operations and $\theta f'(0) < m$. This is illustrated in figure 1. The elbow shaped curve is the firm's internal supply curve of contract labor. Labor utilization decisions have a reservation property: for $\theta \geq \theta^*$, ρ is set equal to 1, and all of the firm's workers are fully employed. θ^* is defined by $\theta^* f'(n) = m$. For $\theta \leq \theta^{**}$, the firm shuts down, and all workers are laid off. The condition $\theta^{**} f'(0) = m$ defines θ^{**}. For $\theta^{**} < \theta < \theta^*$, some of the firm's workers are fully employed and others are laid off. In this region the employment rate $\rho(\theta)$ is increasing in θ, and the firm's layoff rate is decreasing in θ.

Notice that the ex post marginal product of labor is not equated across all firms in a contract market. It is equated only for the fraction $G(\theta^*) - G(\theta^{**})$ which have a common shadow price of labor m. The marginal product of labor exceeds m for those firms experiencing outcomes more favorable than θ^*. This is not a sign of social inefficiency because employment specificity makes it too costly to move workers from one firm to another.

Nonetheless, those firms for which $\theta > \theta^*$ have ex post demands for temporary labor, and one might envision certain labor market institutions arising to take advantage of the situation. One possibility is a subcontract market of temporary workers (Melvin Reder, 1962). The personal productivity of such workers would not be as large as that of contract workers due to less specific human capital, though movements across firms would help arbitrage differences in marginal values of labor across firms. It has been claimed that the Japanese labor market makes heavy reliance on this type of system, and perhaps guest workers in European economies (and use of illegal immigrants in the U.S.) can be partially explained in these terms. A temporary labor market for laid off workers would also serve these purposes. Further, if workers differ in their reserve price of labor m, it is straightforward to show that the firm rationally contracts with several different classes of workers. Those with larger values of m are used as reserves, and are called to work only in the most favorable realizations, similar to the way a power pool brings relatively inefficient generators on line only in periods of peak demand (Azariadis, 1976; Rosen, 1983). Finally, there may be incentives for firm mergers or product diversification that more easily accommodate worker transfers between operating units. The limits of the firm would then be determined by balancing the gains of internal reassignments of workers against the usual diseconomies of scale and lesser overall productivity of the firm's work force due to lesser labor specialization among divisions. This point is related to the gains to flexibility and adaptability in an uncertain environment (George Stigler, 1939).

The implications of this model can be seen in an especially striking manner when firms are risk neutral [$v'(\pi) = 1$]. Then (3) implies complete consumption insurance for all workers in all firms. In this case the first two marginal conditions in (3) are independent of θ because the term in $v'(\pi(\theta))$

equals unity. Therefore $C_1(\theta)$ and $C_2(\theta)$ are constants for all values of θ, given μ. All employed workers in all firms receive the same incomes and so do all unemployed workers. Furthermore, the ex post utility levels $U(C_1) = U(C_2 + m)$ are independent of θ and the same for all workers. The labor utilization condition in (4) remains unchanged. This case is in fact equivalent to complete and costless contingent claims markets in which all socially insurable risks are diversified away, and is identical to the standard insurance result that risk averse people are completely insured when premiums are actually fair. It is as if firms contracted with an actuarially fair insurance company, turned over their entire output to the common fund and contracted to withdraw pro-rata shares.

To further clarify this strong result, write $\theta = \mu\varepsilon$ where ε is an idiosyncratic independent and identically distributed firm-specific random variable with distribution function $Z(\varepsilon)$ where $E\varepsilon = 1$ and μ is a common economy-wide aggregate shock which strikes all firms equally. In a one-period model μ is an undiversifiable risk (this is not necessarily true in a multiperiod dynamic model -- see section VI). Given the information assumptions, all ex ante contracts must be conditioned on μ as well as on ε because of social budget constraints: feasible contracts cannot redistribute more market income than is actually produced.

A larger value of μ shifts the marginal value product curves to the right in figure 1 for every possible value of ε and a smaller μ value shifts these curves down and to the left. Substituting $\theta = \mu\varepsilon$ into (4), we see that given some realization μ, firms for which $\varepsilon \geq \varepsilon^* = m/\mu f'(n)$ fully utilize their work force. The value of ρ for firms on the interior of (4) is also increasing in μ. Consequently the utilization rate of labor in the work force as a whole is increasing in μ and the aggregate unemployment rate is decreasing in μ. Finally, when $v(\pi)$ is linear, (2) defines the social budget constraint for feasible contracts, given μ, as

$$\mu\int \varepsilon f(\rho(\varepsilon/\mu)n)dZ(\varepsilon) = n\int [C_1\rho(\varepsilon/\mu) + C_2(1 - \rho(\varepsilon/\mu))]dZ(\varepsilon). \tag{5}$$

$$= n[C_2 + m\int \rho(\varepsilon/\mu)dZ(\varepsilon)]$$

National income per head (the left-hand side of (5) divided by n) is increasing in μ through its direct multiplicative effect and its indirect effect of increasing ρ. Therefore $C_1(\mu)$ and $C_2(\mu)$ are increasing in μ.

Diversifiable risk ε is completely shifted in this complete contracts case: consumption and utility are independent of local demand ε, suggestive of a form of "real wage rigidity" for these types of demand shocks. Laid off workers are no worse off than employed workers, and layoffs are voluntary. However, a contract market does not at all imply real wage rigidity for uninsurable risks: the consumption and utility levels of workers, be they employed or not, are strictly increasing functions of "aggregate demand" μ. Everyone is better off ex post when μ is larger and worse off when μ is smaller.[5]

The model sketched above has the undesirable prediction that laid off workers fare no worse than employed workers. It is the assumption that consumption and employment risk can be shifted without transactions costs that accounts for much of this result. By analogy, a person who can buy actuarial no-load insurance buys enough to be indifferent to whether his house burns down or not. But that is just a consequence of a simplifying assumption. Most people are worse off if their house burns because they are not fully insured. Incomplete insurance is rational when premiums are nonactuarial and when full insurance implies moral hazard. This is also true of the insurance in an implicit contract. The point gains greater force in this context because workers and firms jointly control layoff decisions, precisely the type of situation where coinsurance is known to be desirable. Therefore, incomplete insurance, or more generally some incompleteness in state contingent claims markets, is necessary to get involuntary layoffs into these models. John Bryant (1978) was the first to point this out; see also Thomas Sargent (1979), Sanford Grossman and Hart (1981), and Bengt Holmstrom (1981). While the point has created much controversy on the usefulness of common knowledge contract models, it seems to me that considerable insight is gained by analyzing actuarial cases, as in more conventional insurance problems.

It is by no means obvious how to incorporate nonactuarial elements into a formal model. The most straightforward way is to interpret the contract as a pooling arrangement with a risk-neutral mutual insurance company and add an employment claims processing cost to the company's budget constraint, similarly to the way load factors are calculated in conventional insurance premiums. Space limitations preclude extended development here. Consider instead an extreme case in which costs of providing private insurance to the unemployed are so large that none is provided at all. This adds the constraint $C_2(\theta) = 0$ to the problem above and is exactly Azariadis's (1975) original formulation.

The absence of indemnities to unemployed persons means that unemployed workers receive incomes of m alone, and the second marginal condition in (3) is irrelevant. But the first one remains. All employed workers receive the same wage C_1 if the firm is risk neutral ($v' = 1$) and their consumption is fully insured. The wage C_1 paid to employed persons must exceed m or else no one would be inclined to work. Therefore $U(C_1) > U(m)$ and employed persons in the same firm are better off ex post than the unemployed. Laid off workers have drawn the losing hand and definitely prefer employment.[6]

One might expect incomplete insurance to affect production efficiency. The third condition in (3) verifies this intuition. Substituting for $\lambda nv'$ from the first condition in (3) and noting that $C_2 = 0$ by assumption, we have, for $\rho > 0$

$$\theta f'(\rho n) \geq C_1 - [U(C_1) - U(m)]/U'(C_1). \qquad (6)$$

This condition holds with equality on the interior ($0 < \rho < 1$), and with inequality for almost all firms whose workers are fully employed. It follows directly from risk aversion ($U'' < 0$) that the bracketed term on the right hand side of (6) exceeds $C_1 - m$, the difference in incomes between employed and unemployed workers. The shadow price of labor is the entire expression on the right hand and therefore falls short of m when insurance is incomplete. The horizontal portion of the internal supply curve in figure 1 now lies below m. $\theta f'(\rho n)$ is compared with a smaller supply price in determining ρ, and the firm utilizes <u>more</u> of its contract labor compared with complete contracts. m is the social opportunity cost for firms with $0 < \rho < 1$. There is socially excessive employment in the incomplete contract equilibrium and social output would be greater if more people were unemployed!

This surprising result is part of a more general proposition in the economics of insurance. Availability of insurance promotes the undertaking of socially beneficial risks by separating the average benefits of actions from fear of risk. Risk averse persons act too cautiously and do not take enough good risks when insurance is unavailable. The only way a risk averse worker can partially insure against the utility loss of layoff and unemployment in this problem is by working in circumstances when it is socially inefficient to do so.

One more comparison must be made before concluding this section, and that is to a situation where employment relationships provide no insurance at all. This state of affairs is sometimes called an "auction market." George Akerlof and Miyazaki (1980) showed that an auction market can imply more unemployment than a contract market. The point is easy to see in this model when employers are risk neutral. Then workers in the firm must go it alone. Any incomes they receive must be distributed out of own firms' output, since claims on other firm's outputs are unavailable by assumption. In making its collective employment decisions, the firm could then do no better than to compare the marginal productivity of its own labor with the opportunity cost of its workers' time, which is m. Therefore, m again becomes the effective shadow price of labor as in figure 1, employment decisions are socially efficient and identical to the full contract model. However, these workers are bearing consumption and wage risks, depending on their own realized value of θ, and some of these are socially diversifiable. Though efficient in production decisions, this solution is inefficient on risk sharing grounds. Clearly it is inefficient in the latter respect relative to a complete contract. However, it is not obviously less efficient than the incomplete contract, which is inefficient on the productivity account but possibly more efficient on the risk-sharing account. Therefore, no contracts at all may dominate an incomplete contract, depending on the extent of worker risk aversion.

IV. CONTRACTS AND LABOR SUPPLY

The unusual and unattractive assumptions about worker preferences in the model above conceals an intimate relationship between contract theory and the familiar theory of labor supply. Contracts embody an implicit nonlinear pricing mechanism that eliminates the income effects of insurable risks in the traditional consumption-leisure choice problem. They thereby smooth consumption which interacts with labor utilization and promotes elastic labor supply responses to external stimuli. Contracts suggest much more volatility of employment to insurable risks than conventional models do.

To illustrate these important points in the most straightforward way, worker preferences in section III are generalized, and the technology is simplified. Assume neoclassical worker preferences $u = U(C,L)$. The indifference curves of $U(C,L)$ are strictly convex and the worker is risk averse. As in the conventional labor supply problem, the quantity $(1 - L)$ is identified with time worked, and remaining time L is associated with nonmarket production (partial layoffs if one wishes). Assume that the firm consists of one worker ($n = 1$) with production function $x = \theta f(1 - L)$ where θ is the productivity shock. To simplify even more, assume $f(1 - L)$ is linear. Then the production function is $x = \theta(1 - L)$ and θ has the ready interpretation of the marginal product of the worker's labor, similar to a wage rate. Everything to be said here applies to a concave function $f(.)$, a refinement that only adds expository noise to the main point.

Consider first the conventional problem of labor supply under uncertainty. Nature draws a ball out of the θ urn, the worker observes θ and makes the optimal labor-consumption decision. If an external market does not allow risks to be spread, the worker is constrained to consume out of own production (the "auction market" of section III) and any source of nonearned income, say y. So given θ, the budget constraint is the standard one, $C = \theta(1 - L) + y$. The solution is described by the budget constraint and the first order condition $\theta = U_L/U_C$, which define demand functions $C = C(\theta, y)$ and $L = L(\theta, y)$. Assume that both C and L are normal goods and compare two alternative realizations of θ. A larger value of θ increases C, but has ambiguous effects on L. The substitution effect tends to induce greater labor supply $(1 - L)$ but the income effect works in the other direction and may cause labor supply to fall. Substituting the demand functions into the utility function yields the indirect utility function $u(\theta, y)$. Indirect utility in increasing in θ (and y) irrespective of the labor supply response because full income is increasing in θ.[7]

An economy with many persons opens possibilities for mutually advantageous social arrangements that allow risk pooling. The conventional problem strictly ties a worker's consumption to current production, but a contract allows current consumption to be disassociated from current production for any given person if risks are diversifiable. The simplest way to model this is to replace the personal budget constraint with its expectation (over all workers), precisely what an actuarially fair insurance policy would do. Yet this is not standard insurance: the contract specifies exactly how much the person has to work for each possible realization of θ in order to eliminate adverse effects on work incentives that consumption insurance implies.

Assuming common knowledge, the contract specifies that the worker puts forth $(1 - L(\theta))$ hours of work in state θ and that the wage payment or consumption is $C(\theta)$ in state θ. Expected profitability of the firm is the difference between expected output and expected wage (consumption) payments

$$\int[x(\theta) - C(\theta)]dG(\theta) = \int[\theta(1 - L(\theta)) - C(\theta)]dG. \tag{7}$$

Complete contracts (given μ) are analyzed in what follows, assuming risk-neutral firms, to bring out the connections between conventional theory and contract theory in the clearest possible way. Competition in the market for contracts implies that the equilibrium contract solves:

$$\max_{L(\theta),C(\theta)} \int U(C(\theta), L(\theta))dG(\theta) \tag{8}$$

subject to

$$\int[\theta(1 - L(\theta)) - C(\theta)]dG(\theta) = 0 . \tag{9}$$

The Lagrangian for this problem is

$$\int\{U(C,L) - \lambda[\theta(1 - L) - C]\}dG \tag{10}$$

The first order conditions for $L(\theta)$ and $C(\theta)$ given θ equivalent to (3) above are

$$U_C(C(\theta), L(\theta)) = -\lambda \tag{11}$$

$$U_L(C(\theta), L(\theta)) = -\theta\lambda \tag{12}$$

where $\lambda < 0$ as before. C and L are solved as functions of θ and λ from equations (11) and (12). Then the expected income constraint is used to solve for λ and hence the optimum contract $L(\theta)$ and $C(\theta)$. Notice that the conventional problem is completely nested in this one. It is feasible that $C(\theta) = x(\theta)$, but the contract surely will not specify equality of consumption and output for every realization of θ. True, (11) and (12) imply $U_L/U_c = \theta$ -- the marginal rate of substitution between leisure and consumption is equated with the marginal product of labor for any θ in a complete contract. However, now there is an extra degree of freedom: the expected income constraint allows the marginal utility of consumption to be equated in all states of the world (condition (11)), the Borch-Arrow-Wilson risk-sharing condition when one of the agents is risk neutral, equivalent to optimal choice of insurance in the actuarial, no-load case.

The properties of $L(\theta)$ and $C(\theta)$ in the contract are implicit in the first order conditions (11) and (12). Since λ does not depend on θ, comparative statics on (11) and (12) directly show how C and L respond to θ in the contract. (11) and (12) define marginal utility constant demand functions (Ragnar Frisch, 1932), which prove useful when preferences are additively separable, as they are across states-of-the-world here. Browning, et al. (forthcoming) contains an elegant statement of the method and gives prior references. Differentiating with respect to θ yields

$$U_{CC}C'(\theta) + U_{CL}L'(\theta) = 0$$

$$U_{CL}C'(\theta) + U_{LL}L'(\theta) = -\lambda$$

with solutions

$$L'(\theta) = -\lambda U_{CC}/\Delta \tag{13}$$

$$C'(\theta) = \lambda U_{CL}/\Delta \tag{14}$$

where $\Delta = [U_{CC}U_{LL} - U_{CL}^2] > 0$, by risk aversion.

From (13) we have $L'(\theta) < 0$, since $U_{CC} < 0$ by concavity and $\lambda < 0$. $d(1-L(\theta))/d\theta = 1 - L'(\theta) > 0$. The implicit contract always specifies that the employee works more hours in favorable states (larger values of θ) and works less in less favorable states. There is no ambiguity due to opposing income and substitution effects in the optimal contract. Negativity of $L'(\theta)$ is basically a result of substitution effects. The worker is constrained by the expectation of output, not by realized output itself. A favorable or unfavorable drawing of θ carries no income effects because the good fortunes of one firm are counterbalanced by bad fortunes of another for diversifiable risks. Therefore, it is always efficient for the worker to work more when the marginal product of labor is larger (to make hay when the sun shines) and to redistribute consumption by insurance. If leisure is a normal good, contracts result in greater variance in hours worked than standard models and intuition based on them suggest.

Equation (14) shows that total wage payments -- identified with consumption under the contract -- are rising, constant, or falling in θ as $U_{CL} \lesseqgtr 0$. Only when preferences are strongly separable in C and L is it true that $C'(\theta) = 0$ and consumption is completely smoothed, as in the permanent income hypothesis (Friedman, 1957). Nonzero cross derivatives U_{CL} strongly link consumption behavior with labor supply.[8]

That a contract with full insurance does not necessarily imply full consumption smoothing suggests that the connection between complete insurance and income effects is more subtle than usual. Full insurance does not stabilize consumption except when preferences are strongly separable. More surprising, it does not stabilize ex post utility when leisure is a normal good. In this bivariate problem full insurance is completely described by condition (11) that the marginal utility of consumption is equalized in all states of the world, not necessarily total utility. Define $u(\theta)$ as ex post indirect utility given θ in the optimal contract. Then

$$\begin{aligned} u'(\theta) &= U_C C' + U_L L' \\ &= -(U_C/U_{CC})[U_{CL} - (U_L/U_C)U_{CC}]L'(\theta). \end{aligned} \tag{15}$$

The second equality follows from (13) and (14). The bracketed term in (15) is familiar. It determines the sign of the income effect in a conventional labor supply problem. Ex post utility is completely assured by the contract only if $u' = 0$, and this happens only when the income effect is zero, or when $U(C, L) = U(C + \psi(L))$ of which section III is a special case. But if utility is completely assured, consumption $C(\theta)$ cannot be assured for it must compensate for the variation in L. The contract does not assure utility if the income effect is nonzero. $u'(\theta)$ is negative when the income effect is positive.[9]

A complete insurance contract makes a worker who has "suffered" an adverse draw of an insurable risk better off ex post than a worker who draws a more favorable value except when income effects are negative. Contracts under-insure ex post utility levels only when leisure is an inferior good. This strong result is a result of strong assumptions. It is not necessarily true when the firm is risk averse (then v(.) multiplies the right hand side of (11) and (12) so that risks are shared and insurance is incomplete. Nor is it necessarily true when information is private or when the shock is undiversifiable. A nondiversifiable risk affects μ, and has a powerful effect on the total amount of consumption produced and redistributed. It changes the marginal utility of consumption λ. Ex post utility necessarily increases in μ, as it did in section III.

The consumption smoothing and insurance aspects of contracts have profound implications on the meaning of wage data in a contract market. Observed wages do two things in a contract: they allocate labor and shift risks.[10] These roles are best described by thinking of the observed wage as the outcome of a two-part variable tariff. The insurance aspect determines the equivalent of nonearned income in a conventional labor supply problem, conditional on the realized state θ. For risk pooling and insurance to have meaning, it must be that workers experiencing favorable realizations of θ subsidize those with unfavorable realizations. Given these "lump sum" taxes and subsidies, the contract allows workers to "choose" their optimal labor supply at the correct "marginal wage" θ, the marginal product of labor.

Define $s(\theta)$ as the worker's net debit position with the firm: $s(\theta) = C(\theta) - \theta(1 - L(\theta))$ is the difference between the wage payment and output in state θ. This equation is of the conventional budget form except that $s(\theta)$ has replaced the usual nonearned income term. A worker for whom $s(\theta) > 0$ is effectively subsidized by the contract ex post and one for whom $s(\theta) < 0$ is effectively taxed. Substituting $s(\theta)$ into the budget constraint (9) reveals that these subsidies and taxes balance each other on average across all workers in an actuarial system. Differentiate $s(\theta)$ with respect to θ and substitute from (13) and (14)

$$s'(\theta) = -(1 - L) - (L'/U_{CC})[U_{CL} - (U_L/U_C)U_{CC}] \tag{16}$$

so $s(\theta)$ is decreasing in θ if leisure is noninferior.

The two-part tariff interpretation of contracts is shown in figure 2. The first panel shows the solution to the conventional problem (assuming zero nonearned income). Two budget lines are shown. The realized marginal product θ_1 is assumed to be larger than θ_2, and comparison of equilibrium points involves the usual income and substitution effects. The second panel shows the effects of a contract, assuming $U_{CL} < 0$. For θ_1 above the mean we know from (16) that the worker is taxed and $s(\theta) < 0$. For θ_2 below the mean the worker is subsidized and $s(\theta_2) > 0$. The contract acts as if it puts the θ_1 worker "in the hole" by amount $s(\theta_1)$ and lets him work out of it by choosing L at (marginal) wage rate θ_1 along the altered budget constraint. The contract acts as if it gives the θ_2 worker a subsidy of $s(\theta_2)$ and then allows him to choose hours worked at marginal wage rate θ_2. The heavy curve labeled C(L) is the locus of (C,L) pairs satisfying marginal condition (11), and $C'(L) < 0$ when $U_{CL} < 0$. The familiar marginal condition $U_L/U_C = \theta$ implied by (11) and (12) jointly is shown by the tangencies with the contract budget constraints. It is these adjustments in the "lump sum" portions of the two part tariff that ameliorate income effects, that promote consumption smoothing and elastic labor supply responses to diversifiable risks.

Figure 2 is useful for studying the observable wage consequences of contracts. The observed "average hourly wage rate" is measured by dividing total earnings (equals $C(\theta)$ in contracts) by hours worked:

$$W(\theta) = C(\theta)/(1-L(\theta)). \tag{17}$$

This is how wage rates are measured in virtually all available data. Differentiating (17), and substituting from above yields

$$W'(\theta)/W(\theta) = [-(U_{CL}/CU_{CC}) + (1/(1-L))]L'(\theta). \tag{18}$$

The sign of this expression is unambiguous only when $U_{CL} \geq 0$, in which case $W(\theta)$ is actually decreasing in θ, given μ. The sign of $W'(\theta)$ is ambiguous when $U_{CL} < 0$ as in figure 2. Figure 3 illustrates the construction of $W(\theta)$ for preferences without income effects. Here $C(L)$ coincides with an indifference curve because utility is constant in the contract, from (15). The points marked A and B correspond to large and small values of θ respectively. The measured everage hourly wage rate is given by the slope of the line connecting either point with $L = 1$ and $C = 0$, from (17). The two values of θ have been chosen so that the wage rate is the same, illustrating nonmonotonicity of $W(\theta)$. In this case $W(\theta)$ is U-shaped. It is decreasing for θ sufficiently small and is increasing for θ sufficiently large.

Two points follow from this:

First, there is no presumption that the measured average wage in a contract is positively correlated with the state θ, as the U-shaped pattern in figure 3 shows, a possibility that could be confused with wage rigidity. This statement refers to real average wage rates and to the diversifiable component of the state. If the economy experienced an adverse aggregate shock μ, the contract would have to be recalibrated. The equilibrium indifference curve in figure 3 would be shifted down and the average hourly wage at each hours worked would be smaller than indicated. Average hourly wages rates should be positively correlated with noninsurable disturbances in a contract market.

The behavior of average real wages over the business cycle has been studied for many years. Manufacturing hourly wage rates show no obvious relationship with aggregate output (Salih Neftci, 1978). Joseph Altonji and Ashenfelter (1980) suggest that the manufacturing real wage rate resembles a random walk. However, panel and personal survey data indicate significant responses of measured personal wage rates to local labor market conditions (John Raisian, 1983; Mark Bils, 1985; and Topel, forthcoming). James Heckman and Guilerme Sedlacek (1984) show that BLS manufacturing numbers may contain selection bias, since less productive workers are less likely to be employed in manufacturing during business cycle troughs, making measured wages fall less than a properly weighted index.

Second, using measured wage rates may lead to misleading inferences regarding unemployment or overemployment in personal surveys. Optimality of the contract means that ex post Pareto-improving recontracts are not possible. There is also no possibility of choosing hours worked ex post at some exogenously determined wage. In figure 3 the worker is instructed to work $(1 - L_1)$ hours in the θ_1 state. Total earnings of C_1 go along with this, so the average hourly wage is $C_1/(1-L_1) = W$. If the worker could freely choose hours at an hourly wage rate W he would work up to point C rather than stay at A. In the θ_2 state, the contract specifies point B. Here the worker would choose to work more hours (point C) than the contract specifies if hours could be freely chosen at wage rate W. A survey respondent might indicate constraints on hours worked under these circumstances. The person who drew θ_2 might say that he would like more work than he is getting at the "going" wage rate and that he is involuntarily underemployed. The worker who drew θ_1 might respond that work hours are excessive and that he is involuntarily overemployed.

All this points out a significant problem for empirical analysis. Virtually all work on labor supply uses a model that assumes point C, that the worker is free to unilaterally choose hours at the measured wage rate W, whereas the insurance features of contracts disassociate the measured average wage rate from both the marginal product of labor and from the marginal rate of substitution. This point is conceptual and applies even if average wages were perfectly measured, so econometric techniques for dealing with measurement error does not dispose of it. This is not trivial because virtually all econometric work (in this field and elsewhere) lives or dies by the assumption that measured prices indicate efficiency margins. Contracts require that the data be adjusted for the lump sum components $s(\theta)$ to impute marginal wage rates. Some recent studies have attempted to include information on survey responses pertaining to whether or not the worker is constrained in the choice of hours, but this is generally viewed as a ration, not as an equilibrium phenomenon along contract lines (Shelly Lundberg, 1984 gives references and a related discussion).

This section concludes with an interesting and surprising comparative static experiment. Complete contracts imply that an increase in diversifiable risk increases expected utility of risk averse workers.

Following Michael Rothschild and Stiglitz (1970), parameterize the density function as $g(\theta) = \xi(\theta) + ar(\theta)$, where $\xi(\theta)$ is a density, a is a positive number, and $r(\theta)$ is a step function with properties:

$$R(\theta) = \int_0^\theta r(z)dz$$

$$R(0) = R(\infty) = 0$$

$$\int_0^\infty R(\theta)d\theta = 0 \tag{19}$$

$$\int_0^\theta R(z)dz \geq 0 \quad .$$

Some reflection reveals that $r(\theta)$ is positive for large and small values of θ and is negative for intermediate values. Therefore an increase in a puts more weight in the tails of $g(\theta)$ and increases the spread of the distribution.

Differentiating the Lagrangian of the maximum problem in (8) with respect to a and using the envelope property gives

$$\partial Eu/\partial a = \int u(\theta)r(\theta)d\theta - \lambda\int[\theta(1 - L) - C]r(\theta)d\theta \quad .$$

This expression may be signed by integrating by parts (twice) and exploiting the properties of (19) (Peter Diamond and Rothschild, 1978). Assuming $g(\theta)$ has bounded support, integration by parts gives

$$\partial Eu/\partial a = -\int\{u'(\theta) + \lambda[\theta L'(\theta) + C'(\theta)]\}R(\theta)d(\theta)$$

$$+ \lambda\int(1 - L(\theta))R(\theta)d\theta$$

$$= \lambda\int(1 - L(\theta))R(\theta)d\theta$$

since the first integral vanishes from first order conditions and (15). Integrating by parts again gives

$$\partial Eu/\partial a = -\lambda\int_0^\infty\int_0^\theta -L'(\theta)R(\tau)d\tau d\theta \ . \qquad (20)$$

The sign of (20) is unambiguously positive because $\lambda < 0$, $L'(\theta) < 0$, from (13), and $\int^\theta R(z)dz > 0$, from (19). Greater diversifiable risk makes the worker better off.

This result is unexpected in light of the Smithian equalizing differences logic, but is easily explained. Full insurance eliminates the adverse direct consequences of risk aversion on expected utility. Increasing spread affords the worker superior opportunities of allocating work to the most favorable states and limiting losses of unfavorable outcomes by consuming more leisure. The opportune substitution of work effort toward more productive states has a value similar to that of an option: that less work is called for in the less favorable states serves to truncate the lower tail of the θ distribution.

V. LAYOFFS OR WORKSHARING?

Misconceptions about the nature of the price mechanism in contracts has led to the impression that contracts somehow rationalize layoffs through "sticky" wages and prices, and nonmarket clearing. This impression is wide of the mark because it confuses ex post contractual wages and prices with conventional "auction" market prices. Section IV clearly demonstrates that resources in contracts are really allocated by a sophisticated nonlinear price system. This nonlinear scheme is as flexible as one ordinarily supposes in competitive market theory and allocates resources as efficiently as the completeness of contingent claims markets permits. The true fact is that contracts per se have little to say about the split between changes in hours per head and layoffs. Contract outcomes fundamentally depend on preferences and technology, so the question of layoffs must rest on these same primitives. Section III produced layoffs by a peculiar assumption about preferences, that market and nonmarket goods are perfect substitutes. The conventional formulation in section IV is not detailed enough to decide these issues.

There are basically two ways of introducing layoffs in contract (or any other) models. One links layoffs to capital utilization decisions based on capital heterogeneity and limited ex post substitution between labor and capital (Lief Johansen, 1972). The idea is related to the "marginal firm." Marginal mines shut down completely when the price of ore falls because their quasi-rents are driven to zero. Production in marginal operations might commence when demand increases. Restricted ex post capital-labor substitution and fixed operating costs create nonconvexities that make it advantageous to shut down inefficient facilities rather than operate them at excess capacity. These ideas could be extended to various divisions of a multiproduct or multiplant firm. The contract model must be extended to incorporate productivity differences among firms, based perhaps on vintage capital ideas (Solow, 1960), differences in site-specific factors or in entrepreneurial capacities. This line has not been pursued much, and will not be developed here.

The other possibility is to directly introduce hours and employees (bodies) into the firm's technology (Feldstein, 1967; Rosen, 1968; Ray Fair, 1969; M. Ishaq Nadiri and Rosen, 1969; Ben Bernanke, 1984), which serves to link the models of sections III and IV above. Miyazaki and Neary (1983) and Murry

Brown and Elmas Wolfstetter (1984) have constructed contract models along these lines.

Extend the production function of section III to $x = \theta f(\rho n, h)$, where h is the intensity of work per employed person and f( ) is concave. Think of ρ as the fraction of contract labor who are employed. Then $1 - \rho$ is the layoff rate. Alternatively, maintain a timing convention in which the "period" is a year. Then h can be regarded as the length of the work week when employed and ρ as the fraction of the year (number of weeks) of employment. $h = 0$ during nonworking weeks spent on layoff. To simplify the presentation, I again assume complete contracts (of course conditional on the mean μ of θ) and risk neutral employers.

Writing the utility function in terms of h rather than L, an employed worker receives contractual wage payment $C_1(\theta)$ and works $h(\theta)$ in state θ, receiving utility $U(C_1(\theta), h(\theta))$. A laid off worker receives payment $C_2(\theta)$ and h is zero, so utility is $U(C_2(\theta), 0)$. The probability of these events is ρ and $1 - \rho$ respectively, so

$$Eu = \int[U(C_1, h)\rho + U(C_2, 0)(1 - \rho)]dG(\theta) \qquad (21)$$

The budget constraint is

$$\int[\theta f(\rho n, h) - n(C_1\rho + C_2(1 - \rho))]dG(\theta) = 0. \qquad (22)$$

The equilibrium contract $\{C_1(\theta), C_2(\theta), h(\theta), \rho(\theta)\}$ maximizes (21) subject to (22). First order conditions for C_1 and C_2 are familiar by now

$$U_C(C_1(\theta), h(\theta)) = U_C(C_2(\theta), 0) = -\lambda n \tag{23}$$

and imply that C_2 is independent of θ (because λn is independent of θ). C_1 depends on θ (unless $U_{Ch} = 0$) only if h does. The intensive margin h is (note that $U_h < 0$)

$$-\rho(\theta)U_h(C_1(\theta), h(\theta)) = -\lambda\theta f_2(\rho(\theta)n, h(\theta)) \tag{24}$$

or, substituting from (23) and rearranging, $\theta f_2 = (\rho n)(-U_h/U_C)$: the marginal product of h in state θ equals its marginal cost, which is the shadow price $(-U_h/U_c)$ per employed worker times the number employed. The extensive margin ρ is, assuming $\rho > 0$ (the firm never closes)

$$U(C_1, h) - U(C_2, 0) + \lambda n[\theta f_1(\rho n, h) - (C_1 - C_2)] \geq 0 \tag{25}$$

so the shadow price of labor utilization ρ is

$$(C_1 - C_2) - [U(C_1, h) - U(C_2, 0)]/U_C(C_1, h).$$

Further analysis of these conditions is neither elementary nor illuminating. At this level of generality about all that can be said is that $d\rho/d\theta \not> 0$ and $dh/d\theta \geq 0$. Yet time-series data on employment and hours follow systematic patterns. Aggregate hours and employment variations are positively correlated with output growth rates (deviations about trend), and hours per week show variation of less than two hours peak to trough. Employment fluctuations account for the bulk of total labor utilization adjustments even in deep recessions. Indivisibilities appear necessary to account for this (Mortensen, 1978; Kenneth Burdett and Mortensen, 1980).

Consider an example: Assume $U(C, h) = U(C - \phi(h))$ where $U'' < 0$ and $\phi(h)$ is an increasing convex function. Then (23) implies equal utility in all states -- there are no income effects -- and $C_1(\theta) - C_2 = \phi(h(\theta)) - \phi(0)$. For production assume $f(\rho n, h) = F(\rho n\gamma(h))$, where $\gamma(h)$ has the interpretation of efficiency units of work hours. A long tradition of labor market research suggests that $\gamma(h)$ may have an ogive shape, due to set-up costs (Sidney Chapman, 1909; Arthur C. Pigou, 1920): productivity of a worker's time is small at small values of h, rises rapidly after some threshhold is passed, and finally shows diminishing returns when h is very large. Indivisibilities due to fixed costs of market participation (John Cogan, 1980; Giora Hanoch, 1980) have similar implications. (Hanoch discusses including both hours worked and weeks worked as arguments of utility functions, which generalizes (21)). Then (24) and (25) become

$$\begin{aligned} &\theta\gamma'(h)F'(.) = \phi(h) \\ &\theta F'(.) \geq [\phi(h) - \phi(0)]/\gamma(h). \end{aligned} \tag{26}$$

When $0 < \rho < 1$, the second condition in (26) holds with equality. Dividing through by the first yields

$$\gamma'(h)/\gamma(h) = \phi'(h)/[\phi(h) - \phi(0)] \tag{27}$$

which gives a unique solution for h, say h^*. At $h = h^*$ we must have diminishing returns, or $\gamma''(h^*) < 0$. (27) is independent of both ρ and θ, so $h(\theta) = h^*$, a constant whenever <u>any</u> layoffs occur. Furthermore we have in this region

$$\theta F'(\rho n \gamma(h^*)) = \phi'(h^*)/\gamma'(h^*) = [\phi(h^*) - \phi(0)]/\gamma(h^*), \qquad (28)$$

so the shadow price of labor is $[\phi(h^*) - \phi(0)]/\gamma(h^*)$, a constant independent of θ. (28) defines $\rho(\theta)$ when layoffs are positive, and implies that $\rho(\theta)$ is increasing in θ. Fewer workers are laid off in more favorable states. Furthermore, wages $C_1(\theta)$ paid to employed workers are rigid and independent of θ whenever layoffs are positive.

Since $\rho(\theta)$ is increasing, there must be some critical value θ^* beyond which $\rho = 1$. The firm would like to hire more workers than it has contracted with in states more favorable than this. Therefore, for $\theta > \theta^*$ it is h that does all the adjusting. In this range $h(\theta)$ is defined by the first condition in (26) with ρ set equal to one. The firm's shadow price of labor is $\phi'(h)/\gamma'(h)$ here and is increasing in h on the assumptions above. Therefore $h(\theta)$ is increasing for $\theta \geq \theta^*$. $C_1(\theta)$ is increasing here as well.

The overall solution is pieced together in figure 4. The employment rate does all the adjusting when θ falls short of θ^*. h is rigidly set at h^* here and the shadow price of labor to the firm is constant. For $\theta > \theta^*$, the shadow price of labor is rising, $\rho = 1$, and hours do all the adjusting. Furthermore, the wage paid to employed persons is "rigid" downward: C_1 is constant for $\theta \leq \theta^*$. The internal supply price of labor would be smaller than shown if contracts did not fully indemnify laid-off workers, and layoffs would be involuntary, as above. In either case the layoff rate is decreasing in μ (the undiversifiable risk) because θ^* is decreasing in μ.

This example suggests the following interpretation of hours and employment data. In normal times (the mean of θ exceeds θ^*) hours per worker account for most total manhours variation (hours are a leading indicator).

Workers are not laid off until conditions get sufficiently bad to pass beyond the threshhold θ^*, at which point hours per head show downward rigidity that puts distinct limits on the use of worksharing.

This type of model can account for some of the broader features of the data, but recent international comparisons present interesting and important challenges. Robert J. Gordon (1982) compared the U.S. with Japan. Both countries exhibit about equal variance in total hours worked, but hours per worker varies more in Japan than in the U.S. and employment varies more in the U.S. The widespread use of bonuses makes for greater wage variability in Japan as well. Models of this type account for these differences on the basis of differences in preferences and technology and surely leave much unexplained. It appears as if some consideration of differences in firm-specific human capital, labor mobility, and quasi-fixed factor ideas are required to fully account for these differences (Hashimoto, 1979).

VI. INTEMPORAL CONTRACTS

This survey follows the literature in expositing timeless single period models. There is a parallel intertemporal formulation, following Baily (1974) who suggested that contracts might exploit gains from trade due to capital market imperfections. The firm's greater access to capital markets allows it to save and dissave on the worker's behalf, and eliminates intertemporal uncertainty in consumption (Brown, 1983) that the worker cannot accomplish on his own. The contract again specifies consumption (wage payments) and labor utilization in each state and each time period, conditional on information available in that period. It mimics the solution to an intertemporal expected utility maximization problem. Now the observed wage payments intermingle elements of intertemporal savings and dissavings as well as the usual productive efficiency considerations. Nonetheless, the formal analysis has many features in common with the one-period model. Under complete information the contract specifies (C_t, L_t) pairs conditional on the history of state realizations θ_t up to the present time t. In the leading model the worker has an intertemporally separable utility function of the form $E\sum U(C_t, L_t)D^t$, where D is the rate of time preference, similar to (8), and the firm is risk neutral. The budget constraint at time t equates the expected present value of future consumption to the expected present value of future production, conditional on the observed sequence $\{\theta_\tau\}$ at t, similar to (9).

The precise solution depends on the properties of $\{\theta_t\}$ and the extent to which capital consumption allows intertemporal diversification of aggregate disturbances (Richard Cantor, 1983). Consider the simplest case in which θ is independently distributed over agents with a constant mean (Grossman and Laurence Weiss, 1984). Then the insurance of section IV is achieved by a consumption loan market subordinated through firms. Those with adverse realizations borrow on their worker's behalf and those with favorable realizations are lenders. The loan market is cleared at a rate of interest equal to the rate of time preference (to satisfy intertemporal marginal conditions) and the analysis of section IV carries through intact. Here the $s(\theta)$ terms of figure 2 are the savings and dissavings components of observed earnings of workers, personal consumption is smoothed and personal labor supply is accentuated by substitution effects. "Capital market imperfections" introduce ex post involuntary elements in contract terms, as above.

More generally, write $\theta_{it} = \mu_t \varepsilon_{it}$. Then the contract is conditioned on the history of the aggregate shock as well as on local disturbances. These aggregate shocks are undiversifiable if there are no stores of nonhuman wealth.

An unanticipated adverse aggregate disturbance increases the demand for consumption loans. The rate of interest rises to ration reduced supply. Smaller aggregate consumption is redistributed out of the diversifiable risks as before, but observed consumption and employment contain elements of Keynesian income effects. The optimal program embodies forecasts of permanent wealth to the extent that the μ-process is serially correlated and persistent. These redistribute planned consumption and labor supply over time through direct wealth effects and indirectly through their anticipated effects on interest rates. In the most general formulation, capital allows the aggregate disturbance to be partially diversified through capital accumulation in favorable aggregate conditions and through decumulation in unfavorable circumstances (Truman Bewley, 1980; William Brock, 1982). These intertemporal trading possibilities reduce the income and wealth effects of aggregate shocks on consumption and employment behavior and accentuate pure substitution effects.[11]

This discussion makes clear that intertemporal contract models are closely related to the intertemporal substitution hypothesis (Lucas and Leonard Rapping, 1970). A substantial practical difference is the role of measured wage rates in uncovering the structure of preferences and technology from actual data, because average wage rates do not index the true marginal product of labor or the marginal rate of substitution between C and L in contracts (section IV). This point is important because almost all empirical studies of intertemporal substitution assumes that measured wage rates fully reflect both margins in the data. Two notable exceptions are Brown (1983), who attempted to estimate the optimal program directly on functional form restrictions, and Abowd and David Card (forthcoming), who attempt to estimate the fraction of workers for whom wage rates reflect marginal conditions. The methods of Finn Kydland and Edward

Prescott (1982) also rest heavily on functional forms and avoid the use of market price and wage data. But on the conventional assumption, most recent estimates of intertemporal substitution on microdata are negligible for prime-age males (MaCurdy, 1981; Joseph Altonji, 1982); but much larger for those classes of workers, such as married women, who exhibit regular labor force transitions (Heckman and MaCurdy, 1980). It is worth pointing out that in light of the greater labor force and (contractual) job attachments traditionally exhibited by men the maintained assumption that observed wage rates index marginal conditions is less likely to apply to them.

Studies by Kydland and Prescott (1982), Robert Barro and Robert King (1982), Kydland (1984), and Jisoon Lee (1984) conclude that the conventional intertemporal model cannot explain certain comovements in aggregate time-series data. The preferred specification is controversial and may require non-separable preferences and technology. However, contract theory does not depend on these special assumptions. A contract can be written for any preferences and technology, but always divorces measured wage rates from the production efficiency conditions of the optimum program that it embodies.

VII. CONTRACTS WITH PRIVATE INFORMATION

As noted above, it is difficult to incorporate transactions costs and incomplete insurance in contract models. Interest in asymmetric information models has been sustained by their potential for doing this in an analytically tractable manner. The problem investigated most thoroughly so far is identical to that of section IV with one bit of information removed: the firm is assumed to observe the realization of θ but the worker doesn't observe it (Guillermo Calvo and Edmond Phelps, 1977; Hall and Lilien, 1979). Recent work by Russell Cooper

(1981) and John Moore (1984) consider two-sided private information models and cannot be reviewed here. Readers are forewarned that this section is more technically demanding than the rest of this survey. However, it may be skipped without significant loss of continuity.

The contract cannot be conditioned on θ because the worker cannot observe it, and since any rational employment decision must depend on the marginal product of labor, that decision must be delegated to the agent with the information, namely the firm. The contract takes the following form (Jerry Green and Charles Kahn, 1983): the worker and firm agree ex ante on a compensation schedule C(L) (equivalently C(1 - L)). The firm observes θ and instructs the employee to work (1 - L) units of time in exchange for contractual compensation C(L). Market competition takes the form of offering attractive compensation schedules C(L), so the competitive contract maximizes expected utility of the worker subject to expected firm utility (or profit) and information constraints. The nonlinear contract pricing schedule C(L) is closely related to the multipart-tariffs of section IV. In fact the solution of the problem is formally identical to the theory of nonlinear pricing (Michael Mussa and Rosen, 1978; Eric Maskin and Riley, 1984).

Given any schedule C(L), the firm observes θ and chooses L to maximize profit. The firm's ex post profit is $\pi(\theta, L) = \theta(1 - L) - C(L)$ so given C(L) and θ, L is chosen to satisfy

$$\frac{\partial \pi}{\partial L} = -\theta - C'(L) = 0 \qquad (29)$$

so long as

$$\frac{\partial^2 \pi}{\partial L^2} = -C''(L) < 0$$

The firm chooses L in (29) so that the marginal product of labor equals its marginal cost to the firm. Write the solution to (29) as $L(\theta)$. Comparative statics reveals

$$L'(\theta) = -1/C'' < 0 .$$

The worker is always instructed to work more in favorable states and less in unfavorable states. Define $C(\theta) = C(L(\theta))$. Then $C'(\theta) = -\theta L'(\theta) > 0$, and compensation unambiguously increases in θ independently of worker preferences.

The method of solution follows an idea of Mirrlees (1971). Given $C(L)$, the firm exploits its information through (29), which holds for every possible realization θ. Therefore (29) may be regarded as a differential equation $dC/dL = -\theta$, or $dC = -\theta dL$. Integrating by parts yields

$$C(\theta) - C(0) = -\theta L + \int_0^\theta L(\nu)d\nu \qquad (30)$$

which is a convenient way of representing the information constraint (29)

The competitive equilibrium contract maximizes the worker's expected utility subject to the firm's expected utility, as before, and to the firm's exploitation of its information (30). Define the transformation $z(\theta) = \int_0^\theta L(\nu)d\nu$. Then $z'(\theta) = L(\theta)$ and (30) becomes

$$C(\theta) = C(0) - \theta z'(\theta) + z(\theta) \quad . \qquad (31)$$

Furthermore (note: assuming $f(1 - L) = 1 - L$ simplifies the presentation without affecting essentials)

$$\pi(\theta) = \max_{L} \pi(\theta, L) = \max_{L} \theta(1 - L(\theta)) - C(\theta)$$

$$= \theta - \theta z' - C(0) + \theta z' - z = \theta - C(0) - z(\theta) \quad .$$

Now the contract can be described as a variational problem in z and z'. Recalling that $Eu = \int U(C, L)dG$, and substituting for C from (31), we seek a function $z(\theta)$ and real numbers λ and $C(0)$ that maximize

$$\int U(C(0) - \theta z' + z, z')dG + \lambda[\overline{v} - \int v(\theta - z - C(0))dG] \qquad (32)$$

where $v(.)$ is the utility function of the firm. Once $z'(\theta) = L(\theta)$ has been found, (30) is used to calculate $C(\theta)$. Eliminating θ from these two expressions implies $C(L)$.

Two marginal conditions and a boundary condition characterize the solution. Differentiating (32) with respect to $C(0)$ yields:

$$\int_0^\infty U_C dG = -\lambda \int_0^\infty v' dG \quad . \qquad (33)$$

The <u>average</u> marginal utility of consumption for the worker is proportional to <u>average</u> marginal utility of the firm. Marginal utilities are not necessarily equated state-by-state. An Euler equation gives the margin for z:

$$(U_C + \lambda v')g(\theta) = \frac{d}{d\theta}(U_L - \theta U_C)g(\theta) \quad . \tag{34}$$

Denote the upper and lower limits of θ in $G(\theta)$ by $\hat{\theta}$ and $\underline{\theta}$ respectively. Then multiplying (34) through by $d\theta$ integrating and exploiting (33) yields

$$U_L(\hat{\theta}) - \hat{\theta}U_c(\hat{\theta}) = U_L(\theta) - \theta U_c(\theta) \quad . \tag{35}$$

The boundary condition sets (35) to zero, so the contract is production efficient ($\theta = U_L/U_C$) in the best and worst states (Cooper, 1983 gives an intuitive explanation in terms of the revelation principle: the firm cannot overstate the most extreme realizations to the worker if the distribution $G(\theta)$ is bounded and the bounds are common knowledge). Using this fact and integrating (34) yields the fundamental condition

$$\int_0^{\theta}(U_C + \lambda v')g(\theta)d\theta = (U_L - \theta U_C)g(\theta) \quad . \tag{36}$$

(36) nicely illustrates the tension between insurance and efficiency under private information. The contract cannot be production efficient for $\underline{\theta} < \theta < \hat{\theta}$ unless there is efficient sharing of risks in the Borch-Arrow sense for each state. In addition the solution generally depends on $G(\theta)$. For example, it can be shown (Mussa and Rosen, 1978; Kahn and Jose Scheinkman, forthcoming) that the firm may choose the same work hours $1 - L$ for a closed interval of states. The contract certainly doesn't achieve first-best efficiency in these regions.

Much effort has gone into analyzing the sign of the inefficiency implied by (36). The interpretation plays heavily on a notion of contractual commitment and enforcement that doesn't arise in the common information case.

For suppose the contract implies production inefficiency in some state. The worker and the firm have agreed to contractual terms C(L) ex ante. When this state materializes, the worker generally can infer the realized value of θ by his implicit knowledge of (29) (the production function and utility function are common knowledge in this formulation; Schwartz, 1983 questions how this knowledge becomes common). At that point there are unexploited gains from trade and both parties could benefit by recalibrating L so that $\theta = U_L/U_C$ ex post. However, if recontracting is allowed, the contract must unravel, because it is written under the assumption that both parties bind themselves to its ex ante terms. The extent to which private information models produce "involuntary" unemployment and overemployment depends on how these ex ante commitments can be enforced ex post. While some authors are careful to recognize this important point (especially Hart, 1983), a convincing description of labor market institutions that embody this enforcement mechanism in implicit contracts has not been forthcoming.

Three special cases of (36) have been analyzed. The method of proof is established by Green and Kahn (1983), to which the reader is referred for details. Denote the left hand side of (36) as a function of θ, say $\zeta(\theta)$. The sign of $\zeta(\theta)$ is established by calculating its derivatives and ascertaining whether it achieves a local maximum or minimum for some interior value of θ, using boundary conditon (35). The results are sensitive to the nature of risk aversion and to income effects in worker preferences.

Case 1 (Hall and Lilien, 1979). Assume firms are risk neutral, workers are risk averse and have preferences of the form $u = U(C + \psi(L))$ -- no income effects. Then the left hand side of (36) turns out to be identically zero, and the contract specifies $\theta = U_L/U_C$ for every θ. There is furthermore complete and optimal risk shifting: $u(\theta)$ is constant and the firm eats all risks. Here the

C(L) schedule coincides with an indifference curve, as in figure 3 of section IV. Private and common knowledge contracts are identical in this case.

Case 2 (Grossman and Hart, 1983; Azariadis, 1983). Maintain the same assumptions about workers as case 1, but let the firm be risk averse. Here Green and Kahn's proof may be extended to show that the left hand side of (36) is negative for almost all θ. Therefore $U_L/U_C < \theta$ and the marginal social cost of labor is less than its ex post marginal product. The worker would like to recontract for more employment ex post in practically every state, and there is involuntary underemployment in the sense qualified above. Furthermore, the worker bears consumption risk and $u(\theta)$ is increasing in θ.

Case 3 (Green and Kahn, 1983; V.V. Chari, 1983). The firm is risk neutral, the worker is risk averse and has a positive income elasticity of demand for leisure (as in section IV). Now the integral in (36) is positive for almost all θ. Therefore $U_L/U_C > \theta$, and the marginal cost of labor exceeds its marginal product. The contract leads to "involuntary overemployment" and the worker would like to recontract ex post for less work than the firm chooses. Here $u(\theta)$ is decreasing in θ and the worker is worse off in the more favorable states, as in section IV.

The nature of these contracts is altered if workers have means to disassociate current consumption decisions from current earnings. Thus, consider the third case and assume that the worker can self-insure (Topel and Finis Welch, 1983), for example by borrowing and lending in a perfect capital market in the intertemporal context. Then the worker's self-insurance activities imply $U_C = -\lambda$ for each θ. Since the firm is risk neutral, the left side of (36) vanishes and the asymmetric information contract is perfectly efficient. Its employment and consumption properties duplicate that of section IV. Hart (1983) adds the assumption that the firm is risk averse and gives an ingeneous argument for the relevance of case 2. Risk neutral stockholders would be reluctant to provide full insurance to the firm's management on moral hazard grounds. However, they would not be so reluctant to contract for consumption insurance with workers, because workers' labor supply is delegated through the manager in private information contracts and there are no direct moral hazards. Hence these third parties could conceivably enforce the $U_C = -\lambda$ condition for workers. But then risk aversion of managers ($v'' < 0$) implies that the left side of (36) must be negative for bad realizations, or involuntary underemployment. This argument is a very delicate one, for it implies that the effect of third party insurance to workers is partially subverted by workers intermediating it and providing partial insurance to managers (because workers become effectively risk neutral). Income risks to managers are reduced by making the contractual C(L) function steeper than when third party insurance is available. In favorable states the marginal cost of labor to the firm is increasing too rapidly in (1 - L) and the firm does not employ as much labor as is socially desirable. In unfavorable states the marginal cost of labor is falling too fast and too much labor is released.

VIII. CONCLUSION

Not all marriages are made in heaven. Firms go bankrupt, demand shifts to other locations, supply shifts to other countries, products become obsolete and relative demands for goods have been known to change over time. Contracts call for permanent dissolutions when quasi-rents on firm specific human capital fall to zero. Serious critics of contract theory have built their case on the observation that quits rise noticably during business cycle expansions (Herschel Grossman, 1977, 1979). Contracts break down if workers opportunistically accept insurance payments in bad times and renege on premium payments by skipping out in good times. How much of observed voluntary turnover reflects opportunism and how much is it the rational outcome of moving workers from lower to higher valued uses?

These issues occupy much attention in current research, which is proceeding in a number of different directions too disparate to be usefully reviewed here. However, these problems are important for delimiting the scope for self-enforcing contracts that the at-will labor market contracting institution requires, and for pointing out potential reasons why contracts might be incomplete. The common knowledge framework illustrates some of these ideas. Under these circumstances the contract would specify the conditions and terms of its dissolution up front.

A suitable reinterpretation of the model in section III clarifies the point. Think of θ as a permanent disturbance that permanently affects the fortunes of the firm, and interpret mL as the value of the worker's time in an alternative job in another market.[12] Then ρ has the interpretation of the probability of a permanent separation. The solution is exactly the same as shown above. The complete contract stipulates a severance payment C_2 to those workers who depart when θ falls short of θ^*. Turnover is efficient if the severance payment offers complete insurance, but is inefficient if severance payments are constrained and workers are not fully protected against permanent separations. For the same reasons as before, there is insufficient turnover in these latter circumstances (see especially Ito, 1984; also Hercules Polemarchakis and Weiss, 1978; Arnott, Arthur Hosios and Stiglitz, 1983; John Geanakopolus and Ito, 1982; Barry Nalebuff and Richard Zeckhauser, 1984).

The need for interfirm mobility in a well functioning labor market suggests important reasons why contracts might be incomplete. A worker's knowledge and perception of outside opportunities do not materialize out of the blue. Information gathering and job search activities are costly and cannot be a matter of common knowledge by the idiosyncratic nature of job-worker matches. A worker must bear some residual job finding risks because of the moral hazard effects of personal actions on success probabilities (Steven Shavell and Weiss, 1979). Furthermore, the nature of searchers' interactions gives rise to externalities that have only recently begun to be understood (Diamond, 1982; Christopher Pissarides, 1984). A contract must embody a delicate balance of encouraging mobility in response to permanent changes in demands and discouraging it for temporary shocks. Full insurance discourages mobility by subsidizing leisure and reducing job search intensity (Bronars, 1983; Mortensen, 1983b; Ito, 1984). This is undesirable when severance is economically warranted, but not when demand and supply disturbances have a more transient character. Since inferences on the permanent-temporary decomposition of disturbances is itself uncertain, it appears as if contracts cannot provide complete insurance. We are driven back to conventional models to the extent this is true. The practical importance of contract thkeory for understanding employment behavior depends on the extent to which risks are socially diversifiable over space and time.

FOOTNOTES

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[1]The common law doctrine of at-will governs employment contracts (Clive Bull, 1983; Richard Epstein, 1984) and allows termination without fault at the will of either party at any time. Union contracts and certain Equal Opportunity legislation are major exceptions to at-will contracts. Both stipulate for-cause provisions and extensive adjudication procedures.

[2]The origins of this problem lie in Wassily Leonteif (1946). Contract curve approaches to trade union bargaining recently have been developed by Ian McDonald and Robert Solow (1981), Thomas MaCurdy and John Pencavel (forthcoming) and Orley Ashenfelter and James Brown (forthcoming). Implicit contract theory substantially differs from these in resolving the uncertainty in the distribution of utility between parties using the theory of optimal risk sharing.

[3]The method may be unfamiliar. Think of the integrals in (1) and (2) as the limits of sums across a large number T of discrete possible realizations of θ (the relation between a histogram and a continuous density). The discrete formulation is a gigantic multivariate optimization problem which, by the logic of the contracts, associates specific values of the C's and ρ with each possible realization. These 3T marginal conditions are compactly written as (3) in the limit. For the third equation in (3), note that a ρ is associated with each value of θ and that is why there are no integrals in these conditions. Some of

the literature works with the dual problem, but the solution is equivalent by pareto optimality.

[4]Something equivalent to U-shaped average cost curves is required to determine n. Contract theory adds no insights to the determination of firm size and this issue is ignored here. Hajime Miyazaki and Hugh Neary (1983) determine n as in a worker-managed firm. Rosen (1983) does it by a local public goods argument. These papers and one by Dale Mortensen (1983) further elaborate models of this type.

[5]Nor do contracts imply nominal wage rigidity because the price level would be a conditioning variable. Fixed duration nominal contracts (John Taylor, 1980; Stanley Fisher, 1977; and Joanna Gray, 1976) must be rationalized on some other grounds, such as contracting costs and lags and errors in observing nominal price levels.

[6]Perceptive readers may have noticed that the complete contract could have been equivalently implemented by having all employees work ρ percent of the time and consume leisure $(1 - \rho)$ percent of the time rather than having a fraction ρ fully employed and a fraction $(1 - \rho)$ completely unemployed. These same possibilities arise in the incomplete contract, but are definitely not equivalent. The virtue of work sharing does not seem to have been noticed in this connection. Some factor that gives value to continuity of a worker's employment time over the period is necessary to avoid pure worksharing solutions. See below.

[7]Increasing the spread of the distribution function $G(\theta)$ does not necessarily make the worker worse off, and Smithian risk compensation is more complex than would appear on the surface. Riskier distributions decrease welfare on risk aversion grounds, but have benefits in allowing workers to choose

labor supply most advantageously in more probable high productivity states. John Hey (1979) summarizes this approach to uncertainty. Nonearned income is ignored in what follows because those issues are better treated in an intertemporal context.

[8]Notice that consumption is positively correlated with labor supply only when $U_{CL} < 0$ from (14). The sign of U_{CL} is determined by the degree of risk aversion as well as by the usual curvature restrictions in demand theory. A richer specification of nonmarket production yields more interesting implications. For example, those on short work schedules would substitute nonmarket goods production for market goods (Gilbert Ghez and Becker, 1975). Michael Grossman (1973) and Daniel Hamermesh (1982) find these types of predictable differences in consumption (e.g., food prepared away from home) between the employed and the unemployed.

[9]This result is formally identical to a paradox found by James Mirrlees (1972) in an optimum spatial equilibrium problem. Mirrlees' paradox arises because of the nonconvexity that a person can occupy only one location (Richard Arnott and John Riley, 1977). The "nonconvexity" here is that nonmarket production must be self-consumed. If it were possible to trade leisure on a competitive market then $u(\theta)$ is nondecreasing.

[10]The emerging literature on efficiency wages (see the survey by Stiglitz, 1984) also rests on the proposition that the wage performs more than one economic function. Multi-part pricing would allocate resources efficiently in these models (e.g., a lump-sum bond as well as a marginal wage rate in Carl Shapiro and Stiglitz's, 1984 shirking problem), but two-part pricing is ruled out by assumption. Involuntary unemployment results because some margin is not satisfied when there are not enough prices available to perform all functions.

Involuntary layoffs in contracts result from imperfections in state-claims markets, which is a different way of saying that there are not enough prices.

[11] This general framework strongly links consumption and labor supply behavior unless one period preferences are strongly separable. Recent research has found excess volatility of consumption relative to permanent income and interest rates, but the extent to which this volatility can be explained by interactions with labor supply has not been studied.

[12] Holmstrom (1983) analyzes an offer-matching equilibrium when the outside opportunity is stochastic. Hall and Edward Lazear (1984) discuss two-sided uncertainty in which the bargaining costs preclude ex post renegotiation. Turnover is socially excessive in this case.

REFERENCES

Abowd, John and Ashenfelter, Orley. "Anticipated Unemployment and Compensating Wage Differentials," in Studies in labor markets. Ed.: Sherwin Rosen. Chicago: U. of Chicago Press for NBER, 1981, pp. 141-170.

________. "Compensating Wage and Earnings Differentials for Employer Determined Hours of Work," U. of Chicago, 1984.

Abowd, John and Card, David. "Intertemporal Substitution in the Presence of Long-Term Contracts," Working Paper 166, Industrial Relations Section, Princeton U., 1983.

Akerlof, George and Miyazaki, Hajime. "The Wage Bill Argument Meets the Implicit Contract Theory of Unemployment," Rev. Econ. Stud. 1980, 47, pp. 321-38

Alchian, Armen. "Information Costs, Pricing and Resource Unemployment," Western Econ. J. 1969, 7(2), pp. 109-28.

Altonji, Joseph G. "The Intertemporal Substitution Model of Labor Market Fluctuations: An Empirical Analysis," Rev. Econ. Stud. 1982, 49, pp. 783-824.

________ and Ashenfelter, Orley. "Wage Movements and the Labour Market Equilibrium Hypothesis," Economica. 1980, 47, pp. 217-45.

Arnott, Richard and Riley, John B. "Asymmetrical Production Possibilities, the Social Gains from Inequality and the Optimal Town," Scan. J. Econ. 1977, 79(3), pp. 301-11.

Arnott, Richard, Hosios, Arthur and Stiglitz, Joseph E. "Implicit Contracts, Labor Mobility and Unemployment," Princeton U., 1983.

Arrow, Kenneth J. "The Role of Securities in the Optimal Allocation of Risk Bearing," Rev. Econ. Stud. 1964, 31, pp. 91-96

________. Essays in the theory of risk bearing. Chicago: Markham, 1971

Ashenfelter, Orley and Brown, James. "Testing the Efficiency of Employment Contracts," J. Polit. Econ. forthcoming.

Azariadis, Constantine C. "Implicit Contracts and Underemployment Equilibria," J. Polit. Econ. 1975, 83(6), pp. 1183-1202.

________. "On the Incidence of Unemployment," Rev. Econ. Stud. 1976, 43(1), pp. 115-25.

________. "Implicit Contracts and Related Topics: A Survey," in The economics of the labour market. Eds.: Z. Hornstein, et al. London: HMSO, 1979.

________. "Employment with Asymmetric Information," Quart. J. Econ. 1983, 98 (supplement), pp. 157-73.

________ and Stiglitz, Joseph E. "Implicit Contracts and Fixed Price Equilibria," Quart. J. Econ. 1983, 98(supplement), pp. 1-22.

Baily, Martin H. "Wages and Employment Under Uncertain Demand," Rev. Econ. Stud. 1974, 41(1), pp. 37-50.

________. "On the Theory of Layoffs and Unemployment," Econometrica. 1977, 45(5), pp. 1043-1064.

Barro, Robert and King, Robert G. "Time-Separable Preferences and Intertemporal-Substitution Models of Business Cycles," U. of Rochester, 1982.

Becker, Gary S. Human capital. NY: Columbia U. Press for NBER, 1964.

________. "A Theory of Marriage, Part I," J. Polit. Econ. 1973, 81(4), pp. 813-46.

Bernanke, Ben. "An Equilibrium Model of Industrial Employment, Hours and Earnings, 1923-39," Graduate School of Business, Stanford U., 1983.

Bewley, Truman F. "The Permanent Income Hypothesis and Long-Run Economic Stability," J. Econ. Theory. 1980, 22(2), pp. 377-94.

Bils, Mark. "Real Wages over the Business Cycle: Evidence from Panel Data," J. Polit. Econ. (forthcoming).

Borch, Karl. "Equilibrium in a Reinsurance Market," Econometrica. 1962, 30(3), pp. 424-44

Brock, William A. "Asset Prices in a Production Economy," Economics of information and uncertainty. Ed.: J. J. McCall. Chicago: U. of Chicago Press, 1982, pp. 1-47.

Bronars, Stephen. "Compensating Wage Differentials and Layoff Risk in U.S. Manufacturing Industries," Ph.D. dissertation, U. of Chicago, 1983.

Brown, James N. "How Close to an Auction Is the Labor Market?" Res. Lab. Econ. 1982, 5, pp. 182-235.

Brown, Murray and Wolfstetter, Elmar. "Underemployment and Normal Leisure," Econ. Letters. 1984, 15(1-2), pp. 157-63.

Browning, Martin; Deaton, Angus, and Irish, Margaret. "A Profitable Approach to Labor Supply and Commodity Demands Over the Life-Cycle," Econometrica. forthcoming.

Bryant, John. "An Annotation of 'Implicit Contracts and Underemployment Equilibria,'" J. Polit. Econ. 1978, 86(6), pp. 1159-60.

Bull, Clive. "The Existence of Self-Enforcing Implicit Contracts," C.V Starr Center, NYU, 1983.

Burdett, Kenneth and Mortensen, Dale T. "Search, Layoffs and Labor Market Equilibrium," J. Polit. Econ. 1980, 88(4), pp. 652-72.

Calvo, Guillermo A. and Phelps, Edmond S. "Employment Contingent Wage Contracts," J. Monet. Econ. 1977, 5, pp. 160-68.

Cantor, Richard. "Long-Term Labor Contracts, Consumption Smoothing and Aggregate Wage Dynamics," Ohio State U., 1983.

Chapman, Sidney J. "Hours of Labour," Econ. J. 1909, 19(3), pp. 354-79.

Chari, V.V. "Involuntary Unemployment and Implicit Contracts," Quart. J. Econ. 1983, 98(supplement), pp. 107-22.

Cogan, John. "Labor Supply With Costs of Market Entry," in Female labor supply. Ed.: J.P. Smith. Princeton, NJ: Princeton U. Press, 1980.

Cooper, Russell. "Risk-Sharing and Productive Efficiency in Labor Contracts Under Bilateral Asymmetric Information," U. of Pennsylvania, 1981.

________. "A Note on Overemployment/Underemployment in Labor Contracts Under Asymmetric Information," Econ. Letters. 1983, 12(1), pp. 81-87.

Debreu, Gerard. The theory of value. Cowles Foundation Monograph 17. New Haven: Yale U. Press, 1959.

Diamond, Peter. "Aggregate Demand Management in Search Equilibrium," J. Polit. Econ. 1982, 90(5), pp. 881-94.

________ and Rothschild, Michael. Uncertainty in economics. NY: Academic Press, 1978.

Epstein, Richard A. "In Praise of the Contract at Will," Univ. Chicago Law Rev. 1984, 51(4), pp. 956-82.

Fair, Ray C. The short run demand for workers and hours. Amsterdam: North-Holland Publishing Company, 1969.

Feldstein, Martin. "Specification of the Labor Input in the Aggregate Production Function," Rev. Econ. Stud. 1967, 34, pp. 375-86.

________. "The Importance of Temporary Layoffs: An Empirical Analysis," Brookings Pap. Econ. Act. 1975, pp. 725-44.

________. "Temporary Layoffs in the Theory of Unemployment," J. Polit. Econ. 1976, 84(5), pp. 937-58.

Fischer, Stanley. "Long Term Contracts, Rational Expectations and the Optimum Money Supply Rule," J. Polit. Econ. 1977, 85(1), pp. 191-205.

Friedman, Milton. "The Role of Monetary Policy," Amer. Econ. Rev. 1968, 58(1), pp. 1-17.

________. Price theory: A provisional text. Chicago: Aldine Publishing Company, 1962.

________. A theory of the consumption function. Princeton, NJ: Princeton U. Press, 1957.

Frisch, Ragnar. New methods of measuring marginal utility. Tubigen: J.C.B. Mohr, 1932.

Geanakoplos, John and Ito, Takatoshi. "On Implicit Contracts and Involuntary Unemployment," Cowles Foundation Discussion Paper No. 640, 1982.

Ghez, Gilbert and Becker, Gary S. Allocation of time and goods over the life cycle. NY: Columbia U. Press for NBER, 1975.

Gordon, Donald F. "A Neoclassical Theory of Keynesian Unemployment, Econ. Inquiry. 1974, 12(4), pp. 431-59.

Gordon, Robert J. "Why U.S. Wage and Employment Behavior Differs from That in Britain and Japan," Econ. J. 1982, 92(1), pp. 13-44.

Gray, Joanna A. "Wage Indexation: A Macroeconomic Approach," J. Monet. Econ. 1976, 2(2), pp. 221-36.

Green, Jerry and Kahn, Charles M. "Wage Employment Contracts," Quart. J. Econ. 1983, 98(supplement), pp. 173-88.

Grossman, Herschel. "Risk Shifting, Layoffs and Seniority," J. Monet. Econ. 1978, 4(4), pp. 661-86.

________. "Risk Shifting and Reliability in Labor Markets," Scand. J. Econ. 1977, 79(2), pp. 187-209.

Grossman, Michael. "Unemployment and Consumption," Amer. Econ. Rev. 1973, 68(1), pp. 208-13.

Grossman, Sanford J. and Hart, Oliver D. "Implicit Contracts, Moral Hazard and Unemployment, Amer. Econ. Rev. (Papers and Proceedings). 1981, 71(2), pp. 301-07.

________. "Implicit Contracts Under Asymmetrical Information," Quart. J. Econ. 1983, 71(supplement), pp. 123-57.

Grossman, Sanford J. and Weiss, Laurence. "Saving and Insurance," Bayesian models in economic theory. Eds.: M. Boyer and R. E. Kihlstrom. NY: Elsevier, 1984.

Hall, Robert E. "Why Is the Unemployment Rate So High at Full Employment?" Brookings Pap. Econ. Act. 1970, (3), pp. 369-402.

________. "The Importance of Lifetime Jobs in the U.S. Economy," Amer. Econ. Rev. 1982, 72(4), pp. 716-24

________. "A Theory of the Natural Unemployment Rate and the Duration of Employment," J. Monet. Econ. 1979, 5(2), pp. 153-69.

________. "Employment Fluctuations and Wage Rigidity," Brookings Pap. Econ. Act. 1980, (1), pp. 91-123.

________. "Labor Supply and Aggregate Fluctuations," Carnegie-Rochester Conference Series on Public Policy. 12, 1980, pp. 7-33.

________ and Lazear, Edward P. "The Excess Sensitivity of Layoffs and Quits to Demand," J. Lab. Econ. 1984, 2(2), pp. 253-58.

________ and Lilien, D.M. "Efficient Wage Bargains Under Uncertain Supply and Demand," Amer. Econ. Rev. 1979, 69(5), pp. 868-79

Hamermesh, Daniel. "Social Insurance and Consumption," Amer. Econ. Rev. 1982, 72(1), pp. 101-13

Hanoch, Giora. "A Multivariate Model of Labor Supply: Methodology and Estimation," in Female labor supply. Ed.: James P. Smith. Princeton, NJ: Princeton U. Press, 1980.

Harberger, Arnold C. "The Social Opportunity Cost of Labor," Int. Lab. Rev. 1971, 103(6), pp. 559-79

Harris, John R. and Todaro, Michael P. "Migration, Unemployment and Development: A Two-Sector Analysis," Amer. Econ. Rev. 1970, 60(1), pp. 126-42.

Hart, Oliver D. "Optimal Labour Contracts Under Asymmetric Information: An Introduction," Rev. Econ. Stud. 1983, 50(1), pp. 3-35.

Hart, Robert A. The economics of non-wage labour costs. London: George Allen and Unwin, 1984.

Hashimoto, Masanori. "Bonus Payments, On-the-Job Training and Lifetime Employment in Japan," J. Polit. Econ. 1979, 85(5), pp. 1086-1104.

Heckman, James J. and MaCurdy, Thomas. "A Life-Cycle Model of Female Labor Supply," Rev. Econ. Stud. 1980, 47(1), pp. 47-74.

Heckman, James J. and Sedlacek, Guilermo. "An Equilibrium Model of the Industrial Distribution of Workers and Wages," U. of Chicago, 1984.

Hey, John D. Uncertainty in microeconomics. NY: NYU Press, 1979.

Hicks, John R. The theory of wages. London: Macmillan, 1932.

Holmstrom, Bengt. "Contractual Models of the Labor Market," Amer. Econ. Rev. (Papers and Proceedings). 1981, 71(2), pp. 308-13.

________. "Equilibrium Long Term Contracts," Quart. J. Econ. 1983, 98(supplement), pp. 23-54.

Hutchens, Robert M. "Layoffs and Labor Supply," Int. Econ. Rev. 1983, 24(1), pp. 37-55.

Ito, Takatoshi. Implicit Contract Theory: A Critical Survey," U. of Minnesota, 1982.

________. "Labor Contracts With Voluntary Quits," U. of Minnesota, 1984.

Johansen, Leif. Production functions. Amsterdam: North-Holland Publishing Co., 1972.

Johnson, William R. "A Theory of Job Shopping," Quar. J. Econ. 1978, 92(2), pp. 261-77

Jovanovic, Boyan. "Job Matching and the Theory of Turnover," J. Polit. Econ. 1979, 87(1), pp. 972-90.

Kahn, Charles M. and Scheinkman, Jose. "Optimal Employment Contracts With Bankruptcy Constraints," J. Econ. Theory. (forthcoming).

Katz, Lawrence. "Layoffs, Uncertain Recall and the Duration of Unemployment," MIT, 1984.

Kihlstrom, Richard E. and Laffont, Jean-Jacques. "A General Equilibrium Entrepreneurial Theory of Firm Formation Based on Risk Aversion," J. Polit. Econ. 1979, 87(4), pp. 719-48.

________. "Implicit Contracts and Free Entry," Quart. J. Econ. 1983, 98(supplement), pp. 55-106.

Kinoshita, Tomio. "Working Hours and Hedonic Wages in the Market Equilibrium," Musachi U., 1985.

Knight, Frank H. Risk, uncertainty and profit. Boston: Houghton Mifflin and Co., 1921.

Kydland, Finn E. "Labor Force Heterogeneity and the Business Cycle," Carnegie-Rochester Conference Series on Public Policy. Autumn, 1984, 20, pp.

________ and Prescott, Edward C. "Time To Build and Aggregate Fluctuations," Econometrica. 1982, 50(6), pp. 1345-70.

Lee, Jisoon. "A Rational Expectations Model of Labor Supply," Ph.D. Thesis, U. of Chicago, 1984.

Leontief, Wassily. "The Pure Theory of the Guaranteed Annual Wage Contract," J. Polit. Econ. 1946, 56(1), pp. 76-79.

Lewis, H. Gregg. "Employer Interests in Employee Hours of Work," U. of Chicago, 1969.

Lilien, David. "The Cyclical Pattern of Temporary Layoffs in United States Manufacturing," Rev. Econ. Stat. 1980, 62(1), pp. 24-31.

Lucas, Robert E., Jr. "Some International Evidence of Output-Inflation Trade Offs," Amer. Econ. Rev. 1973, 63(2), pp. 326-34.

________ and Rapping, L.A. "Real Wages, Employment and Inflation," in Microeconomic foundations of employment and inflation Theory. Eds.: E. Phelps, et al. NY: W.W. Norton, 1970.

Lundberg, Shelly. "Tied Wage Hours Offers and the Endogeneity of Wages," NBER Working Paper 1431, 1984.

MaCurdy, Thomas E. "An Empirical Model of Labor Supply in a Life-Cycle Setting," J. Polit. Econ. 1981, 89(6), pp. 1059-86.

________ and Pencavel, John. "Testing Between Competing Models of Wage and Employment Determination in Unionized Markets," J. Polit. Econ. (forthcoming).

McDonald, Ian M. and Solow, Robert M. "Wage Bargaining and Employment," Amer. Econ. Rev. 1981, 71(5), pp. 896-908.

Maskin, Eric and Riley, John. "Monopoly With Incomplete Information," Rand J. Econ. 1984, 15(2), pp. 171-96.

Millar, James R. "A Theory of On-the-Job Training." U. of Toronto, 1971.

Mincer, Jacob. "Unemployment Effects of Minimum Wages," J. Polit. Econ. 1976. 84(4, part 2), pp. S87-S104.

________ and Jovanovic, Boyan. "Labor Mobility and Wages," in Studies in labor markets. Ed.: Sherwin Rosen. Chicago: U. of Chicago Press for NBER, 1981, pp. 21-64.

Mirrlees, James. "An Exploration in the Theory of Optimum Income Taxation," Rev. Econ. Stud. 1971, 38(114), pp. 175-208.

________. "The Optimum Town," Swedish J. Econ. 1972, 74(1), pp. 114-35

Miyazaki, Hajime and Neary, Hugh M. "The Illyrian Firm Revisited," Bell J. Econ. 1983, 14(1), pp. 259-70.

________. "Output, Work Hours and Employment in the Short-Run of a Labor-Managed Firm," Stanford U., 1983.

Modigliani, Franco. "Liquidity Preference and the Theory of Interest and Money," Econometrica. 1944, 12(1), pp. 45-88.

Moore, John. "Contracting Between Two Parties with Private Information," London School of Econ., 1984.

Mortensen, Dale T. "On the Theory of Layoffs," Northwestern U., 1978.

________. "A Welfare Analysis of Unemployment Insurance: Variations on Second Best Themes," Carnegie-Rochester Series on Public Policy. Autumn, 1983a, 19, pp. 67-98.

________. "Labor Contract Equilibria in an 'Island' Economy," Northwestern U., 1983b.

Mussa, Michael and Rosen, Sherwin. "Monopoly and Product Quality," J. Econ. Theory. 1978, 18(2), 301-07.

Nadiri, M. Ishaq and Rosen, Sherwin. "Interrelated Factor Demand Functions," Amer. Econ. Rev. 1969, 59(1), pp. 457-71

Nalebuff, Barry and Zeckhauser, Richard. "Involuntary Unemployment Reconsidered: Second-Best Contracting with Heterogeneous Firms and Workers," Harvard Univesity, 1984.

Neftci, Salih N. "A Time-Series Analysis of the Real Wages-Employment Relationship," J. Polit. Econ. 1978, 86(2), pp. 281-92.

Oi, Walter Y. "Labor as a Quasi-Fixed Factor," J. Polit. Econ. 1962, 70(6), pp. 538-56.

Okun, Arthur. Prices and quantities, Washington, D.C.: The Brookings Institution, 1981.

Pigou, Arthur C. The economics of welfare. London: Macmillan, 1920.

Pissarides, Christopher A. "Search Intensity, Job Advertising and Efficiency," J. Lab. Econ.,1984, 2(1), pp. 128-43.

Polemarchakis, Hercules M. and Weiss, Laurence. "Fixed Wages, Layoffs, Unemployment Compensation and Welfare," Amer. Econ. Rev. 1978, 68(5), pp. 909-17.

Raisian, John. "Contracts, Job Experience and Cyclical Labor Market Adjustments," J. Lab. Econ. 1983 1(2), pp. 152-70.

Randolph, William C. "Employment Relationships: Till Death Do Us Part?" Ph.D. dissertation, SUNY, Stony Brook, 1983.

Reder, Melvin W. "Wage Structure Theory and Measurement," Aspects of labor economics: A conference of the Universities-National Bureau Committee for Economic Research. Princeton, NJ: Princeton U. Press, 1962, pp. 257-318.

Rosen, Sherwin. "Short-Run Employment Variation on Class-I Railroads in the U.S.," Econometrica. 1968, 36(3), pp. 511-29.

________. "Unemployment and Insurance," Carnegie-Rochester Conference Series on Public Policy. Autumn, 1983, 20, pp. 5-49.

Rothschild, Michael and Stiglitz, Joseph E. "Increasing Risk: I. A Definition," J. Econ. Theory. 1970, 2(3), 225-43.

Sargent, Thomas J. Macroeconomic theory. New York: Academic Press, 1979.

Schultz, Charles. "Microeconomic Efficiency and Nominal Wage Stickiness," Amer. Econ. Rev. 1985, 75(1), pp. 1-16.

Shapiro, Carl and Stiglitz, Joseph E. "Equilibrium Unemployment as a Worker Discipline Device," Amer. Econ. Rev. 1984, 74(3), pp. 433-44.

Shavell, Stephen and Weiss, Laurence. "The Optimal Payment of Unemployment Insurance Benefits Over Time," J. Polit. Econ. 1979, 87(6), pp. 1347-62.

Smith, Adam. The wealth of nations, Modern Library Edition, NY: Random House, 1947.

Solow, Robert M. "Investment and Technical Progress," Mathematical models in the Social sciences. Eds.: Kenneth J. Arrow, S. Karlin and P. Suppes. Stanford: Stanford U. PLress, 1960.

Stigler, George J. "Production and Distribution in the Short-Run," J. Polit. Econ. 1939, 47(3), pp. 305-27.

Stiglitz, Joseph E. "Theories of Wage Rigidity," Princeton U., 1984.

Schwartz, Aba. "The Implicit Contract Model and Labor Markets: A Critique," Tel Aviv U., 1983.

Taylor, John. "Aggregate Dynamics and Staggered Contracts," J. Polit. Econ. 1980, 88(1), pp. 1-23.

Todaro, Michael P. "A Model of Labor Migration and Urban Unemployment In Less-Developed Countries," Amer. Econ. Rev. 1969, 59(1), pp. 138-48.

Topel, Robert E. "On Layoffs and Unemployment Insurance," Amer. Econ. Rev. 1983, 83(4), pp. 541-59.

________. "Local Labor Markets," J. Polit. Econ. forthcoming.

________ and Welch, Finis. "Self-Insurance and Efficient Employment Contracts," U. of Chicago, 1983.

Wilson, Robert. "The Theory of Syndicates," Econometrica. 1968, 68(1), pp. 119-32.

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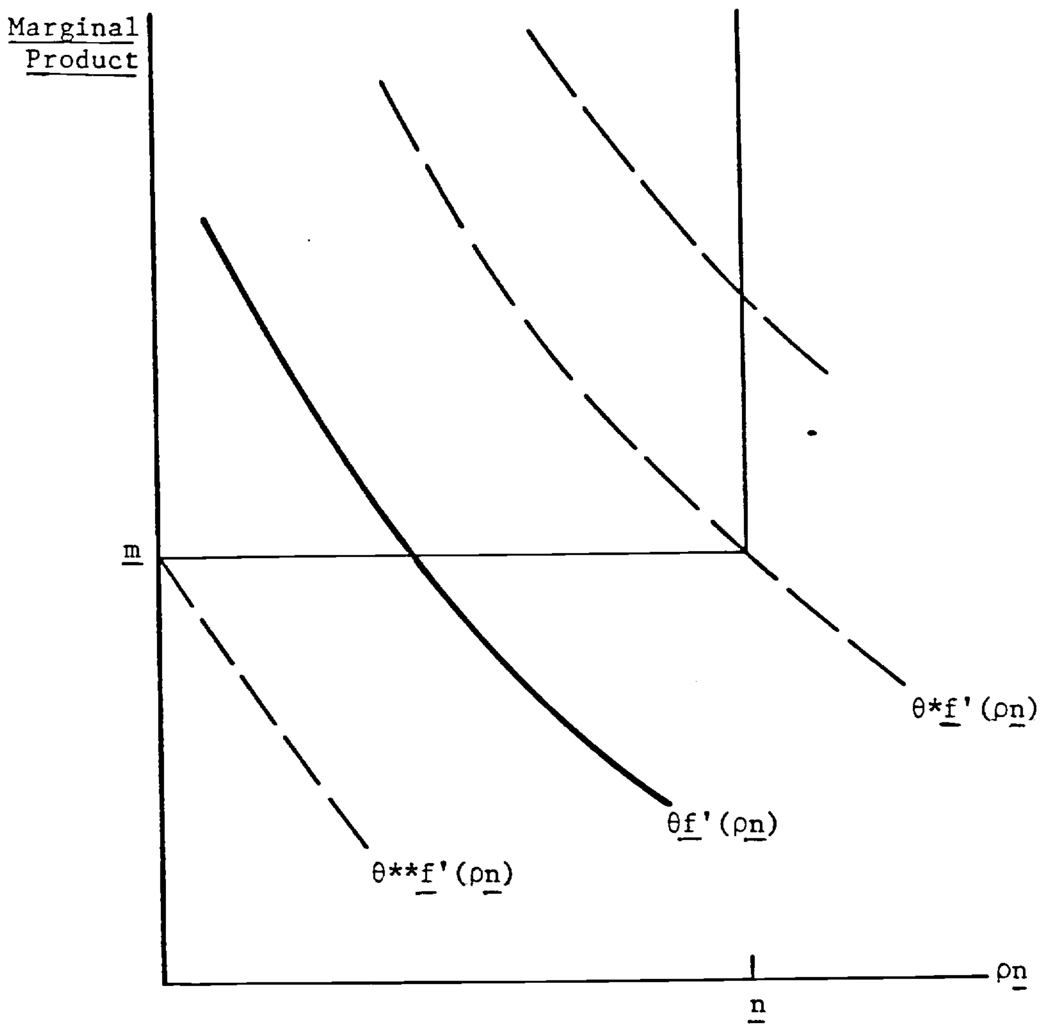

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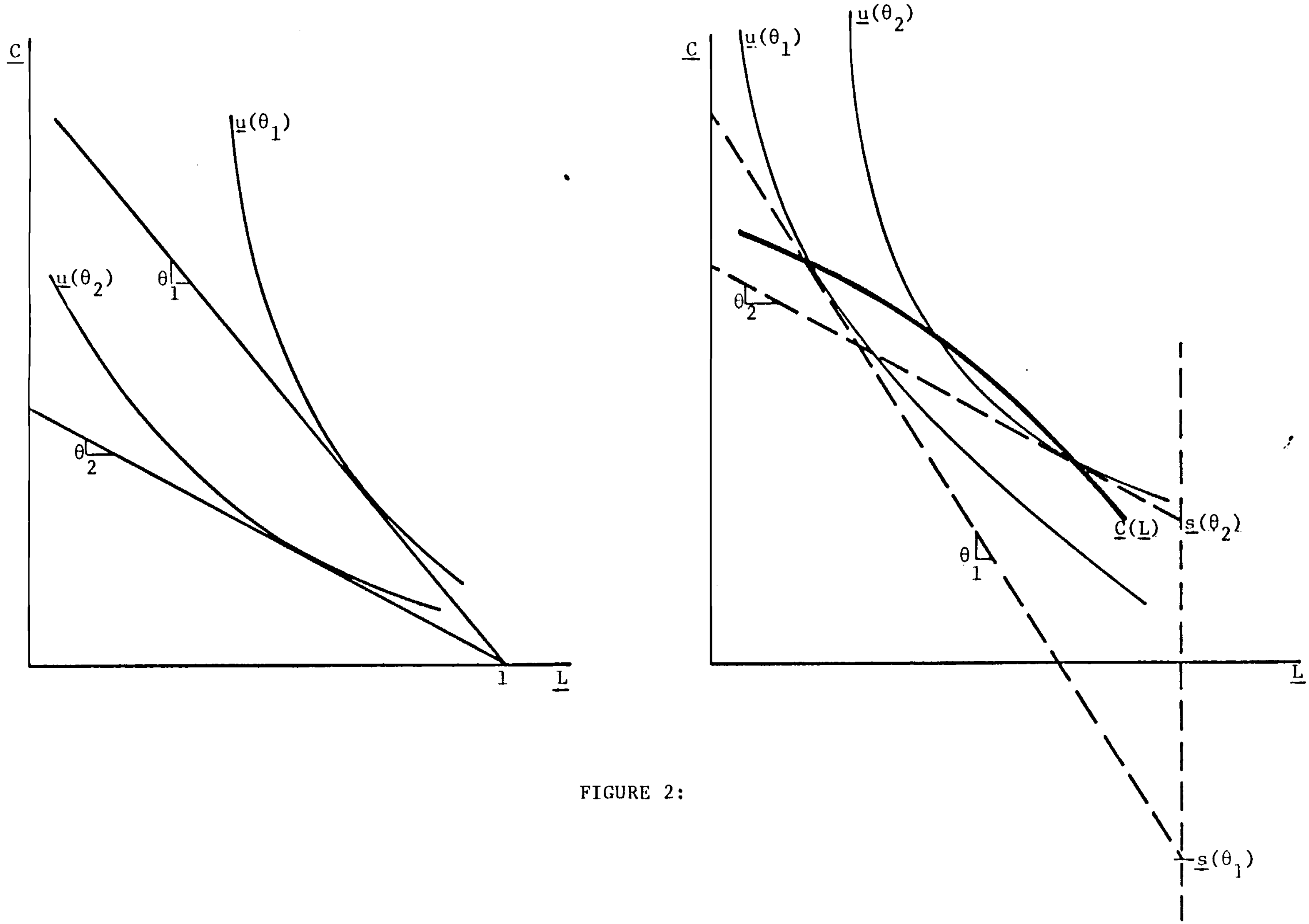

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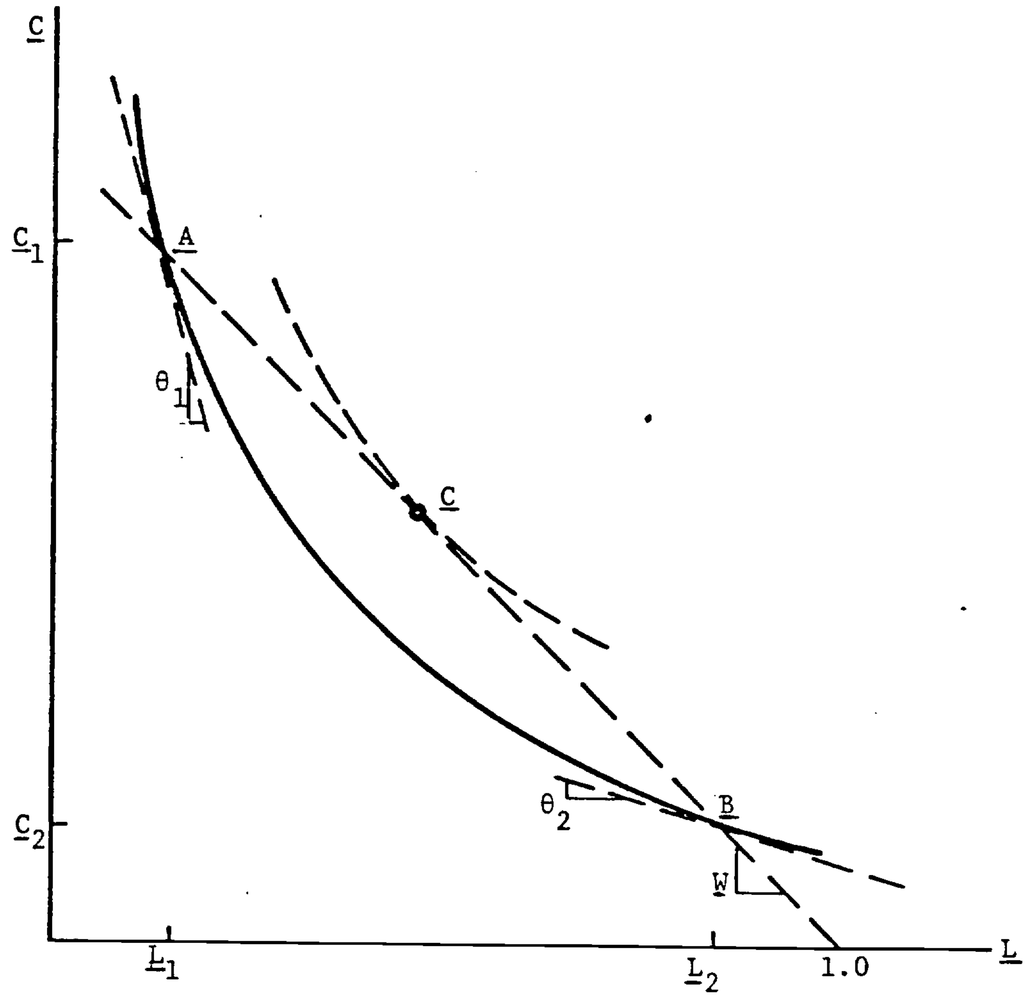

FIGURE 3; Measured Wage Rates

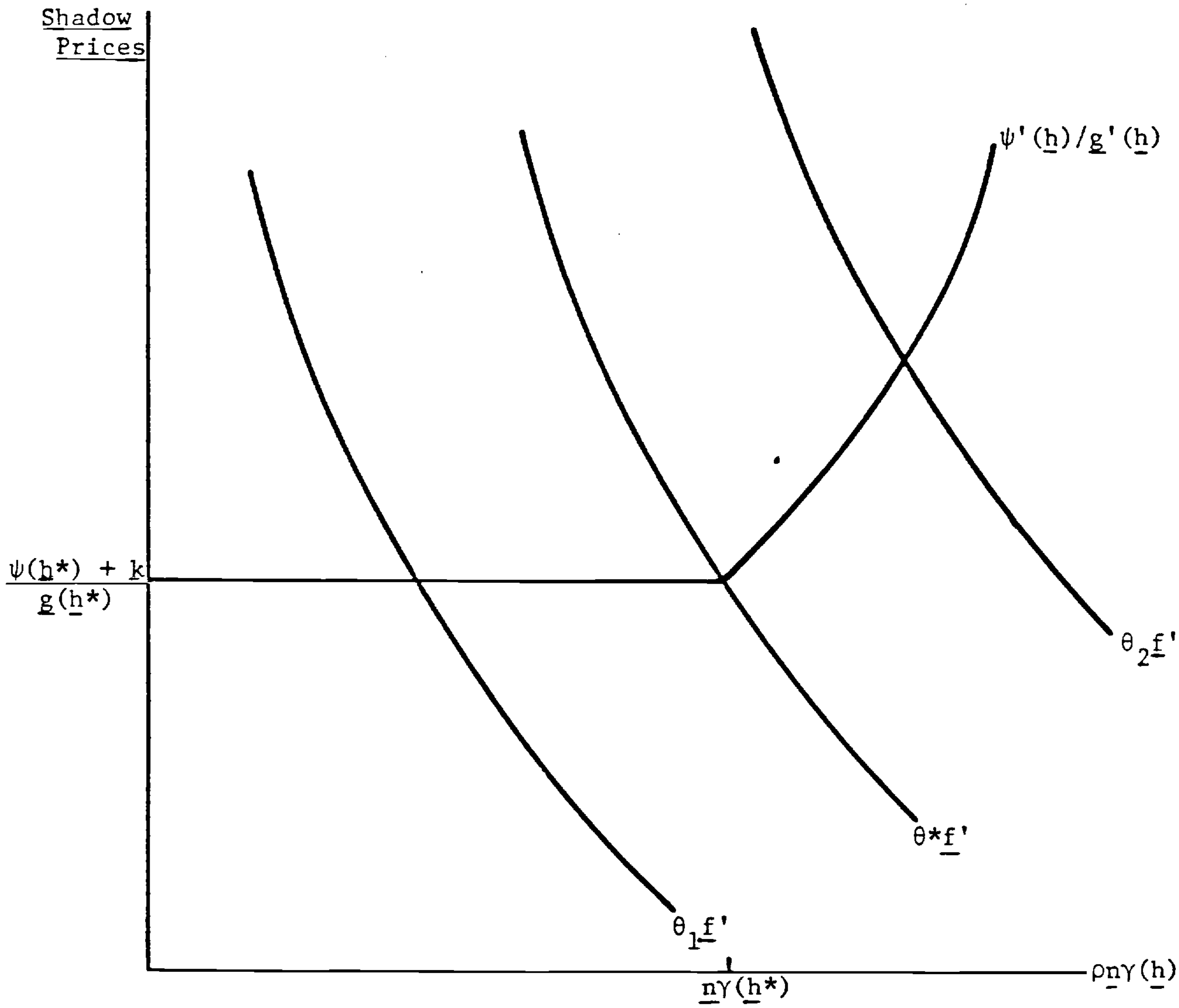

FIGURE 4: