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4 Anticipated Unemployment, Temporary Layoffs, and Compensating Wage Differentials

John M. Abowd and Orley Ashenfelter

This paper models the competitive equilibrium wage rate when employment offers vary according to the amount of anticipated unemployment and unemployment risk. The competitive wage reflects a compensating differential which includes a certainty equivalent compensation proportional to the squared expected unemployment rate and a risk compensation proportional to the coefficient of unemployment variation. The factors of proportionality are half the inverse compensated labor supply elasticity and half the relative risk aversion, respectively. We use panel data to construct a model of anticipated unemployment and unemployment variance which depends on personal employment history and industry-wide and economy-wide factors. Compensating wage differentials ranging from less than one percent to more than fourteen percent are estimated for a two-digit industry classification over the years 1970–75.

4.1 Introduction

The appropriate theoretical framework for the interpretation of measurements of unemployment is once again a matter of controversy. The issues involved are important both because of the overwhelming role

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that measured unemployment plays in the discussion of public policies designed to mitigate it and because of the research strategies implied for understanding the causes and consequences of movements in it. One natural research strategy is to interpret unemployment as the equilibrium outcome of a worker's choices about job search or the intertemporal allocation of nonmarket time.¹ Of course, labor supply theoretic explanations of movements in unemployment are not complete without further specification, but this approach does imply a general strategy for the necessary research. An alternative approach is to treat unemployment as a constraint on individual behavior rather than a result of it.² Although this demand theoretic approach is also incomplete without further specification, it also implies a general strategy for further research.

Treating unemployment as a constraint on behavior may appear to have immediate normative implications for public policies regarding unemployment benefits or compensation. It may seem plausible that workers would, as a group, purchase insurance against an unpredictable exogenous constraint on the hours they are able to sell in the market. Whether this insurance is provided privately or governmentally would seem, then, to be a matter of form rather than substance. Predictable variations in the nature and extent of the risks of unemployment are surely extensive, so that a uniform governmental insurance benefit scheme would still leave considerable variation in the incidence of unemployment constraints to be compensated within the labor market. The purpose of this paper is to examine a theoretical model of market wage adjustments to compensate for the uninsured differences in the incidence of unemployment. We examine the empirical significance of these compensations using data from the Panel Study of Income Dynamics for the years 1967 to 1975 (Survey Research Center 1972ab 1973 1974 1975 1976).

Our analysis concerns two different but related issues. First, we extend the emerging empirical and theoretical analyses of the sources of compensating wage differentials to include a systematic treatment of the impact of constraints on hours at work.³ Our analysis shows clearly how the determination of wage rates in the presence of fully anticipated constraints is systematically related to the determination of labor supply in the absence of such constraints, and demonstrates that these two issues are connected in a way that has not been fully appreciated in the past. The analysis provides a theoretical framework for measuring the impact of risky labor supply constraints on the determination of market wages. At the same time, our model also provides some evidence of how fruitful a research strategy that treats unemployment as a constraint on behavior is likely to be. We find that the labor market compensates anticipated layoffs and unemployment by 2–6 percent per year. The estimated compensations vary from industry to industry but are relatively stable from

year to year within industries. Section 4.2 provides a theoretical analysis of equilibrium wage compensations. Section 4.3 disusses the empirical methodology and results.

4.2 A Theoretical Model of Compensating Differentials and Employment Constraints

In this section we consider the determination of wages when workers may choose employment in either of two sectors. In the unconstrained sector the worker may choose the optimum labor supply given the prevailing wage. In the constrained sector the worker accepts a fixed wage and employment conditions contract which sets the average number of work hours and employment variability. In a competitive equilibrium with identical workers, the utility of these two employment situations will be equal. This condition is used to characterize the relationship between the wage in the constrained sector and the conditions of employment. Specifically, we relate the equilibrium wage to the expected extent of unemployment and hours variability.

In the absence of a constraint on the hours a worker may sell in the market, the usual assumptions about preferences between nonmarket time and commodities lead to an optimal offer of labor supply $h^0(w, p, y)$ and optimal commodity demands of $x^0(w, p, y)$ that depend on the wage rate w , commodity prices p , and nonlabor income y . The indirect or maximal utility for this consumer-worker is than $V(w, p, y)$ which also depends on w, p , and y . Consider now a constraint $\bar{h} < h^0(w, p, y)$ which prevents the worker from selling more than \bar{h} hours on the labor market. Faced with a binding constraint, the worker will supply \bar{h} hours of work, demand commodities $x^*(\bar{h}, p, w\bar{h} + y)$, and achieve maximal utility of $V^*(\bar{h}, p, w\bar{h} + y)$. For the same w, p , and y the constraint on hours will, of course, lead to a maximal utility $V^*(\bar{h}, p, w\bar{h} + y)$ which is less than $V(w, p, y)$. The constrained worker would then reach a lower utility level than would be the case in the unconstrained job. The maximum of V^* with respect to \bar{h} is simply $V(w, p, y)$ and is achieved at the point $\bar{h} = h^0$. V^* is graphed in figure 4.1 as a function of \bar{h} for given w, p , and y . We assume V^* is concave in the relevant region although this is necessary only at the point $\bar{h} = h^0(w, p, y)$.

If the worker is faced with a choice of a job in the unconstrained sector versus a job in the constrained sector at the same wage rate, the worker would always prefer employment in the unconstrained sector. Labor market equilibrium will entail the condition

$$(1) \quad V^*(\bar{h}, p, w^*\bar{h} + y) = V(w, p, y)$$

where w is the prevailing wage in the unconstrained sector and w^* is the equilibrium wage rate when the employment contract requires labor

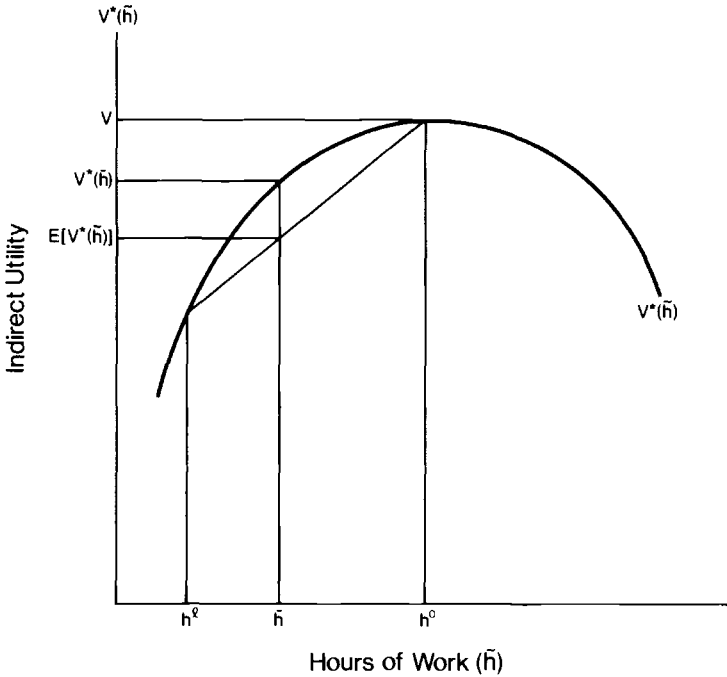


Figure 4.1 Sources of Compensating Differentials Illustrated Using Hours of Work and Constrained Maximal Utility

supply of \bar{h} hours.⁴ Equation 1 defines the proportionate compensating wage differential $(w^* - w)/w \approx \ln(w^*/w)$ implicitly. Figure 4.1 demonstrates this idea for the choice between jobs that entail h^0 and \bar{h} hours at work. The compensating wage differential is simply the increase in the wage rate sufficient to eliminate $V - V^*(\bar{h})$, the utility difference.⁵ The consumer worker is indifferent between the wage-hours package w, h^0 and the wage-hours pair w^*, \bar{h} . Both allow the attainment of the same utility level.⁶ Formally, w^* is the solution of the implicit equation 1 and may be written as

$$(2) \quad w^* = w^*(\bar{h}, w, p, y)$$

We will discuss some straightforward approximations to equation 2 below.

The preceding analysis supposes that the hours of work constraint \bar{h} is known with certainty. In some situations it may be more realistic to assume that \bar{h} is a random drawing from a distribution of possible hours constraints with expected value \bar{h} . The worker must choose between a job in the constrained sector which offers the known wage w^{**} and a known distribution of hours of work, versus a job in the unconstrained sector

with the known combination w, h^0 . Labor market equilibrium will then require that w^{**} compensate for the riskiness of fluctuations in hours worked and for the presence of the mean constraint on hours worked. Figure 4.1 also illustrates this point. We have assumed in the figure that $\bar{h} = h^0$ with probability π , and $\bar{h} = h^\ell$ with probability $1 - \pi$. The probability is chosen such that $E[\bar{h}] \equiv \bar{h} = \pi h^0 + (1 - \pi)h^\ell$. Expected utility is then $E[V^*(\bar{h})] = \pi V^*(h^0) + (1 - \pi)V^*(h^\ell)$. The wage difference $w^{**} - w^*$ compensates for the utility difference $E[V^*(\bar{h})] - V^*(\bar{h})$, which is the incremental utility loss associated with the addition of risk to the model with only a mean constraint. As usual, the sign of the compensating differential depends on the worker's attitude toward risk. The case of risk aversion, represented by the concavity of the function $V^*(\bar{h})$ in figure 4.1 implies that additional risk adds to the compensating wage differential $w^{**} - w^*$. This may be seen by noticing that a mean preserving decrease in h^ℓ would lead to greater variance in hours, a greater (absolute) difference in $E[V^*(\bar{h})] - V^*(\bar{h})$, and a greater compensating wage differential. The concavity of the function $V^*(\bar{h})$ is guaranteed in the neighborhood of $\bar{h} = h^0$ so that for small deviations of \bar{h} from h^0 , increased risk will generally imply an increased compensating wage differential.

In general, labor market equilibrium will now require that

$$(3) \quad V^{**}(w^{**}, p, y; \theta) = V^*(\bar{h}, p, w^*\bar{h} + y)$$

where $V^{**} \doteq \int V^*(\bar{h}, p, w^*\bar{h} + y)f(\bar{h}; \theta) d\bar{h}$ is expected utility and θ represents the parameters of the density function for hours of work offered. Equation 3 defines w^{**} implicitly as

$$(4) \quad w^{**} = w^{**}(w^*, p, y; \theta)$$

which is the wage rate which must accompany an employment contract which offers expected constraints and uncertain employment.

The representation of a simplified unemployment insurance (UI) system does not add any major complications. We use the simple specification that the UI system replaces a fixed proportion γ of lost earnings. Labor income is, then, $w^{**}[\bar{h} + \gamma(h^0 - \bar{h})]$. The number of hours actually compensated is $\bar{h} + \gamma(h^0 - \bar{h})$, which we call effective hours.⁷ Equilibrium condition 1 is replaced by

$$(1') \quad V^*(\bar{h}, p, w^*[\bar{h} + \gamma(h^0 - \bar{h})] + y) = V(w, p, y)$$

Effective hours, and not actual hours, enter the relevant budget constraint. It should be noted that we used h^0 which depends on w and not w^* as the hours base for calculating lost earnings. The relevant comparison for determining the opportunity cost of the layoff or hours reduction is with the labor supply in the unconstrained sector. The wage w is the only wage at which the worker can optimize hours of work directly. The market operates to make the utility level provided by the insured con-

strained job equal to the utility level provided by $h^0(w, p, y)$. The utility level provided by $h^0(w^*, p, y)$ is irrelevant since no worker can achieve it. Condition 1' introduces an important new twist into the analysis. Depending on the values of γ and $h^0 - \bar{h}$, it is possible for w^* to be less than w . This occurs whenever the utility payment for the UI benefits exceeds the utility loss from being required to consume too much leisure. The nature of this tradeoff is clear from the approximations below. When the hours offer \bar{h} is a random variable with mean \bar{h} in the insured sector, the equilibrium condition 3 becomes

$$(3') \quad V^{\gamma**}(w^{**}, p, y; \theta) = V^{\gamma*}(\bar{h}, p, w^*[\bar{h} + \gamma(h^0 - \bar{h})] + y)$$

The compensating wage differentials defined implicitly by (1') and (3') will, of course, depend on γ as well as the wage, price, nonlabor income triple w, p, y , and the θ parameters.⁸

We now address the problem of deriving useful approximations to the compensations expressed in equations 2 and 4. The results reveal that the parameters of the approximations have familiar interpretations which relate to conventional labor supply and risk analysis. We combine the approximations to form an estimating equation for the wage-generating function for a panel of continuously employed (or temporarily laid off) workers.

Let $U(x, 1 - h)$ be a strictly quasiconcave, twice continuously differentiable utility function, and let $px = wh + y$ be the budget constraint. It is convenient⁹ to work with the minimum expenditure function $R(w, p, v)$, defined as

$$(5) \quad R(w, p, v) = \min_{\{x, h\}} px - wh$$

subject to $v = U(x, 1 - h)$ and $0 < h < 1$. In the absence of unemployment insurance the minimum expenditure function for an individual constrained by $h = \bar{h}$ with certainty is given by

$$(6) \quad R^*(\bar{h}, p, v) - w\bar{h} = \min_{\{x\}} px - w\bar{h}$$

subject to $v = U(x, 1 - \bar{h})$. Equilibrium condition 1 is equivalent to

$$(7) \quad R^*(\bar{h}, p, v) - w^*\bar{h} = R(w, p, v)$$

Expanding the left-hand side of (7) around the point $\bar{h} = h^c(w, p, v)$, the compensated labor supply function, yields the second order approximation

$$(8) \quad \frac{w^* - w}{w} \approx \frac{1}{2} \frac{1}{e} \frac{[\bar{h} - h^0(w, p, y)]^2}{\bar{h} h^0(w, p, y)}$$

where e is defined as the compensated labor supply elasticity for the unconstrained individual. The compensating differential is approximate-

ly proportional to the squared expected unemployment rate $u \equiv (h^0 - \bar{h})/h^0$. The factor of proportionality is half the inverse compensated labor supply elasticity. The more inelastic the compensated labor supply schedule, the greater the compensating differential will be for anticipated underemployment or anticipated spells of unemployment. The formula is symmetric. It also determines the overtime premium for anticipated overemployment although equation 8 expresses the overtime premium as if it applied to the average rather than the marginal wage rate.

Next consider the introduction of a UI system which pays benefits as γ percent of lost earnings $w^*(h^0 - \bar{h})$. Replacing constrained hours \bar{h} by effective hours in the budget constraint implies that the constrained minimum expenditure function is

$$(6') \quad R^{\gamma*}(\bar{h}, p, v) - w[\bar{h} + \gamma[h^c(w, p, v) - \bar{h}]] \\ = \min_{\{x\}} px - w[\bar{h} + \gamma[h^c(w, p, v) - \bar{h}]]$$

subject to $v + U(x, 1 - \bar{h})$.¹⁰ Replacing R^* in equation 7 with $R^{\gamma*}$ and expanding the left-hand side around $\bar{h} = h^c$ yields, to second order,

$$(8') \quad \frac{w^* - w}{w} = \frac{-\gamma(h^0 - \bar{h})}{h^0 + \gamma(h^0 - \bar{h})} + \frac{1}{2} \frac{1}{e} \frac{(h^0 - \bar{h})^2}{h^0[\bar{h} + \gamma(h^0 - \bar{h})]}$$

where $h^0 = h^0(w, p, y)$. The presence of the UI benefits causes the compensating differential to fall in proportion to the expected unemployment rate. The factor of proportionality is exactly the UI system replacement rate. Equation 8' shows explicitly the tradeoff between UI benefits and the labor supply compensation. The function describing the compensating differential is approximately quadratic in the expected unemployment rate. For small expected unemployment rates the compensating differential is negative. As the expected unemployment rate increases, the compensating differential falls to a (negative) minimum and then increases. The unemployment rate corresponding to the minimum compensating differential and the rate corresponding to a zero compensating differential depend on the values of γ and e as well as on the optimal and constrained labor supplies. Because (8') is approximately quadratic in the expected unemployment rate, however, the basic dependence is on the product γe . It is approximately true that the minimum differential occurs at the unemployment rate $u = \gamma e$ and the two zero compensating differentials occur at unemployment rates of zero and γe .¹¹ These three points determine the quadratic approximation.

If the labor supply constraint \bar{h} is drawn from a distribution with $E[\bar{h}] = \bar{h}$ and $Var[\bar{h}] = \sigma^2$ then, in the absence of UI insurance, equilibrium condition 3 can be expanded in a Taylor series around \bar{h} to yield the approximation

$$(9) \quad \frac{w^{**} - w^*}{w^*} \approx \frac{1}{2} r \frac{\sigma^2}{\bar{h}^2}$$

where r is the relative risk aversion function when \bar{h} is the sole source of randomness in V^* .¹² Equation 9 implies that the incremental compensating differential implied by positive hours variance is approximately proportional to the squared coefficient of variation in hours of work. The factor of proportionality is half the relative risk aversion, r , which must be positive, at least when \bar{h} is near h^0 . When a UI system is in effect, equation 9 is modified to be

$$(9') \quad \frac{w^{**} - w^*}{w^*} = \frac{1}{2} r \frac{\sigma^2}{\bar{h}[\bar{h} + \gamma(h^0 - \bar{h})]}$$

where h^0 is evaluated at $h^0(w, p, y)$ as in (8') above.

Although we apply the approximations 8 and 9 to individual data using individual unemployment rates, the theory has some implications for the use of aggregate unemployment rates in wage determination equations as well. Two points should be remembered. First, the error in hours of work, $\bar{h} - \tilde{h}$, is not a determinant of the compensating differential. Consequently, the individual's realized unemployment rate is not relevant; only the predictable component $h^0 - \bar{h}$ affects the wage. Using the aggregate unemployment rate in the individual's wage determination equation is justified only if this variable is the appropriate expected unemployment rate for the individual. Second, the use of the squared aggregate unemployment rate confounds two effects. The coefficient on the squared expected unemployment rate measures the inverse labor supply elasticity, while the coefficient on the expected squared error (squared coefficient of variation) measures the risk compensation. Unless the aggregate unemployment rate is decomposed into predicted and error components, these effects will be confounded.

The approximations in equations 8' and 9' make clear the relationship between our model and labor supply decisions when layoffs are correctly anticipated. Workers may enter into explicit contracts such as collective bargaining agreements or implicit contracts with particular employers in order to secure employment in the constrained sector. A temporary layoff is one tool which the employer may use to make the expected constraint a realized constraint. If temporary layoffs were the only form of hours reduction that an employer used, then the key parameters θ in the distribution of \bar{h} would be the layoff probability π ; the conditional expected completed duration given a layoff δ ; and the conditional variance of the layoff duration ϕ^2 . The implied compensating wage differential is

$$(10) \quad \frac{w^{**} - w}{w} = -\gamma \frac{\pi\delta}{h^0 + (\gamma - 1)\pi\delta} + \frac{1}{2} \frac{1}{e} \frac{\pi^2\delta^2}{h^0[h^0 + (\gamma - 1)\pi\delta]} + \frac{1}{2} r \frac{\pi[(1 - \pi)\delta^2 + \phi^2]}{(h^0 - \pi\delta)[h^0 + (\gamma - 1)\pi\delta]}$$

Equation 10 forms the basis of our empirical analysis. It shows clearly that the theoretical constructs—expected constrained hours and hours variance—may be replaced with the parameters of the layoff structure associated with the job. The probability of temporary layoff, the conditional mean layoff duration, and conditional duration variance are all observable characteristics of a given job, in principle. Consequently, equation 10 implies that $\ell(w^{**}/w)$ can be specified in terms of employment conditions that are identifiable in many survey data sets. In addition, this formulation does not require a priori determination of which workers are employed in constrained labor supply situations. As the probability of experiencing a layoff approaches zero, the compensating differential also approaches zero. Hence, the layoff probability for every worker can be used as a continuous indicator of the extent to which labor supply constraints are an important aspect of the worker's job.

In this section we have shown that the appropriate compensating differential for employment situations involving anticipated spells of unemployment can be expressed in terms of familiar labor supply parameters. The job-specific variables affecting the size of the differential can be expressed in terms of quantifiable properties of the layoff incidence and layoff duration characteristics of the job. In the next section we calculate empirical analogues of these variables and estimate the compensating wage differentials.

4.3 Empirical Analysis of Compensating Wage Differentials

The wage function in equation 10 holds at the market level under the assumptions of section 4.2. Specifically, given data on individual opportunity wages w , expected unemployment $\pi\delta$, and unemployment variance $\pi[(1 - \pi)\delta^2 + \phi^2]$, we could estimate the parameters γ , e , and r directly from (10). There are no genuine issues of simultaneous determination as long as unobserved individual heterogeneity is confined to opportunity wages, unemployment incidence, and layoff duration.¹³ The common utility function parameters e and r will still determine the market-equilibrium-compensating differential. On the other hand, if individuals vary substantially in either the value of the compensated labor supply elasticity or the relative risk aversion parameter, the market will induce a sort in which firms are matched with employees who supply the

appropriate constrained hours and hours variance at minimum cost to the firm. For example, if e varies over the population while r does not, then individuals with the highest e will be sorted into the firms which use temporary layoffs the most—large $\pi\delta$. This combination provides the firm with its demanded employment flexibility at the lowest cost. Individuals with small e , however, are sorted into jobs with small expected unemployment, since these individuals require the largest compensating differentials. If the distribution of e is known, then, in principle, the market sorting of individuals into jobs according to $\pi\delta$ can be inferred directly. In practice, these equilibria are difficult to generate and analyze except in the simplest of cases.¹⁴ We will confine our analysis to the model in which all workers share a common γ , e , and r but may differ systematically and permanently according to w , π , δ , and ϕ^2 . That is, we will allow personal heterogeneity in the opportunity wages and job characteristics but not in the utility function. This preserves equation 10 as an operational form of the equilibrium without requiring that all individuals be observationally identical, given observed characteristics.

Panel data permit us to construct measures of the probability of layoff and layoff duration parameters which control for the individual's personal characteristics, past layoff durations, industry-specific past layoff durations, and economy-wide layoff histories. Although this information is probably inferior to the individual's own information, there is no doubt that controlling for personal history differences gives a substantially more accurate measure of the individual's employment situation than we could get from annual survey averages produced separately for different industries and occupations. As in other empirical analyses of expectational equilibria, our task is to identify the consistent patterns in the employer's behavior and estimate the relationship between these forecastable actions and the market wage. We do observe that there are permanent differences across industries in the extent and duration of layoffs; however, there is also substantial intraindustry variability which reflects firm-specific and individual-specific differences in employment conditions. Our method of constructing π , δ , and ϕ^2 will capture these employer and individual components as well as industry-specific and economy wide differences in the unemployment expectations of the workers.

Formally, let d_{it} be the duration of unemployment for individual i in year t . Let z_{it} be the individual's employment history and personal characteristics up to year t , including d_{it-1} , d_{it-2} , d_{it-3} and economy histories. Consider the two equation systems for the latent variables y_{1it} and y_{2it} :

$$(11) \quad \begin{aligned} y_{1it} &= z'_{it} \beta_1 + \varepsilon_{1it} \\ y_{2it} &+ z'_{it} \beta_2 + \varepsilon_{2it} \end{aligned}$$

where $\varepsilon_{it}(2 \times 1)$ is distributed $N(\mathbf{0}, \Sigma)$ independently and identically for all i and t , and β_1 and β_2 are unknown parameter vectors. Define the event

$$(12) \quad \ell_{it} = \begin{cases} 1 & \text{if } i \text{ is laid off in year } t \\ 0 & \text{otherwise} \end{cases}$$

We use equation system 11 along with the following sample selection rules to determine the individual's employment-specific layoff parameters

$$(13) \quad d_{it} = \begin{cases} y_{1it} & \text{if } \ell_{it} = 1 \\ 0 & \text{if } \ell_{it} = 0 \end{cases}$$

and

$$(14) \quad \ell_{it} = \begin{cases} 1 & \text{if } y_{2it} > 0 \\ 0 & \text{otherwise} \end{cases}$$

Following Heckman (1979), the selection rules 13 and 14 imply that

$$(15) \quad \pi_{it} \equiv \Pr\{\ell_{it} = 1\} = \int_{\frac{-z'_{it}\beta_2}{\sqrt{\sigma_{22}}}}^{\infty} f(s) ds$$

$$(16) \quad \pi_{it}\delta_{it} \equiv E[d_{it} | z_{it}] = \pi_{it}(z'_{it}\beta_1 + \frac{\sigma_{12}}{\sqrt{\sigma_{22}}}\gamma_{it})$$

and

$$(17) \quad \phi_{it}^2 = \sigma_{11}[(1 - \frac{\sigma_{12}^2}{\sigma_{11}\sigma_{22}}) + \frac{\sigma_{12}^2}{\sigma_{11}\sigma_{22}}(1 - \frac{z'_{it}\beta_2}{\sqrt{\sigma_{22}}}\lambda_{it} - \lambda_{it}^2)]$$

where $f(s)$ is the standard normal density, $F(s)$ is the cumulative normal distribution function, and

$$\lambda_{it} \equiv f(\frac{z'_{it}\beta_2}{\sqrt{\sigma_{22}}})/F(\frac{z'_{it}\beta_2}{\sqrt{\sigma_{22}}})$$

Equation 15 models π_{it} as a probit function given the history contained in z_{it} . Equation 16 defines the unconditional mean duration as the expectation of the conditional mean durations δ_{it} and zero. Equation 17 defines the conditional variance ϕ_{it}^2 . We use these quantities to form the unconditional variance $\pi_{it}[(1 - \pi_{it})\delta_{it}^2 + \phi_{it}^2]$. The statistical model of equations 15–17 provides an empirical counterpart to each of the required theoretical employment condition measures. We turn next to the estimation of the parameters of the layoff duration model and the compensating differentials.

4.3.1 The Data

Estimates are based on waves 1–9 of *The Panel Study of Income Dynamics*, (PSID) corresponding to calendar years 1967–75.¹⁵ Only the 3,318 households in the wave 9 release of the probability sample were eligible for inclusion in the estimation sample. Since we used three years of employment history to calculate the unemployment measures, esti-

mated differentials cover the period from 1970 (wave 4) to 1975 (wave 9). In order to be included in a particular year's estimation sample, an observation was required to come from a household with a white male head who was interviewed in the employed battery in the current year and each of the three previous years. This last requirement means that an individual must have been employed or temporarily laid off at the time of the interview (usually March of the following year) for four consecutive years. The unemployed battery is given to individuals who have experienced a prolonged layoff or who are unemployed and do not anticipate returning to their previous jobs. This selection rule, although primarily dictated by data availability considerations, results in an analysis sample of very stably employed individuals. On average, the sampled individuals have twenty-four years of labor force experience and over nine years of employer tenure. We are not concerned here with extending our conclusions to a population of less stably employed individuals such as youths or females. Rather, we realize that our conclusions apply primarily to individuals who have made relatively long-term employment commitments in industries and occupations which display substantial differences in short-term unemployment and temporary layoff patterns.

About forty percent of the 3,318 cases qualify for inclusion in any one year's estimation sample. Changes in the head of household and failure of the requirement of four consecutive interviews in the employed battery were about equally responsible for deletions. Experienced users of the PSID data will recognize that samples of 1,200–1,300 are common when continuous histories of individuals (as opposed to households) are drawn from the probability sample. Table 4.A.1 presents definitions and annual summary statistics for all variables used in the analysis.

4.3.2 Estimation and Measurement of the Unemployment Variables

The basic unemployment variable used in our analysis is $DSCRPM_{it}$, which is defined as the number of hours individual i spent unemployed in year t .¹⁶ Hours unemployed are measured as the product of days spent unemployed, or on strike, times the average hours worked per week when employed regularly. The variable $DUNEM_{it}$ is defined as one when $DSCRPM_{it} > 0$ and zero otherwise. Table 4.1 presents the results of estimating a probit equation for $DUNEM$ (column 1) and a selection-bias-corrected conditional expectation equation for $DSCRPM$ (column 2), given that layoff duration is positive.

The probit equation in column 1 of table 4.1 measures the effect of the individual's employment history on π_{it} . The determinants of π_{it} are the individual's history of layoff durations for the past three years ($DSCRPM1$ – $DSCRPM3$), the industry-specific average layoff durations for the past three years ($MDSCRPM1$ – $MDSCRPM3$), and the economy-

Table 4.1**Estimates of the Parameters of the Layoff Probability and
Conditional Duration Equations (Standard errors in parentheses)**

Variable	DUNEM ^a (Probit) (1)	DSCRPM ^b (Lambda) (2)
DSCRPM1	1.813 (.100)	.384
DSCRPM2	.726 (.098)	.277
DSCRPM3	.492 (.083)	.131
MDSRPM1	-3.848 (.749)	-1.395
MDSRPM2	-2.031 (.879)	-.376
MDSRPM3	-.986 (.684)	-.914
YDSRPM1	.053 (2.537)	3.761
YDSRPM2	-10.809 (3.737)	-3.284
YDSRPM3	7.021 (2.205)	3.404
SCHCLASS1	.987 (.066)	-.014
SCHCLASS2	.654 (.063)	-.022
SCHCLASS3	.451 (.065)	.028
EXPERIENCE	-.010 (.007)	-.001
EXPERIENCE ² /100	.006 (.014)	.007
TENURE	-.028 (.008)	-.012
TENURE ² /100	.085 (.027)	.020
LAMBDA	n.a.	.135
Constant	-.871 (.176)	.117

Table 4.1 (continued)

Variable	DUNEM ^a (Probit) (1)	DSCRPM ^b (Lambda) (2)
R^2	n.a.	.111
S. E. equation	n.a.	.314
\ln likelihood	-2185.870	n.a.
χ^2 (16)	9698.044	n.a.

^aEstimated by maximum likelihood. Equation also includes industry dummy variables.

^bEstimated by OLS. Equation also includes industry dummy variables. The reported S. E. equation and R^2 have been corrected.

wide average layoff durations for the same period (YDSCRPM1–YDSCRPM3). Permanent interindustry differences are captured by a set of fifteen industry dummy variables. Personal characteristics are measured by schooling dummy variables (relative to college graduates) (SCHCLAS1–SCHCLAS3), total labor force experience (EXPERIENCE, EXPERIENCE²), and total time spent with the same employer (TENURE, TENURE²). Although the determinants of π_{it} are not the major concern of this analysis, it is worth noting that personal unemployment history is an important predictor of current unemployment probability, even when industry average durations and economy-wide durations have been held constant. We interpret this effect as measuring employer and individual elements of the employment contract. No attempt is made to separate the employer-specific effect from the individual-specific effect since we remove a person effect from the wage equation used later in the analysis. The effects of common influences on all employers in a given industry are captured by the industry-specific variables. These allow both permanent and serially correlated transitory effects of unemployment history to influence predicted layoff probabilities. It is interesting to note that lagged industry layoff durations decrease the probability of a current layoff, given the industry dummy variables. This indicates that workers (and employers) expect unemployment to undershoot the long-term average after an exceptionally bad year and to overshoot the long-term average after an exceptionally good year. Economy-wide influences are mixed and rather imprecisely estimated. Personal characteristics have reasonable effects. High school dropouts (SCHCLAS1) are the most like to suffer layoffs, followed by high school graduates (SCHCLAS2), college dropouts (SCHCLAS3) and college graduates. Increases in employment tenure substantially reduce layoff probabilities (at a decreasing rate); lifetime labor force experience has a weak negative effect on layoffs (also at a decreasing rate).

Column 2 of table 4.1 shows the selection-bias-corrected estimates of the conditional duration equation. The pattern of effects is similar to the layoff probability equation, but no assessment of statistical significance can be made from the least-squares estimates. The implied interequation correlation coefficient is $\sigma_{12}/\sqrt{\sigma_{11}\sigma_{22}} = .43$. Under the null hypothesis of $\sigma_{12} = 0$, the standard error of the coefficient on LAMBDA is .181. Although the hypothesis that $\sigma_{12} = 0$ cannot be rejected at conventional significance levels, we do not want to ignore a sample correlation of .43; hence, we maintain the selection bias correction when calculating δ_{it} and ϕ_{it}^2 .

Table 4.2 provides a comprehensive summary of observed layoff incidence and duration as well as the layoff incidence, expected duration, and duration variance implied by the equations in table 4.1. Table 4.2 reveals the substantial and relatively permanent interindustry differences in the use of temporary layoffs as a means of reducing work hours for long-term employees.¹⁷ The row labeled DUNEM shows the actual annual average layoff frequency for each industry. The row labeled FDUNEM is the predicted layoff probability π_{it} , based on table 4.1. The DSCR row shows the average layoff duration in thousands of hours.¹⁸ The row EXPDURAT shows the expected layoff duration $\pi_{it}\delta_{it}$, based on table 4.1. The unconditional variance based on table 4.1 is shown in the row VARDURAT. Durable manufacturing industries (30–33) and the construction industry (51) have the highest layoff incidences and expected durations. Nondurable manufacturing (40, 45) also shows substantial use of layoff unemployment. These same industries exhibit higher unemployment risk (measured by VARDURAT) also.¹⁹ Government (92) and professional service industries (86, 87) use layoff unemployment relatively little. Overall, 1975 was the year with the highest predicted unconditional unemployment duration (47 hours) and the highest observed unconditional unemployment duration (64 hours). The year 1971 had the largest overprediction (10 hours) while 1975 had the largest underprediction (–17 hours).

4.3.3 Estimation of the Wage Equation

The empirical counterparts of the variables in equation 10 were defined using the predicted probabilities, durations, and variances estimated in table 4.1 and summarized in table 4.2. We used reported hours ($HACT_{it}$) plus unemployed hours ($DSCR_{it}$) as our measure of desired hours ($HOPT_{it}$). The empirical counterparts of the expressions in (10) are:

$$(18) \quad \text{HEFF}(\gamma) \equiv h^0 + (\gamma - 1)\pi\delta = \text{HOPT}_{it} \\ + (\gamma - 1)\text{EXPDURAT}_{it}$$

$$(19) \quad \text{CERTEG}(\gamma)_{it} \equiv \frac{-\pi\delta}{h^0 + (\gamma - 1)\pi\delta} = \frac{-\text{EXPDURAT}_{it}}{\text{HEFF}(\gamma)_{it}}$$

Table 4.2 Unemployment, Expected Unemployment, and Compensating Differential Measures for Annual Industry Aggregates

	1970	1971	1972	1973	1974	1975		1970	1971	1972	1973	1974	1975
1. DSCR	.0017	.0558	.0235	.0402	.0802	.0595	55. DSCR	.0758	.0558	.0517	.0436	.0604	.0456
EXPURAT	.0325	.0532	.0327	.0455	.0496	.0567	EXPURAT	.0364	.0588	.0265	.0407	.0576	.0653
VARDURAT	.0184	.0309	.0152	.0217	.0240	.0318	VARDURAT	.0211	.0298	.0148	.0205	.0278	.0286
DUNEM	.0203	.1194	.0458	.0685	.1473	.1429	DUNEM	.3239	.2727	.1312	.1129	.2121	.1667
FDUNEM	.0910	.1079	.0705	.0906	.1114	.1160	FDUNEM	.1725	.2001	.1171	.1685	.2079	.1967
Comp. Diff.	2.564	5.205	6.779	7.469	4.888	4.441	Comp. Diff.	2.865	4.233	3.492	3.746	5.372	5.820
(Std. Error)	(.430)	(.961)	(1.592)	(2.232)	(1.072)	(.815)	(Std. Error)	(.507)	(.783)	(.678)	(.787)	(1.125)	(1.386)
30. DSCR	.0095	.0522	.0638	.0278	.0596	.0573	57. DSCR	.0050	.0395	.0088	.0025	.0075	.0383
EXPURAT	.0332	.0537	.0208	.0442	.0501	.0394	EXPURAT	.0126	.0219	.0167	.0226	.0190	.0224
VARDURAT	.0183	.0288	.0121	.0209	.0214	.0198	VARDURAT	.0079	.0124	.0065	.0120	.0112	.0126
DUNEM	.1207	.1429	.2143	.0943	.2076	.1818	DUNEM	.0862	.1452	.0400	.0208	.0417	.0208
FDUNEM	.1320	.1539	.0963	.1337	.1475	.1428	FDUNEM	.0661	.0761	.0520	.0700	.0811	.0800
Comp. Diff.	3.968	4.792	2.087	4.878	4.881	3.859	Comp. Diff.	1.354	1.992	1.818	2.215	1.786	1.908
(Std. Error)	(.681)	(.846)	(.349)	(1.130)	(1.130)	(.721)	(Std. Error)	(.221)	(.329)	(.510)	(.458)	(.303)	(.318)
31. DSCR	.0097	.0375	.0149	.0267	.0117	.0593	61. DSCR	.0133	.0159	.0149	.0128	.0242	.0309
EXPURAT	.0204	.0355	.0166	.0307	.0349	.0329	EXPURAT	.0153	.0252	.0113	.0205	.0258	.0318
VARDURAT	.0117	.0196	.0092	.0142	.0186	.0179	VARDURAT	.0090	.0140	.0066	.0112	.0141	.0158
DUNEM	.0435	.0769	.0864	.0648	.0865	.1628	DUNEM	.0674	.0315	.0516	.0446	.0828	.0898
FDUNEM	.0859	.0999	.0624	.0891	.1045	.0965	FDUNEM	.0678	.0802	.0504	.0753	.0874	.0896
Comp. Diff.	1.860	2.977	1.748	3.454	3.260	4.871	Comp. Diff.	1.672	2.042	.812	2.433	2.026	2.625
(Std. Error)	(.311)	(.507)	(.308)	(.814)	(.584)	(.915)	(Std. Error)	(.287)	(.343)	(.134)	(.451)	(.344)	(.511)
32. DSCR	.2073	.0747	.0360	.0584	.1062	.1292	81. DSCR	.0107	.0000	.0057	.0413	.0248	.0637
EXPURAT	.0909	.0744	.0669	.0615	.1177	.1118	EXPURAT	.0180	.0288	.0117	.0231	.0257	.0376
VARDURAT	.0439	.0317	.0310	.0315	.0538	.0468	VARDURAT	.0103	.0161	.0068	.0129	.0142	.0163
DUNEM	.4456	.2410	.1714	.3000	.4407	.3529	DUNEM	.0333	.0000	.0286	.1316	.0811	.1471
FDUNEM	.2851	.2262	.1795	.2511	.3388	.2853	FDUNEM	.0691	.0843	.0493	.0774	.0853	.0870
Comp. Diff.	8.450	8.101	5.992	7.047	14.011	10.281	Comp. Diff.	1.327	2.075	.964	2.094	2.200	3.337
(Std. Error)	(1.621)	(1.933)	(1.288)	(1.313)	(2.744)	(2.317)	(Std. Error)	(.218)	(.348)	(.158)	(.348)	(.370)	(.786)

Table 4.2 (continued)

	1970	1971	1972	1973	1974	1975		1970	1971	1972	1973	1974	1975
33. DSCRП	.0161	.0329	.0097	.0197	.0374	.0782	85. DSCRП	.0162	.0047	.0177	.0204	.0353	.0319
EXPДURAT	.0191	.0351	.0166	.0286	.0357	.0354	EXPДURAT	.0167	.0340	.0153	.0230	.0286	.0353
VARDURAT	.0112	.0179	.0087	.0158	.0177	.0187	VARDURAT	.0095	.0150	.0086	.0128	.0148	.0184
DUNEM	.0870	.1154	.0571	.0308	.1967	.1667	DUNEM	.0676	.0333	.0769	.0526	.0794	.0625
FDUNEM	.0852	.1056	.0702	.0990	.1165	.1086	FDUNEM	.0653	.0794	.0519	.0759	.0892	.0895
Comp. Diff.	1.964	3.134	1.450	2.519	3.120	3.381	Comp. Diff.	1.801	3.854	1.635	1.925	3.887	3.739
(Std. Error)	(.327)	(.591)	(.268)	(.435)	(.637)	(.616)	(Std. Error)	(.299)	(.872)	(.285)	(.323)	(.689)	(.707)
40. DSCRП	.0095	.0176	.0034	.0241	.0117	.0310	86. DSCRП	.0119	.0000	.0025	.0000	.0131	.0190
EXPДURAT	.0093	.0220	.0055	.0127	.0187	.0225	EXPДURAT	.0120	.0204	.0119	.0145	.0211	.0291
VARDURAT	.0104	.0143	.0070	.0111	.0138	.0146	VARDURAT	.0072	.0114	.0063	.0084	.0118	.0158
DUNEM	.0588	.2051	.1290	.1667	.1250	.1026	DUNEM	.0351	.0000	.0208	.0000	.0600	.0328
FDUNEM	.1121	.1256	.0766	.1151	.1378	.1291	FDUNEM	.0559	.0646	.0408	.0613	.0740	.0752
Comp. Diff.	1.509	2.438	1.151	1.879	2.269	4.330	Comp. Diff.	1.303	1.817	1.382	1.170	1.907	3.392
(Std. Error)	(.245)	(.403)	(.187)	(.306)	(.398)	(.804)	(Std. Error)	(.213)	(.302)	(.279)	(.194)	(.318)	(.657)
45. DSCRП	.0399	.0188	.0049	.0351	.0465	.1261	87. DSCRП	.0011	.0189	.0006	.0002	.0040	.0216
EXPДURAT	.0372	.0367	.0258	.0429	.0580	.0562	EXPДURAT	.0104	.0219	.0070	.0155	.0216	.0220
VARDURAT	.0205	.0196	.0143	.0189	.0234	.0244	VARDURAT	.0074	.0122	.0053	.0095	.0124	.0124
DUNEM	.2118	.0488	.0241	.1333	.1487	.2647	DUNEM	.0230	.0460	.0116	.0130	.0274	.0811
FDUNEM	.1326	.1186	.0893	.1296	.1459	.1423	FDUNEM	.0697	.0812	.0503	.0792	.0915	.0870
Comp. Diff.	3.330	3.607	2.150	4.052	6.019	6.305	Comp. Diff.	1.351	2.049	.944	1.473	2.368	2.248
(Std. Error)	(.564)	(.626)	(.364)	(1.057)	(1.683)	(1.569)	(Std. Error)	(.227)	(.347)	(.155)	(.241)	(.394)	(.372)
51. DSCRП	.1226	.0427	.0411	.0574	.1072	.1982	92. DSCRП	.0176	.0022	.0252	.0176	.0035	.0050
EXPДURAT	.0604	.0835	.0537	.0725	.0938	.1006	EXPДURAT	.0160	.0197	.0116	.0160	.0203	.0196
VARDURAT	.0257	.0348	.0255	.0317	.0402	.0450	VARDURAT	.0081	.0109	.0057	.0084	.0113	.0109
DUNEM	.2761	.1667	.1683	.1682	.2789	.4078	DUNEM	.0652	.0274	.0225	.0538	.0194	.0206
FDUNEM	.1781	.2095	.1594	.2061	.2360	.2356	FDUNEM	.0502	.0564	.0346	.0529	.0624	.0601
Comp. Diff.	5.824	9.277	5.721	7.065	10.645	10.673	Comp. Diff.	1.862	1.627	3.797	1.509	5.182	2.057
(Std. Error)	(1.379)	(2.310)	(1.226)	(1.613)	(2.619)	(2.437)	(Std. Error)	(.377)	(.274)	(.921)	(.266)	(.891)	(.344)

$$(20) \quad \text{CERTSQG}(\gamma)_{it} \equiv \frac{.5\pi^2\delta^2}{h^0[h^0 + (\gamma - 1)\pi\delta]}$$

$$\equiv \frac{.5(\text{EXPDURAT}_{it})^2}{\text{HOPT}_{it} \text{HEFF}(\gamma)_{it}}$$

$$(21) \quad \text{COEFVSG}(\gamma)_{it} \equiv \frac{.5\pi[(1 - \pi)\delta^2 + \phi^2]}{(h^0 - \pi\delta)[h^0 + (\gamma - 1)\pi\delta]}$$

$$\equiv \frac{.5 \text{VARDURAT}_{it}}{(\text{HOPT}_{it} - \text{EXPDURAT}_{it})\text{HEFF}(\gamma)_{it}}$$

From the definitions in equations 18–21 it is clear that there is a nonlinear dependence on γ (the UI replacement rate) in all three of the expressions which enter the equation for $\ell n(w^{**})$. We deal with this problem in two different ways. First, we estimate γ along with e , r , and the determinants of $\ell n(w)$ by nonlinear methods. Second, we compute the sample average UI replacement rates by industry for each year (MCOMPRAT_{it}) and use these replacement rates instead of γ in the formation of the effective hours variable $\text{HEFF}(\gamma)$.²⁰

Table 4.3 reports the results of direct estimation of γ , e , and r by nonlinear least squares. Columns 1 and 2 report the use of the reported hourly wage $\ell n(\text{WAGE})$ as the dependent variable and columns 3 and 4 use the calculated hourly wage $\ell n(\text{EARN}/\text{HACT})$ as the dependent variable. We use as variables determining the opportunity wage—last year's wage (LAGW)—collective bargaining status (UNION), schooling, labor force experience, tenure, region, and year.²¹ Columns 1 and 3 show the results from the specification implied by equation 10. Columns 2 and 4 show the results from the specifications implied by equation 10 but allowing unanticipated unemployment (UNANTIC) expressed as a percentage of desired hours to enter the equation.²² The first three rows of table 4.3 show the implied estimates of γ , $1/e$, and r . The row labeled \hat{e}_{MELO} shows the implied estimate of e using Zellner's (1978) method.²³ The row labeled average compensating differential shows the percentage compensating differential gross of the implicit UI purchase payment.

In general, the results of columns 1 and 2 are quite favorable to our model. The implied ninety percent confidence interval estimate of $.093 \pm .085$ for labor supply elasticity is rather imprecise but certainly consistent with previously reported values for white males in both magnitude and precision of estimation.²⁴ The estimated γ is too large to be a UI replacement rate; however, we will discuss this problem in more detail below. The estimated relative risk aversion of $14.048 (\pm 3.714)$ reveals substantial distaste for unemployment risk. This result supports the hypothesis that the difference in risk aversion between employees and employers results in a demand for implicit labor contracts of the type

developed here.²⁵ Overall, the compensating differential is 3.82 percent ($\pm 1.26\%$) which is not an unreasonably large price for employers to pay for the right to set π , δ , and ϕ^2 . Of this differential, .60 percent ($\pm .55\%$)

Table 4.3 Nonlinear Least-Squares Estimates of Wage Parameters under Alternative Specifications (Standard errors in parentheses)

Variable Parameter	ℓn (WAGE) ^a (1)	ℓn (WAGE) ^a (2)	ℓn (EARN/HACT) ^a (3)	ℓn (EARN/HACT) ^a (4)
CERTEQG ^b γ	2.486 (.530)	2.485 (.531)	4.035 (.600)	4.312 (.618)
CERTSQG l/e	8.107 (4.572)	8.102 (4.592)	7.283 (5.292)	9.234 (5.624)
COEFVSQG r	14.048 (2.258)	14.044 (2.263)	28.177 (3.073)	29.555 (3.171)
UNANTIC		-.001 (.058)		.241 (.059)
LAGW	.767 (.009)	.767 (.009)	.772 (.009)	.773 (.009)
UNION	.029 (.009)	.030 (.009)	.042 (.009)	.041 (.009)
SCHOOL	.015 (.002)	.015 (.002)	.015 (.002)	.015 (.002)
EXPERIENCE	.006 (.001)	.006 (.001)	.007 (.001)	.007 (.001)
EXPERIENCE ² /100	-.013 (.003)	-.013 (.003)	-.014 (.003)	-.015 (.003)
TENURE	.003 (.001)	.003 (.001)	.003 (.001)	.004 (.002)
TENURE ² /100	-.002 (.005)	-.002 (.005)	-.004 (.005)	-.004 (.005)
Average compensating differential (%) ^c	3.820 (.767)	3.820 (.768)	7.000 (.995)	7.460 (1.041)
$\hat{\epsilon}_{MELO}$.093 (.052)	.093 (.053)	.090 (.065)	.079 (.048)
R^2	.693	.693	.699	.700
S. E. equation	.075	.075	.076	.076
Residual d.f.	5551	5550	5551	5550

^aRegressions include annual regional dummy variables.

^bThis variable is defined as the negative of the theoretical variable so that its coefficient is γ and not $-\gamma$.

^cComputed at the sample averages of CERTSQG and COEFVSQG, .00074 and .002293, respectively.

is attributable to the certainty equivalent compensation arising from the mean constraint, while 3.22 percent ($\pm .85\%$) is attributable to risk compensation arising from the variability of unemployment, given the mean constraint. The addition of the unanticipated part of unemployment to the equation (UNANTIC) has no effect on the results.

The rows labeled Comp. Diff. and (Std. Error) in table 4.2 show the industry by year-estimated compensating differentials and associated standard error implied by column 1 of table 4.3. The reported compensating differentials are gross of the implicit payment for UI. The interindustry patterns reveal that automobile workers (32) received compensating differentials varying from 6.00 percent (1972) to 14.01 percent (1974) of hourly wages in exchange for bearing the mean constraints and employment risks discussed above. Construction workers (51) received compensating differentials ranging from 5.72 percent (1972) to 10.67 percent (1975). Workers in the public sector (92), however, received substantially smaller compensations ranging from 1.51 percent (1973) to 5.18 percent (1974). Other interindustry and time series comparisons are obvious from the results reported in table 4.2.

The results in table 4.3, columns 3 and 4, show that the parameter estimates are sensitive to the choice of dependent variable. The general pattern of results remains the same except for two points. First, the estimated effects are larger when calculated wage rates are used. The implied average compensating differential becomes 7.00 percent ($\pm 1.64\%$). Second, the addition of unanticipated unemployment to the equation using calculated wages as the dependent variable (column 4) does produce a substantial effect of .241 ($\pm .097$). This suggests that directly measured wage rates (WAGE) are probably more reliable measures of the hourly compensation relevant to implicit or explicit labor contracts than are the ex post calculated wage rates.

Table 4.4 reports estimates based on our second solution to the nonlinear dependence on γ . The compensating differential variables have been calculated using the observed industry average values of UI replacement rates (MCOMPRAT) reported in table 4.A.1. Using these variables we can remove a person-specific effect from each individual's opportunity wage by standard fixed effect methods. The results are presented in columns 1 and 2 for reported wages and columns 3 and 4 for calculated wages. Once again, the results for reported wages are highly supportive of the model. The estimated labor supply elasticity is .224 ($\pm .729$), which is more imprecise than the result in table 4.3 but still consistent with the previous estimates. The estimated risk aversion parameter, 8.982 (± 1.828), is smaller in the fixed effect model. The estimated UI replacement rate $\hat{\gamma} = 1.206$ ($\pm .681$) now includes reasonable values in its ninety percent confidence interval. The average compensating differential is 2.14 percent ($\pm .55\%$), which is smaller than the values

Table 4.4 Fixed Effect Estimates of the Compensating Differential Parameters (Standard errors in parentheses)

Variable Parameter	ℓn (WAGE) ^a (1)	ℓn (WAGE) ^a (2)	ℓn (EARN/HACT) ^a (3)	ℓn (EARN/HACT) ^a (4)
CERTEQG ^b γ	1.206 (.414)	1.082 (.426)	.718 (.413)	.184 (.423)
CERTSQG l/e	1.140 (2.258)	.806 (2.272)	-2.327 (2.250)	-3.758 (2.257)
COEFVSQG r	8.982 (1.111)	9.041 (1.112)	10.523 (1.109)	10.782 (1.106)
UNANTIC		.083 (.066)		.357 (.065)
Average compensating differential (%) ^c	2.144 (.334)	2.133 (.334)	2.241 (.333)	2.194 (.332)
$\hat{\epsilon}_{\text{MELO}}$.224 (.443)	.139 (.391)	^d	^d
R^2	.856	.859	.865	.866
S. E. equation	.223	.223	.222	.221
Residual d.f.	3863	3862	3863	3862

^aRegressions include all variables in table 4.3.

^bThis variable is defined as the negative of the theoretical variable so that its coefficient is γ and not $-\gamma$.

^cComputed as in footnote c, table 4.3.

^dCoefficient of CERTSQG has the wrong sign.

in table 4.3. Finally, the addition of UNANTIC has a larger effect in column 2 than the comparable effect in table 4.3, column 2, but the effect is imprecisely estimated—.083 ($\pm .109$)—and its presence does not change any of the other effects substantially. As in the nonlinear model, the results are sensitive to the specification of the dependent variable. Columns 3 and 4 show that calculated wages give wrong-signed estimates of e and depend importantly on unanticipated unemployment. This is consistent with the conclusions for calculated wages shown in table 4.3.

Finally, we consider the implied wage payments for UI benefits. According to equation 10 and definition 19, the appropriate price is $\gamma \text{CERTEG}(\gamma)$. This price implies that wages fall by exactly the expected UI benefits in percentage terms. Table 4.5 shows the annual lower and upper 90 percent confidence bounds for the implicit UI price based on table 4.3, column 1, and data for CERTEQG found in table 4.A.1. It also shows the unconditional sample average UI benefits as a percentage of labor earnings. As we noted above, the estimated γ is too large to reflect the UI replacement rate parameter. Nevertheless, the implied wage payments are quite close to the observed unconditional averages con-

Table 4.5 Annual Average UI Benefits Compared with Benefit Expectations Implied by Estimates of γ

	1970	1971	1972	1973	1974	1975	Overall
Lower bound (%) ^a	2.30	3.18	1.97	2.75	3.45	3.62	2.87
Upper bound (%) ^a	4.78	6.62	4.11	5.72	7.17	7.53	5.97
Observed average (%) ^b	1.06	2.47	.72	1.10	1.58	2.38	1.54

^aLower and upper bounds of 90% confidence interval computed using $\hat{\gamma} = 2.486$ (table 4.3, column 1) and standard error of $\gamma = .530$. Values of CERTEQG are in table 4.A.1.

^bAnnual average UI benefits expressed as a percentage of total labor earnings (EARN + benefits) for the whole sample (MCOMPRAT · DUNEM).

sidering the fact that the actual UI benefits were not ever used in the analysis leading to the estimates in table 4.3. Furthermore, an estimated γ of about 1 would give values for the implicit price of UI which are fully consistent with the observed percentages. This is, essentially, the value of γ produced by the estimation technique used in table 4.4.²⁶ It is reasonable to conclude that our high estimates of γ give an approximate consistency with the competitive requirement that the wage in the constrained job should fall by the expected UI benefit level.

4.3.4 Conclusions

The empirical analysis supports our major theoretical points. Estimated compensating differentials range from less than one percent in industries where the workers experience little anticipated unemployment to over fourteen percent in industries which experience substantial anticipated unemployment and unemployment risk. We find the implied estimate of the compensated labor supply elasticity is around .09, which is consistent with the prevailing evidence on this parameter. Our estimate of a relative risk aversion parameter of 14 is high, but, when coupled with the low values of the coefficient of variation for unemployment, the implied risk premium is modest. Finally, we present some evidence that the implicit price of UI implied by our model is somewhat large under one estimation method and approximately equal to the expected UI benefits under the alternative estimation method.

Appendix

Table 4.A.1 contains variable definitions and summary statistics for all variables used in the analysis. All data manipulations and estimation were performed using the *Statistical Analysis System* (1979 version).

Table 4.A.1 **Definitions and Means for All Variables Used in the Empirical Analysis (Standard deviations in parentheses)**

Variable	Definition
WAGE	Reported wage in current \$/hr for main job
$\ell n(\text{WAGE})$	Natural logarithm of reported wage
EARN	Reported total labor income in current \$
$\ell n(\text{EARN}/\text{HACT})$	Natural logarithm of EARN/HACT
HACT	Reported average hours per week \times reported weeks worked (thousands of hours)
HOPT	HACT plus hours unemployed and hours on strike (thousands of hours)
DSCR P	HOPT-HACT
DUNEM	Equals 1 if DSCR P > 0 , equals 0 otherwise
FDUNEM	Predicted probability of layoff spell
CONDDURA	Equals DSCR P if DSCR P > 0 , missing otherwise (Summary statistics are conditional sample means and standard deviations)
EXPDURAT	Predicted unemployment using the formula in the text
VARDURAT	Predicted variance of unemployment using the formula in the text
HBAR	HOPT-EXPDURAT
MCOMPRAT	Industry average unemployment benefits received as a percentage of lost labor earnings
HEFF	HBAR + MCOMPRAT \times EXPDURAT (Note: in table 4.3 HEFF is evaluated at the estimate of γ , not at MCOMPRAT)
CERTEQG	$-\text{EXPDURAT}/\text{HEFF}$ (expected percentage unemployment, defined as the negative of the theoretical quantity)
CERTSQG	$.5(\text{EXPDURAT}^2)/(\text{HOPT} \times \text{HEFF})$ (Half of squared expected percentage unemployment. Table entries $\times 10^{-3}$)
COEFV SQG	$.5 \text{VARDURAT}/(\text{HBAR} \times \text{HEFF})$ (Half of the squared coefficient of variation of unemployment duration. Table entries $\times 10^{-3}$)

1970	1971	1972	1973	1974	1975	Overall
5.146 (2.952)	5.456 (3.313)	5.764 (3.425)	6.036 (3.187)	6.478 (3.531)	7.216 (3.862)	5.992 (3.447)
1.517 (.481)	1.571 (.488)	1.624 (.494)	1.681 (.479)	1.750 (.484)	1.858 (.492)	1.663 (.499)
11501 (5932)	12121 (6493)	12917 (6980)	13662 (7305)	14403 (7828)	15155 (8293)	13243 (7261)
8.423 (.488)	8.477 (.488)	8.528 (.501)	8.581 (.501)	8.657 (.501)	8.716 (.508)	8.560 (.509)
2.329 (.610)	2.311 (.558)	2.319 (.551)	2.333 (.558)	2.279 (.548)	2.259 (.563)	2.306 (.567)
2.369 (.583)	2.343 (.538)	2.339 (.537)	2.360 (.537)	2.321 (.524)	2.316 (.525)	2.342 (.542)
0.040 (.46)	0.032 (.136)	0.021 (.110)	0.027 (.127)	0.042 (.157)	0.064 (.207)	0.038 (.150)
0.129	0.105	0.074	0.085	0.136	0.153	0.114
0.111 (.093)	0.120 (.110)	0.079 (.096)	0.108 (.108)	0.129 (.122)	0.126 (.124)	0.112 (.111)
0.312 (.283)	0.309 (.303)	0.279 (.303)	0.325 (.308)	0.307 (.317)	0.416 (.365)	0.331 (.319)
0.030 (.048)	0.042 (.060)	0.024 (.053)	0.034 (.069)	0.043 (.071)	0.047 (.073)	0.036 (.063)
0.016 (.016)	0.021 (.020)	0.012 (.020)	0.017 (.020)	0.021 (.023)	0.023 (.024)	0.018 (.021)
2.339 (.587)	2.302 (.541)	2.316 (.543)	2.327 (.544)	2.277 (.530)	2.269 (.528)	2.306 (.547)
0.082 (.087)	0.236 (.414)	0.097 (.096)	0.130 (.211)	0.116 (.010)	0.156 (.091)	0.136 (.211)
2.342 (.586)	2.311 (.539)	2.319 (.542)	2.330 (.543)	2.284 (.528)	2.278 (.528)	2.312 (.546)
.0142 (.0246)	.0197 (.0365)	.0122 (.0391)	.0170 (.0538)	.0214 (.0431)	.0224 (.0404)	.0178 (.0404)
.352 (2.526)	.703 (5.310)	.644 (5.733)	.970 (12.879)	.927 (6.516)	.902 (4.671)	.740 (6.966)
1.866 (2.872)	2.451 (4.102)	1.759 (7.536)	2.120 (5.239)	2.835 (7.288)	2.779 (4.892)	2.293 (5.528)

Table 4.A.1 (continued)

Variable	Definition
SCHOOL	Years of school (SCHCLAS1 < 12, SCHCLAS2 = 12, SCHCLAS3 > 12 and/or S < 16, SCHCLAS4 > 16)
EXPERIENCE	Years of actual labor force experience
TENURE	Years employed with the same employer
UNION	Equals 1 if covered by a collective bargaining agreement (1975) or member of a labor union (1970-74)
UNANTIC	(DSCRPM-EXPDURAT)/HOPT (Unanticipated unemployment as a proportion of desired hours)
DSCRPM1	Lagged values of individual DSCRPM; 1, 2, 3 years, respectively (Means only shown. Overall standard deviation = .130)
DSCRPM2	
DSCRPM3	
MDSRPM1	Lagged values of industry average DSCRPM; 1, 2, 3 years, respectively
MDSRPM2	
MDSRPM3	
YDSRPM1	Lagged values of overall average DSCRPM; 1, 2, 3 years, respectively
YDSRPM2	
YDSRPM3	
INDUSTRY	Aggregates of the PSID 2-digit industry classification (Sample percentages shown)
1	All industries not classified
30	Metal manufacturing
31	Machinery, including electrical, manufacturing
32	Motor vehicles, other transportation equipment manufacturing
33	Other durable manufacturing
40	Food and tobacco manufacturing
45	Other nondurable manufacturing
51	Construction
55	Transportation
57	Other public utilities
61	Retail, wholesale, other trade
81	Repair services
85	Business, personal, amusement services
86	Professional, noneducational services
87	Educational services
92	Government (nonmedical, noneducational)

1970	1971	1972	1973	1974	1975	Overall
12.090 (3.157)	12.233 (3.112)	12.228 (3.131)	12.312 (3.083)	12.477 (3.004)	12.711 (2.870)	12.335 (3.069)
26.017 (11.204)	25.598 (11.207)	24.696 (11.502)	23.525 (11.024)	22.496 (11.396)	21.534 (11.580)	24.033 (11.429)
9.416 (8.540)	10.250 (8.990)	9.569 (8.564)	9.389 (8.728)	8.862 (8.702)	8.473 (9.140)	9.335 (8.791)
.356	.330	.325	.299	.297	.286	.317
.0049 (.0591)	-.0041 (.0616)	-.0017 (.0513)	-.0025 (.0535)	-.0007 (.0652)	.0083 (.0879)	.0007 (.0642)
.019	.042	.031	.025	.029	.042	.031
.026	.019	.041	.036	.030	.028	.029
.024	.027	.023	.045	.049	.043	.035

Same as above

Same as above

10.64	10.53	12.68	11.98	10.57	10.97	11.21
4.17	3.85	3.48	4.35	4.34	3.63	3.97
6.61	8.17	6.71	8.86	8.52	7.10	7.64
7.26	6.52	5.80	4.10	4.83	5.61	5.73
6.61	6.13	5.80	5.33	5.00	4.95	5.66
2.44	3.06	2.57	3.45	3.28	3.22	2.99
6.11	6.44	6.88	6.15	6.06	5.61	6.21
9.63	9.90	8.37	8.78	8.52	8.50	8.97
5.20	5.18	5.05	5.09	5.41	5.45	5.21
4.17	4.87	4.14	3.94	3.93	3.96	4.17
12.80	12.49	12.84	12.88	12.86	13.78	12.93
2.16	1.81	2.90	3.12	3.03	2.81	2.62
5.32	4.71	4.31	4.68	5.16	5.28	4.92
4.10	3.77	3.98	3.36	4.10	5.03	4.05
6.25	6.83	7.12	6.32	5.98	6.11	6.43
6.61	5.73	7.37	7.63	8.44	8.00	7.27
1,391	1,273	1,207	1,219	1,221	1,212	7,523

Notes

1. See Mortensen (1970) and Lucas and Rapping (1969) for examples of unemployment as an optimal labor supply strategy.
2. See Malinvaud (1977) and Ashenfelter (1980) for examples of unemployment viewed as a constraint on labor supply behavior.
3. See especially Rosen (1978 1974). Lewis (1969) provides an early theoretical analysis of the problem of joint worker-employer determination of work hours.
4. Other terms of employment may vary in order to force equality between V^* and V . For example, a lump sum payment could be made to the worker or the fringe benefit package could be altered. We assume that the full adjustment occurs in wage rates.
5. In figure 4.1, V^* depends only on h since w , p , and y are being held constant.
6. This condition of equilibrium follows from the same type of argument as Feldstein (1978 1976) uses in analyzing the effects of the unemployment insurance system on temporary layoffs.
7. Later we will use Taylor series approximations around h^0 to provide estimating formulas. Only the linear term $\gamma(h^0 - h)$ enters these formulas even if the UI system is modeled in a completely general way.
8. The wage w^{**} is an example of an implicit contract equilibrium wage in the spirit of Azariadis (1975) and Baily (1977). Condition 3' ensures that the contract $w^{**}, f(h; \theta)$, which leads to unemployment or underemployment is just as desirable as the full employment contract, w, h^0 . The firm's production and demand conditions determine which type of contract it will offer.
9. It is easier to derive the relevant approximations using the minimum expenditure function rather than the indirect utility function when there are no risk problems. Of course, we will use the utility function when we consider risk.
10. For the appropriate value of $v = V(w, p, y)$, $h^c(w, p, v) = h^0(w, p, y)$. Hence, the UI system in equation 6' is identical to the system underlying 1'.
11. The reader is reminded that the unemployment rate used here is the expected personal unemployment rate $u = (h^0 - h)/h^0$ and not the economy-wide unemployment rate.
12. The reader is referred to Abowd and Ashenfelter (1979) for the derivation of this result. The relative risk aversion function used here is a straightforward extension of the concept in Pratt (1964) and Arrow (1970).
13. Duncan and Stafford (1980) consider simultaneous determination of wages and compensating differentials in the context of union wages and working conditions. In this model, personal heterogeneity is assumed to influence the size of the required compensation.
14. Rosen (1974) works an example.
15. See Survey Research Center (1972a) for a description of the methods and sampling frame. See Survey Research Center (1972b 1973 1974 1975 1976) for the relevant questionnaires and variable definitions.
16. All annual hours variables, including DSCR_P, are defined in thousands of hours.
17. Sherwin Rosen provided some valuable comments concerning the usefulness of identifying industry patterns when forecasting the hours of work constraint.
18. The average shown is unconditional so that it can be compared with EXPDURAT and VARDURAT. The data for DUNEM and the industry proportions in table 4.A.1 can be used to calculate the conditional average duration.
19. EXPDURAT and VARDURAT are not independent since $\pi\delta$ and $\pi[(1 - \pi)\delta^2 + \phi^2]$ will, in general, be correlated when π , δ , and ϕ all depend on z_{it} . The sample correlation coefficient is .91.
20. PSID reports a variable: income from unemployment and workmen's compensation. The sample replacement rates were calculated as industry by year averages of the ratio of

this UI income variable to the implied lost earnings ($WAGE * DSCR P$) of the head. The average is taken only over nonzero values of $DSCR P$.

21. The use of last year's wage is intended to remove a person effect from the nonlinear regression. We do not mean to imply any dynamics. As is well known, a fixed person effect cannot be consistently estimated in a nonlinear regression model by the usual deviation from time average method.

22. Ken Wolpin suggested this variation.

23. The method minimizes the posterior expected loss from a Bayesian viewpoint and improves the mean squared estimate error from the sampling theory viewpoint. The method is designed for problems where the parameter of interest is the inverse of the estimated parameter.

24. Ashenfelter and Heckman (1974) estimated the ninety percent confidence interval for the compensated labor supply elasticity at $.06 (\pm .05)$ at their sample means in their table 1. Keeley, et al. (1978a b) estimated the ninety percent confidence interval at $.23 (\pm .17)$ at our sample means using their table 2.

25. See Azariadis (1975) and, especially, Baily (1974) for a discussion of the differential risk aversion hypothesis.

26. We have produced summary measures based exclusively on table 4.3, column 1, since it is, overall, the most reasonable equation. The ninety percent confidence interval for the UI price implied by the estimate in table 4.4, column 1, is 2.14 percent ($\pm 1.21\%$) which includes all the observed values reported in table 4.5. We should also note, however, that Feldstein (1978) reports that reported UI benefits received by CPS respondents understate the aggregate payments by fifty percent. This supports our estimate of γ in table 4.3, column 1, summarized in table 4.5.

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