NBER WORKING PAPER SERIES

TAXATION, WAGE VARIATION, AND JOB CHOICE

James N. Brown

Harvey S. Rosen

Working Paper No. 1284

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 1984

This work was supported in part by the National Bureau of Economc Research, the Hoover Institution, and the Industrial Realtions Section of Princeton University. We are grateful to members of the Microeconomics Seminar at the University of Virginia and the Labor Workshop at the University of Pennsylvania for useful suggestions. The research reported here is part of the NBER's research program in Taxation. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper #1284
March 1984

Taxation, Wage Variation and Job Choice

ABSTRACT

This paper examines the effect of earnings taxes on the variability of wages over time. We estimate a "hedonic wage locus" which indicates how the market allows individuals to substitute the mean level of the wage for its variability across jobs. Information from this locus is used to estimate the parameters of individuals' indifference curves between the mean and temporal variation of hourly wages. On the basis of these utility function parameters, we predict that lowering the rate of taxation on earnings would on average lead workers to choose jobs with a higher pre-tax mean wage and with greater wage variation.

James N. Brown and
Harvey S. Rosen
Department of Economics
Princeton University
Princeton, NJ 08544
(609) 452-4000

I. Introduction

According to standard theoretical considerations, a worker chooses that job (among those feasible) whose characteristics maximize his utility. In the process, the worker equates his marginal rate of substitution between any two job attributes with the marginal rate of transformation between them. As the individual's economic environment changes, so too may these marginal rates of substitution and transformation, leading to a change in the characteristics of the worker's optimal job package. In particular, one might well expect the worker's tax situation to affect his choice.

In this paper, we examine the effect of earnings taxes on one important job attribute, the variability of wages over time. In our model, we assume that each job can be characterized by the mean and variance of hourly wages over time. These are calculated using longitudinal data, and the results used to estimate a "hedonic wage locus" which indicates how the market allows individuals to substitute the mean level of the wage with its variability across jobs. We use the information obtained from this locus to estimate the parameters of individuals' indifference curves between the mean and temporal variation of hourly wages. Given these utility function parameters, we then predict how individuals' job choices would change in response to alternative proportional rates of taxation on earned income. The results indicate that lowering the rate of taxation on earnings would on average lead workers to choose jobs with a higher pre-tax mean wage and with greater wage variation.

In Section II, we model an individual worker's choice of wage variability and demonstrate that wage variability may increase or decrease utility. To the extent wage variability is foreseen and the worker is able to increase his labor supply in high wage years, variability is desirable. On the other hand, to the extent wage variability is not foreseen and the worker is risk averse, it is undesirable. Our discussion formalizes this distinction and shows its implications.

In section III we adopt specific functional forms so that the theory can be used as the basis for empirical analysis, which follows in Section IV. Section V concludes the paper with some suggestions for future research.

II. Theoretical Considerations

Each worker chooses a job that is characterized by a particular combination of mean and temporal variation in the hourly wage. In this section, we begin by considering the worker's preferences for mean and variation in hourly wages. We then consider, in turn, the worker's opportunity set for the choice of a job and the optimal job choice.

A. The Worker's Preferences for Mean and Variation in Hourly Wages

Consider an individual at the beginning of his working life who, having accumulated some given level of education, is choosing from a set of alternative lifetime jobs. At each job, the derived demand schedule for the worker's services will generally embody some variation, due to variation in the supply of complementary and substitutable factors of production or in the demand for final products. As a result, the hourly wages paid on each job, although perhaps constant over some intervals (e.g., within years) will generally vary across intervals (e.g., across years). Some of this variation may be foreseen by the worker but, in general, some portion of this variation will not be foreseen.

Wage variation that is not foreseen by the worker complicates the worker's intertemporal allocation of the lifetime wealth offered by any job and may reduce the worker's realized lifetime utility. Nevertheless, to the extent that the worker can benefit from the opportunities for substitution created by variable wages, exposure to wage variation may still be considered a good, even though some or all of that variation may be unpredictable to the worker. Whether the worker prefers or dislikes exposure to wage variation will depend on two things: first, the degree to which that variation can be predicted and second, the worker's tastes -- in particular, the overall concavity of the worker's utility function and the substitutability between the various arguments of that function.

To illustrate these points, consider a worker whose lifetime utility function is given by

$$(1) \qquad U(C_1, L_1, C_2, L_2, \ldots, C_N, L_N) ,$$

where N denotes the length of the individual's working life, C_i

denotes consumption of market goods in period i, L_i denotes the proportion of the time endowment devoted to leisure in period i, and where $U(\cdot)$ is assumed to be an everywhere continuous, twice differentiable, strictly concave function. Assume that the worker can borrow and lend freely at a constant rate of interest, but is constrained to have zero net assets at the end of his working life. Ignoring taxes, the worker's budget constraint is given by

$$(2) \qquad A + \sum_{i=1}^{N} [w_i(1-L_i) - C_i](1+r)^{-i} = 0$$

where A denotes the initial level of assets, w_i denotes the hourly wage in period i, and r is the rate of interest. Assume also that the wage in period i is given by

$$(3) \qquad w_i = \mu + \varepsilon_i + v_i \ ,$$

where ε_i denotes a zero-mean, non-stochastic component of the period-i wage which is foreseen by the worker prior to job choice; and v_i denotes a zero-mean component of the period-i wage which is stochastic to the worker prior to job choice, but which becomes fully known to the worker immediately after job choice.[1] We define:

---

[1]For example, ε_i might represent an anticipated trend component of earnings attributable to seniority-related compensation, while v_i might represent unanticipated job- or employer-specific factors revealed to the worker only after the worker's job choice has been made.

$$(4)\qquad \text{Var}(\varepsilon_i) = \sigma_\varepsilon^2 \text{ for all } i$$

$$\text{Var}(v_i) = \sigma_v^2 \text{ for all } i$$

$$\text{Cov}(\varepsilon_i, \varepsilon_j) = \rho_{ij}$$

$$\text{Cov}(v_i, v_j) = \gamma_{ij}$$

$$\text{Cov}(\varepsilon_i, v_j) = 0 \text{ for all } i, j.$$

Given these assumptions, the actual wage sequence to be realized by the worker is uncertain prior to job choice, but becomes fully known by the worker immediately after job choice. Thus, the criterion on which the worker's job choice in period zero rests is

$$(5)\qquad E_0V(w_1, \ldots, w_N; A,r)$$

where $V(\cdot)$ denotes the indirect utility function associated with equation (1). In this expression, the expectation is taken over the "period zero" distribution of wages in all future periods.

Taking a second-order expansion about the point $(\mu, \ldots, \mu; A,r)$, expression (5) can be restated as

$$(6)\qquad E_0V(w_1, \ldots, w_N; A,r) \approx$$

$$V(\mu, \ldots, \mu; A,r) + \frac{1}{2} E_0 \sum_{i=1}^{N} \sum_{j=1}^{N} \frac{\partial^2 V(\cdot)}{\partial w_i \partial w_j} (w_i-\mu)(w_j-\mu).$$

Applying Roy's identity, expression (6) can be simplified to

$$(7) \qquad E_0 V(w_1, \ldots, w_N; A,r) \approx$$

$$V(\mu, \ldots, \mu; A,r) + \frac{1}{2}\lambda(\cdot) \sum_{i=1}^{N} \sum_{j=1}^{N} (1+r)^{-i} S_{ij}(\cdot)\, \rho_{ij}\, \sigma_\varepsilon^2$$

$$+ \frac{1}{2}\lambda(\cdot) \sum_{i=1}^{N} \sum_{j=1}^{N} (1+r)^{-i} S_{ij}(\cdot)\, \gamma_{ij}\, \sigma_v^2$$

$$+ \frac{1}{2}\frac{\partial\lambda(\cdot)}{\partial A} \sum_{i=1}^{N} \sum_{j=1}^{N} (1+r)^{-i} (1-L_i(\cdot))\,(1-L_j(\cdot))\, \gamma_{ij}\, \sigma_v^2 ,$$

where $\lambda(\cdot)$ denotes the marginal expected utility of wealth in period "zero", S_{ij} denotes the Slutsky-compensated derivative of time worked in period i with respect to the wage in period j, and where all functions are evaluated at the point $(\mu, \ldots, \mu; A,r)$.

As is evident from expression (7), the expected level of lifetime utility associated with any particular job depends (approximately) on two basic things: The mean level of wages realized over the worker's lifetime and the variance-covariance structure of those wages. To a second-order approximation, a higher mean level of wages, ceteris paribus, increases the first term on the right hand side of (7) without altering the other terms, so it clearly increases utility. The effect of the variance-covariance structure of wages is less clear, however.

One fundamental determinant of this effect, shown in the second and third terms on the right hand side of (7), is the substitutability (as measured by the S_{ij}) between the various arguments of the worker's utility function. Ceteris paribus, an increase in the covariance of wages in period i and j increases expected utility if leisure in periods i and j are substitutes, and decreases expected utility if leisure in periods i and j are complements. Also, the more responsive is the demand for leisure in any period i to the wage in period i, the more positive is the effect of wage variance on expected utility.[2]

The second fundamental determinant of the effect of wage variation on expected utility is evident in the last term on the right hand side of (7). This term reflects the effect on expected utility of the worker's _ex ante_ uncertainty regarding lifetime wealth.[3] The assumption of perfect foresight immediately _after_ job choice guarantees that the uncertainty of wages prior to job choice has no effect on the worker's ultimate consumption and labor supply behavior. It therefore guarantees that this uncertainty will have no effect on the lifetime utility realized by the worker, conditional on any given hourly wage sequence. Nevertheless, as long as λ is diminishing in wealth, the unconditional period "zero" expected lifetime utility for the worker generally is reduced by this uncertainty. Only in the case where the worker's marginal utility of wealth is constant $(\frac{\partial\lambda(\cdot)}{\partial A} = 0)$ is this effect absent.

It is natural to measure the strength of the worker's "taste" for

---

[2]Strict concavity of the worker's utility function implies that the S_{ij} matrix in (5) is positive semi-definite, and thus that the second and third terms on the right hand side of (6) are positive.

[3]The term $\sum_{i=1}^{N}\sum_{j=1}^{N}(1+r)^{-i}(1-L_i(\cdot))(1-L_j(\cdot)\gamma_{ij}\sigma_v^2$ is equal to the period "zero" variance of realized lifetime wealth.

wage variation by the marginal change in the mean value of hourly wages that would just compensate the worker for a marginal increase in the variation of hourly wages about their mean value. Assuming for simplicity that ε and v are uncorrelated over time, differentiation of expression (7) with respect to μ, σ_ε^2, and σ_v^2, shows that the compensating differential asssociated with fully foreseen wage variation can be expressed as

$$(8a)\quad \left.\frac{\partial\mu}{\partial\sigma_\varepsilon^2}\right|_{dE_0V(\cdot)\,=\,0} = \frac{1}{2}\frac{\sum_{i=1}^{N}(1+r)^{-i}S_{ii}}{\sum_{i=1}^{N}(1+r)^{-i}[1-L_i(\cdot)]},$$

while the compensating differential associated with intially unforeseen wage variation is

$$(8b)\quad \left.\frac{\partial\mu}{\partial\sigma_v^2}\right|_{dE_0V(\cdot)\,=\,0} = \frac{1}{2}\frac{\sum_{i=1}^{N}(1+r)^{-i}\left[S_{ii}+\frac{1}{\lambda}\frac{\partial\lambda(.)}{\partial A}[1-L_i(\cdot)]^2\right]}{\sum_{i=1}^{N}(1+r)^{-i}[1-L_i(\cdot)]}$$

From these expressions, we can make two observations.

First, from expression (8a), it can be seen that the worker unambiguously prefers wage variation which can be foreseen to the absence of such variation. Moreover, the greater the worker's ability to respond to variable wages (more precisely, the larger the S_{ii}), the greater will be the worker's preference for such wage variation. Second, expression (8b) indicates that the worker may either prefer or dislike wage variation that is initially unforeseen. As with foreseeable wage variation, the worker's preference for initially unforeseen wage variation is more positive, the greater the worker's ability to substitute leisure across periods. Unlike the case of foreseeable wage variation, however, the uncertainty regarding realized wealth that is implied by initially unforeseen wage variation introduces an additional, negative effect on the worker's expected utility. This effect is more negative, the greater the overall concavity of the workers utility function (or more precisely, the more negative the value of $\frac{\partial\lambda(\cdot)}{\partial A}$.) Without further restrictions on the worker's utility function, therefore, expression (8b) cannot be signed.

At this point, it is important to emphasize that our empirical focus in this paper is on wage "variation" rather than wage "uncertainty". We cannot observe directly the indicators of wage uncertainty that are relevant to individuals. We see only ex post wage variation, some component of which may have been forseen by the worker. Given this fact, any empirical analysis of workers' responses to wage uncertainty must rest on some prior assumption linking ex post wage variation to ex ante wage uncertainty.[4] Rather than employ such an assumption, we choose instead to focus simply on wage variation.

---

[4]For some examples, see Weiss [1972], Abowd and Ashenfelter [1980], and Johnson [1980].

In the absence of further information regarding worker's preferences and regarding the exact distinction between foreseen and unforeseen variation for each individual, the most we can say is that the worker will be more likely to prefer wage variation, the more foreseeable that variation is, and the greater the worker's intertemporal substitutability of leisure. The more rapidly diminishing the worker's marginal utility of wealth, the more likely it is that the worker will be observed to require a positive wage premium for exposure to wage variation.

More explicitly, if we define σ_w^2 as the variance of the wage, then on the assumption that

$$\sigma_v^2 = \alpha\sigma_\varepsilon^2 ,$$

the assumption that ε and v are uncorrelated implies that

$$\sigma_\varepsilon^2 = \left(\frac{1}{1+\alpha}\right)\sigma_w^2$$

and

$$\sigma_v^2 = \left(\frac{\alpha}{1+\alpha}\right)\sigma_w^2 \quad .$$

Consequently, expressed in terms of the observable σ_w^2 rather than the unobservable components σ_v^2 and σ_ε^2 , expression (7) becomes

(9) $E_0V(w_1, w_2, \ldots, w_N; A,r) \approx$

$$V(\mu, \ldots, \mu; A,r) + \frac{1}{2}\lambda(\cdot) \sum_{i=1}^{N}\sum_{j=1}^{N} (1+r)^{-i} S_{ij} \left[\left(\frac{1}{1+\alpha}\right)\rho_{ij} + \left(\frac{\alpha}{1+\alpha}\right)\gamma_{ij}\right]\sigma_w^2$$

$$+ \frac{1}{2}\frac{\partial\lambda(\cdot)}{\partial A} \sum_{i=1}^{N}\sum_{j=1}^{N} (1+r)^{-i} (1-L_i(\cdot))(1-L_j(\cdot))\left[\left(\frac{\alpha}{1+\alpha}\right)\gamma_{ij}\right]\sigma_w^2 ,$$

while the compensating differential observed for σ_w^2 (as opposed to σ_ε^2 or σ_v^2) is given by

$$(10) \quad \left.\frac{\partial\mu}{\partial\sigma_w^2}\right|_{dE_0V(\cdot) = 0} = \frac{\frac{1}{2}\sum_{i=1}^{N}(1+r)^{-i}\left[S_{ii} + \frac{1}{2}\frac{\partial\lambda(\cdot)}{\partial A}\left(\frac{\alpha}{1+\alpha}\right)[1-L_i(\cdot)]^2\right]}{\sum_{i=1}^{N}(1+r)^{-i}[1-L_i(\cdot)]} .$$

As discussed above, it can be seen from expression (10) that the worker's compensating differential will be larger as the share of unpredictable wage variation in total wage variation is larger (α larger), and as the worker's marginal utility of wealth is more rapidly diminishing ($\frac{\partial\lambda(\cdot)}{\partial A}$ larger negative). The compensating differential will be smaller as the worker is more able to substitute leisure across periods (S_{ii} larger negative).

B. The Worker's Opportunity Set for Combinations of Mean and Variance in Hourly Wages

Across individuals, one might expect to find considerable variety in tastes for wage variation. In terms of our theoretical model, the indirect utility function $V(\cdot)$ might differ from person to person, or the relative shares of σ_ε^2 and σ_v^2 in total wage variation might differ from person to person. At the same time, profit-maximizating firms, because of the nature of their technologies, might find it in their interests to offer employees different combinations of μ and σ_w. Using Rosen's [1974] terminology, in equilibrium, workers and firms are perfectly matched when their respective "offer" and "value" functions for variability and return are tangent, and the value of the tangent gives the implicit price of variability in terms of expected return. The joint envelope of all offer and value functions comprises a "market locus", which shows how the market will permit workers and employers to substitute variability and return.

Of course, wage variation is not the only important job attribute. Presumably, individuals and firms are matched on the basis of a large number of individual and firm-specific characteristics. Denoting these other characteristics by the vector Z, the constraint facing the worker in his choice of a specific combination of mean and variance in the hourly wage can be summarized by the market locus,

(11) $\mu = f(\sigma_w^2, Z)$.

It is important to emphasize that we assume equation (11) to be generated by the optimizing behavior of firms and workers. The relationship between the level of wages (or earnings) and its variance has been studied in a number of quite different contexts. For example, simple mathematical models in which income at any time is modelled as a sum of random shocks from previous periods yield predictions on the mean-variance relationship in income, and similar arguments could be applied to wages.[5] Obviously, any observed empirical relationship can be consistent with a large number of interpretations, and we have found no way to "prove" that ours is better than such a mechanistic point of view. We merely note that an equilibrium interpretation is in the spirit of much other theoretical and empirical work on labor markets. (See for example, C. Brown [1980].)

Theory provides few clues as to the functional form of the market locus given by (11). In part, this indeterminacy results from the ambiguity involved in characterizing the individual worker's preferences for mean and variance in the hourly wage. In addition, the presence of heterogeneous tastes and technologies in the market reinforces this indeterminacy. At this very general level, aside from the existence of some equilibrium relation such as (11), theory provides little structure for data analysis.

C. The Worker's Optimal Job Choice

Utility maximization requires that the worker equate his marginal rate of substitution between μ and σ_w^2 to the marginal rate of transformation implicit in the set of wages for jobs among which he

---

[5]See Mincer [1970] for a critical discussion of such models.

can choose. More explicitly the worker's optimal choice of a job is characterized by the following equality:

$$(12) \qquad \left.\frac{d\mu}{d\sigma_w^2}\right|_{dE_0V(\cdot) = 0} = \frac{df(\cdot)}{d\sigma_w^2} ,$$

where f(•) is given by (11). Given the theoretical ambiguities discussed above, condition (12) yields no unambiguous comparative statics results. As a basis for estimation of worker preferences, however, it can be of value. Coupled with the hypothesis of unchanging preferences and augmented by empirical information, moreover, condition (12) can serve as a basis for the prediction of worker behavior. The following section exploits this fact by stating equation (12) in a specific form suitable both for the estimation of worker preferences and the subsequent prediction of worker behavior.

III. Empirical Specification

Empirical implementation of equation (12) requires a specific functional form. Consider first the right-hand-side of (12), which is derived from (11). The first issue in specifying (11) is the selection of the variables in the vector Z. As noted above, jobs are characterized by a large number of attributes.[6] We make no attempt to include all possible attributes. Instead, we consider only two, education (ED) and years of experience (EXP), which have been shown in

---

[6] C. Brown [1980] discusses a number of possibilities.

other studies to be important.

With respect to the form of $f(\cdot)$, we note that deriving a closed form expression for the market locus on the basis of underlying utility and production functions is virtually an intractable problem. (This point has been emphasized by Rosen [1974].) In our view, the most sensible approach is to choose a convenient functional form that fits the data fairly well. We have selected the commonly used semilogarithmic specification

$$(13) \quad \ln \mu_k = \psi_0 + \psi_1 ED_k + \psi_2 EXP_k + \psi_3 EXP_k^2 + \psi_4 \sigma_k + \psi_5 \sigma_k^2 ,$$

where the subscript k indexes individuals.[7] (For simplicity we suppress the w subscript on σ in equation (13) and hereafter.)

If the usual additive error term is appended to (13), then it can be estimated by ordinary least squares.[8] Note that although the ψ's are identical across individuals, the implied values of $\frac{\partial \mu_k}{\partial \sigma_k^2}$ depend upon levels of μ_k and σ_k, and hence vary from person to person.

---

[7]Several other functional forms were examined, including some which allowed for interaction among the right hand side variables. The substantive implications of these other functional forms were not much different from those of (13). These results are reported in the Appendix.

[8]Although the individual chooses μ and σ jointly, ordinary least squares estimation of (13) is nevertheless appropriate within a single market, if within such a market all participants face the same market locus. In contrast, going across markets, differences in opportunity sets may lead to wealth effects on choice that require simultaneous equations methods in the estimation of (13).

We turn next to the parameterization of preferences. In keeping with the earlier theoretical treatment of the worker's preferences for mean and variation in hourly wages, we seek a specification that does not constrain the sign of the worker's marginal rate of substitution between μ_k and σ_k^2. It would also be desirable if the specification did not constrain the relation between this marginal rate of substitution and the overall level of wealth (as measured by μ_k). Nor should the specification predetermine the effect of a tax change upon the pre-tax mean and variation of the wage.[9] At the same time, however, the chosen specification should economize on the number of parameters to be estimated and should provide a convenient basis for subsequent prediction. We assume that the indirect utility function for the k^{th} worker is given by[10]

$$V(w_1, w_2 \ldots, w_N; A, r) = \sum_{i=1}^{N} [1 - \exp[-(\theta_k w_i)^{\beta_k}]] \quad ,$$

where β_k is a parameter that varies across individuals, and θ_k is one minus the kth worker's marginal tax rate.[11] If we approximate this function by a second order Taylor series and then take the

---

[9]As is well-known from the literature on taxation and portfolio behavior, a tax can either increase or decrease the equilibrium variability of a portfolio. See Feldstein [1969]. Similar considerations apply here.

[10]This is the distribution function of the Weibull distribution. See Mood, Graybill and Boes [1974, p. 542].

[11]For simplicity, we assume the worker's marginal tax rate to be independent of the worker's wage in period i . We interpret β_k as incorporating the individual worker's values of A and r .

expected value, we find that

$$(14)\quad \left.\frac{\partial \mu_k}{\partial \sigma_k^2}\right|_{dE_0 V(\cdot) = 0} \approx \frac{1}{2}[\beta_k(\theta_k\mu_k)^{\beta_k - 1} + (1-\beta)(\theta_k\mu_k)^{-1}] .$$

Estimates of the market locus (13) together with the first-order condition (12) and slope of the indifference curve (14) enable us to compute a value of β_k for each individual. From the market locus, we know that for the k^{th} individual, the marginal trade-off between mean and variation of hourly wages is given by

$$(15)\qquad \frac{\partial \mu_k}{\partial \sigma_k^2} = \frac{\mu_k}{2\sigma_k}(\psi_4 + 2\psi_5\sigma_k).$$

By the first-order condition, expression (15) must equal the value of expression (14) for the k^{th} individual:

$$(16)\qquad \frac{\mu_k}{2\sigma_k}(\psi_4+2\psi_5\sigma_k) = \frac{1}{2}[\beta_k(\theta_k\mu_k)^{\beta_k-1} + (1-\beta_k)(\theta_k\mu_k)^{-1}].$$

Equation (16) does not yield a closed form expression for β_k, but a solution can be found using numerical methods. Note that equation (16) allows the calculation of a unique β_k for each individual in the sample. Unlike previous studies in this area (e.g., Weiss [1972]), heterogeneity in tastes is allowed.

Using these estimates of β_k in conjunction with the opportunity locus parameters, we can estimate each individual's response to a hypothetical change in the tax rate faced by that individual. Specifically given β_k and θ_k, (13) and (16) can be regarded as two equations in the two unknowns μ_k and σ_k. Consider now a case in which the tax rate of only the m^{th} individual changes. In general, when θ_m changes, new values for μ_m and σ_m are required to solve the equations. The solution to this simultaneous non-linear system can be found using numerical methods. In this way, we obtain predictions of how variance and return combinations for this individual would change if his tax rate were modified.

In the same way, we can repeat the exercise for each individual, computing how his u_k and σ_k would change if he alone were to face a change in his existing θ_k . Below we report the sample averages of the changes so generated.

It is tempting to use these sample averages to predict the aggregate response that might follow from a change in tax rates for all workers. However, if every worker's tax rate were simultaneously modified, the market locus itself would shift, leading to a further readjustment not captured by the sample averages reported here. Only if firms were homogenous could these sample averages be used to predict aggregate responses to general changes in tax rates. In this case the market locus would coincide with the firm's value functions and, because the locus would depend only on firms' preferences, any change in exogeneous factors influencing workers' opportunity sets (for example, tax rates) would leave the market locus unchanged and would cause workers merely to relocate along this fixed locus. A more general analysis would allow for a "supply response" that would shift the locus, but this is beyond our scope.[12]

In addition to calculating how taxes modify workers' selections of μ_k and σ_k, it would be useful to obtain some measure of the impact of tax changes on welfare. Looking at the differences between mean wages under alternative tax regimes is not enough, because the variability of wages also changes. A natural way to take both the mean and variance of wages associated with a given tax system into account is provided by the compensating differentials previously estimated.

Specifically, within our framework, the expected utility for the k^{th} worker associated with any job can be approximated by the linear function

$$(17) \qquad E_0 V_k(\cdot) \approx \eta_0 + \eta_1 \theta_k \mu_k + \eta_2 \theta_k^2 \sigma_k^2.$$

where the η's are parameters. A change in expected utility is given by

$$(18) \qquad \Delta E_0 V_k(\cdot) \approx \eta_1 \Delta(\theta_k \mu_k) + \eta_2 \Delta(\theta_k^2 \sigma_k^2).$$

Neither η_1 nor η_2 can be observed directly, so the actual effects on expected utility cannot be directly calculated. Nevertheless, a close alternative is possible. On the basis of equation (17), expected utility on any job can be converted into monetary units by dividing by η_1:

---

[12]In the literature using cross-sectional data to estimate the elasticity of hours of work with respect to the post-tax wage, it is typically (implicitly) assumed that the structure of before-tax wages is invariant with respect to the tax change. The assumption of a fixed locus is our analogue to this standard assumption.

$$(19) \qquad \frac{1}{\eta_1} \text{ E V}(\cdot) \approx \frac{\eta_0}{\eta_1} + \theta_k\mu_k + \frac{\eta_2}{\eta_1}(\theta_k^2\sigma_k^2).$$

Equation (19) gives the approximate monetary value of the expected utility on any job for any particular individual. (Recall that η_1 is "like" $dV/d\mu$.) From (19), it follows that for a discrete change in μ_k and σ_k^2,

$$(20) \qquad \Delta \frac{E_0V(\cdot)}{\eta_1} \approx \Delta(\theta_k\mu_k) + \frac{\eta_2}{\eta_1} \Delta(\theta_k^2\sigma_k^2).$$

Thus, given η_2/η_1, the effect of any change on the monetary value of expected utility for any individual can be calculated. Moreover, unlike η_2 or η_1 taken separately, the ratio η_2/η_1 is observable -- it is just the compensating variation in μ_k that would leave the individual's utility unchanged in the face of a marginal increase in σ_k^2. As indicated by equation (14), this compensating variation is given by $-\frac{1}{2}[\beta_k(\theta_k\mu_k)^{\beta_k-1} + (1-\beta_k)(\theta_k\mu_k)^{-1}]$. Substituting this expression into (20), we find

$$(21) \ \Delta \frac{E_0V_k(\cdot)}{\alpha_1} = \Delta(\theta_k\mu_k) - \frac{1}{2}\left[\beta_k(\theta_k\mu_k)^{\beta_k-1} + (1-\beta_k)(\theta_k\mu_k)^{-1}\right]\Delta(\theta_k^2\sigma_k^2) \ ,$$

values of which corresponding to alternative tax rates are also reported below.

IV. Data and Results

A. Data

Because our framework requires the computation of μ and σ_w^2 for each worker, data that record individuals' wage rates over time are required. We use data from the Panel Study of Income Dynamics for the years 1970 to 1976. Given that the model assumes individuals to choose lifetime jobs, we restrict our sample only to those individuals who do not change jobs during the sample period. As Hall [1982] has noted, lifetime jobs are indeed quite important in the U.S. economy. We include only white males in order to avoid possible complications that might arise because of labor market discrimination and anticipated career interruptions. After deleting a few observations due to unusable data, we were left with 728 observations.

The theory assumes that individuals respond only to real magnitudes, so all wage rates were converted to 1970 levels by deflating with the Bureau of Labor Statistics Consumer's Price Index (all items). The period-zero expected wage for each individual, μ_k, was calculated as the arithmetic mean of the individual's wage rates over the seven-year period. The mean value of μ_k in our sample was \$4.77. The variable σ_k^2 was calculated as the sample variance of the wage.[13] Its average value was \$0.59. The other variables required

[13] We emphasize again that our focus is on "variation" of the hourly wage, rather than its "risk" or "uncertainty". More elaborate methods for calculating the expected wage and its dispersion could have been used. Given the potential for inaccuracy in modelling expectations, however, it seemed to us desirable to use the simplest formulation possible.

for estimation are education, experience and the marginal federal income tax rate. These were measured by their 1976 values.[14]

B. Results

Our first step was to estimate the market locus. We estimated the following relation:

$$(22)\quad \ell n\mu_k = \underset{(0.74)}{4.638} + \underset{(.00359)}{.0584ED_k} + \underset{(.00495)}{.0371EXP_k} - \underset{(9.42\times10^{-5})}{.000544EXP_k} + \underset{(4.81\times10^{-4})}{.00476\sigma_k} - \underset{(1.69\times10^{-6})}{8.19\times10^{-6}\sigma_k}$$

$$R^2 = 0.55,$$

where the numbers in parentheses are standard errors. The coefficients on education, experience and experience squared are similar in magnitude to those that have been found in other studies. The coefficient on the linear term in σ_k is positive and that on the quadratic term is negative. At low levels of σ_k, μ_k increases as σ_k increases, but at high levels it decreases.[15] Evaluated at the means, the elasticity of μ with respect to σ is .23.

The model developed in Section II highlighted the theoretical indeterminacy of the effect of σ_k upon μ_k. In our empirical work, we

[14] In our sample, the mean value for ED is 12.2 (std.dev.=3.01); for EXP, 26.2 (std.dev.=9.54); and for the marginal Federal income tax rate, 0.26 (std.dev.=0.0713).

[15] As mentioned above, we experimented with several functional forms. These results, which are reported in the Appendix, indicate that the implied values of $\partial\mu_k/\partial\sigma_k^2$ are not very sensitive to changes in functional form.

find that the quadratic term in (22) does not dominate until σ_k takes on a value of $2.90, and in our sample, there are only a few observations for which σ_k exceeds this value. Thus, we now see that for most of the people in our sample, increases in σ require a compensating increase in μ. The "positive" effect of wage variation associated with inter-temporal substitutability is outweighed by the "negative" effect associated with risk aversion. This result is consistent with recent research on intertemporal labor supply, which suggests that intertemporal substitution elasticities are indeed quite small. (See, e.g. MaCurdy [1981].)

With equation (22) in hand, $\partial\mu_k/\partial\sigma_k^2$ can be computed for each individual. Substituting this and the individual's value of $\Theta_k\mu_k$ into the first-order condition (16), we can calculate a β_k for each individual. The average value of β_k in our sample was 0.541, with a sample standard deviation of 0.105. The relatively large standard deviation suggests considerable heterogeneity of tastes, a phenomenon that has also been noted in studies of other types of labor supply decisions (see Heckman and Willis [1977]).

Finally, with estimates of β_k, we can predict how σ_k, μ_k, and the money-equivalent value of the individual's bundle would change under alternative tax regimes. To illustrate, we consider a case in which each individual's tax rate is reduced by one-third, and use equations (13) and (16) to find the new equilibrium values of μ_k and σ_k. We then substitute these into equation (21) to find $\Delta(1/\eta_1)E_0V_k(\cdot)$, the money-equivalent value of the change in utility.

In a second simulation, we compute the individual's new equilibria when the tax is removed altogether, $\theta = 1$. The results of this second exercise must be regarded with particular caution, however, because our parameter estimates are probably more reliable for analyzing local than global changes.

The first entry in row 1 of Table I shows the average expected pre-tax marginal wage (μ_k) under the <u>status quo</u>, the second when the tax rate is reduced by one-third, and the third when the tax rate is zero. The second row gives the same information for the temporal standard deviation (σ_k) of the wage. Our estimates indicate that to a first approximation, if tax rates were cut by one-third, the average pre-tax wage would increase by about 1.2%, and its variability (measured by the standard deviation) would increase by about 5.0%.[16] Removing taxes altogether would increase the pre-tax wage and its standard deviation by approximately 3.3% and 15.2% respectively.

The third row of the table shows the average change in the expected marginal after-tax wage ($\Delta\theta_k\mu_k$) under the alternative regimes As noted above, this measure is likely to misrepresent the welfare effect of a tax change, because it does not take into account that the variability of the wage stream changes as well. To the extent that individuals are averse to variability, the difference in net wages overstates the welfare change, and vice versa. In row 4, we report

---

[16] As emphasized above, it should be kept in mind that these implications are only approximate, for they ignore any changes in the market locus that might be induced by a general change in taxes.

Table I*

Tax Simulations

		Status Quo	Tax Rate Reduced by One-Third	Tax Rate Equal to Zero
(1)	μ	\$4.77 (0.052)	\$4.83 (0.053)	\$4.93 (0.054)
(2)	σ	\$0.59 (0.017)	\$0.62 (0.017)	\$0.68 (0.020)
(3)	$\Delta(\theta\mu)$	--	\$0.46 (0.0095)	\$1.41 (.029)
(4)	$\Delta \frac{1}{\alpha_1} E_0 V(\cdot)$	--	\$0.36 (0.0068)	\$1.04 (0.019)

*Numbers in parentheses are standard errors of the means. Variables are defined in the text.

the approximate monetary equivalent of the utility change, which takes into account both changes in the mean wage and its variability. This is $\Delta(\frac{1}{\eta_1} E_0 V(\cdot))$, as defined by equation (21).

When taxes are lowered by one-third, the combined effect of the higher pre-tax wage and the lower tax rate is to raise the average expected net wage by \$0.46. The result in row 4 indicates that taking the concomitant increase in wage variability into account lowers the monetary equivalent value of the change to \$0.36. Similarly, the change in the net wage induced by setting tax rates equal to zero, \$1.41, exceeds the monetary equivalent value of \$1.04

We conclude that in the long run, tax reductions would induce increases in both pre- and post-tax wage rates. However, due to simultaneous increases in the variability of wages, measuring the welfare effects by merely comparing changes in net wages would substantially overestimate the welfare gain to individuals.

V. Conclusions

We have examined how taxes affect the trade-off between the expected level of the wage and its variance. The data we examine indicate that reductions in tax rates would lead to a substantial increase in the level and variability of people's pre-tax wages. Given the absence of any earlier analyses of this kind, it is difficult to say whether or not effects of the magnitude we have found are "reasonable". To us, they seem well within the bounds of possibility.

A considerable amount of sensitivity analysis was done to assure that our substantive results were not too dependent on particular choices of functional forms. Nevertheless it may be the case that generalizing the theoretical framework could change the outcome. Several possibilities are worth pursuing:

1. In our model, the variability-return locus is invariant with respect to changes in the tax rate. Although partial equilibrium analysis of the relationship between taxes and risk-taking has a long tradition (see Tobin [1958]), ideally one would want to analyze how the locus itself would shift in response to changes in tax rates.

2. The analysis ignores the interaction between financial portfolio and occupational decisions. It might be, for example, that people can buy assets whose returns are negatively correlated with their wages, and thereby hedge their risks.[17]

3. The individual's decision is taken in isolation from ~~the~~ labor supply behavior of other family members. There is a substantial literature suggesting that husbands' and wives' hours of work decisions are made jointly. It would be interesting to examine whether or not spouses choose "job portfolios" which allow family variability to be diminished.

[17] Landskroner [1977] discusses the theoretical issues that surround this problem.

APPENDIX

Theory does not give much guidance with respect to the appropriate functional form for the market locus. In this appendix, we report two alternatives to the specification (13) described in the text.

1. Instead of a quadratic in σ, its logarithm is entered:

$$\ln \mu = \underset{(0.082)}{4.1443} + \underset{(0.0037)}{0.0566ED} + \underset{(0.00497)}{0.0379EXP} - \underset{(0.0000945)}{0.000554EXP^2} + \underset{(0.0135)}{0.192} \ln \sigma$$

$$R^2 = 0.55$$

The elasticity of μ with respect to σ is 0.192, a bit below the figure of 0.23 generated by the equation in the text.

2. The level of the mean wage, rather than its logarithm, is the dependent variable. Interactions between education and experience are included to allow for non-linearities:

$$\ln \mu = \underset{(124.53)}{172.16} - \underset{(14.01)}{27.91ED} + \underset{(0.45)}{1.75}\, ED^2 + \underset{(4.26)}{9.77EXP} - \underset{(0.052)}{.230}\, EXP^2 + \underset{(0.214)}{.583}\, EXP \cdot ED$$

$$+ \underset{(0.262)}{2.39}\, \sigma - \underset{(0.001)}{.00322}\, \sigma^2$$

$$R^2 = 0.55$$

The elasticity evaluated at the mean is 0.25

BIBLIOGRAPHY

Abowd, John and Orley Ashenfelter, "Anticipated Unemployment, Temporary Layoffs and Compensating Wage Differentials", Princeton University, Industrial Relations Section Working Paper #137, June 1980.

Brown, Charles, "Equalizing Differences in the Labor Market", Quarterly Journal of Economics, February 1980, pp. 113-134.

Feldstein, Martin S., "The Effects of Taxation on Risk Taking", Journal of Political Economy 77, 1969, pp. 755-764.

Hall, Robert, "The Importance of Lifetime Jobs in the U.S. Economy", American Economic Review 72, No. 4, September 1982, pp. 716-724.

Heckman, James and Robert Willis, "A Beta-logistic Model for the Analysis of Sequential Labor Force Participation by Married Women", Journal of Political Economy, February 1977, pp.27-58.

Johnson, William R., "The Effect of a Negative Income Tax on Risk-Taking in the Labor Market", Economic Inquiry, 18, July 1980, pp. 395-407.

Landskroner, Yoram, "Nonmarketable Assets and the Determinants of the Market Price of Risk", Review of Economics and Statistics, LIX, 4, November 1977, pp. 482-492.

MaCurdy, Thomas E., "An Empirical Model of Labor Supply in a Life-Cycle Setting", Journal of Political Economy 89, December 1981, pp. 1059-1085.

Mincer, Jacob, "The Distribution of Labor Incomes: A Survey with Special Reference to the Human Capital Approach", Journal of Economic Literature, VII, No. 1, March 1970, pp. 1-26.

Mood, Alexander M., Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, McGraw-Hill: New York, 1974.

Rosen, Sherwin, "Hedonic Prices and Implicit Markets", Journal of Political Economy 82, 1974, pp. 34-55.

Tobin, James, "Liquidity Preference as Attitude Toward Risk", Review of Economic Studies 25, February 1958, pp. 65-86.

Weiss, Yoram, "The Risk Element in Occupational and Educational Choices", *Journal of Political Economy* LXXX, November 1972, pp. 1203-1213.