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INTERTEMPORAL LABOR SUPPLY AND LONG TERM EMPLOYMENT CONTRACTS

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ABSTRACT

In this paper we compare the implications of a symmetric information contracting model and a dynamic labor supply model for changes in individual earnings and hours over time. The critical distinction between these models is whether earnings represent optimal consumption or payment for current labor services. We develop a simple test between labor supply and contracting models based on the relative variability of earnings and hours with respect to changes in productivity. If earnings represent consumption then changes in productivity generate smaller changes in earnings than hours. The opposite is true in the labor supply model. We apply our test to longitudinal data on male household heads from the Panel Study of Income Dynamics and the National Longitudinal Survey of Older Men, focusing on individuals who do not change employers during the survey period. Neither model fits the data well. In both surveys, however, the contribution of changes in productivity to changes in earnings is greater than the contribution to changes in hours. The data are more consistent with a labor supply interpretation, although the estimated labor supply elasticities suggest that changes in hours occur at fixed wage rates.

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Despite rapid progress over the last decade in modeling employment contracts[1/] and recent evidence on the importance of long-term jobs in the economy,[2/] microeconomic studies of labor supply continue to interpret individual hours and earnings data in terms of an auction model of the labor market.[3/] Traditional labor supply analysis assumes that earnings represent the product of desired hours and market wage rates. Contracting models, on the other hand, interpret earnings as optimal consumption for the payment period, including savings and insurance payments from firms to workers.[4/] If savings and insurance are important components of earnings, then average hourly earnings provide noisy information on underlying productivity.[5/] Contract models, therefore, offer a simple explanation for the weak link between wage rates and hours that has confounded empirical studies of intertemporal labor supply.[6/]

In this paper we compare the implications of life cycle labor supply models and intertemporal contracting models for changes in individual earnings and hours over time.[7/] We consider a standard dynamic labor supply model in which individuals have access to complete capital markets. We compare this model to a symmetric information labor contracting model in which employees receive complete insurance from their employers. The critical distinction between the labor supply and contracting models is whether earnings represent optimal consumption or the product of wage rates and hours of work. We develop a simple test between labor supply and contracting models based on the variability of earnings with respect to changes in productivity. If earnings represent the product of wages and hours, then changes in productivity generate bigger changes in earnings than hours. If earnings represent consumption, on the other hand, then changes in productivity generate smaller changes in earnings than hours, provided that leisure is a normal good.

This simple test is complicated by changes in wealth that may occur with changes in productivity. For employees who are covered by implicit contracts, however, wealth changes are ruled out by the form of the optimal contract, which provides complete insurance against productivity risks. We therefore propose the following test of the implicit contract model: compare the relative contribution of productivity shocks to changes in earnings and changes in hours for workers who are observed on the same job over time. If, as the intertemporal contracting model suggests, these workers are fully insured, then the contribution of productivity shocks to changes in earnings should be smaller than the contribution of productivity shocks to changes in hours. If the labor supply model is correct, then the contribution of these shocks to changes in earnings should be greater than the contribution to changes in hours.

Our empirical analysis is conducted with data from the Panel Study of Income Dynamics (PSID) and the National Longitudinal Survey of Older Men (NLS). To focus attention on workers who are potentially covered by long term contracts, we compare individuals who have the same employer during the sample period and individuals who change employers at least once. We find that earnings and hours changes are substantially less variable for individuals with the same employer. For both groups of workers, however, the contribution of productivity shocks to earnings is greater than the contribution to hours. We conclude that earnings and hours changes of long term employees are consistent with complete intertemporal contracting only if one is prepared to accept that leisure is a nonnormal good. The same data are consistent with an intertemporal labor supply model, however, only if one is prepared to accept large intertemporal substitution elasticities and significant differences between those who change employers and those who do not.[8/] Neither a symmetric information contracting model nor a dynamic labor supply model with complete capital markets is likely to provide a complete description of individual labor market outcomes.

The first section of the paper presents a simple theoretical analysis of intertemporal contracting and intertemporal labor supply. For both models we derive the theoretical implications of aggregate shocks, changes in tastes, productivity variation, and survey measurement error for the variances and covariances of earnings and hours changes. These theoretical models provide the basis for our empirical analysis.

In the second section of the paper we show how to estimate the theoretical models using the variances, autocovariances, and cross-covariances of earnings and hours changes from individual longitudinal data. A two-factor variance components model provides a convenient framework for distinguishing productivity changes from other sources of earnings and hours variation, including changes in tastes and measurement error.

In the third section of the paper we summarize the data from both surveys and present estimates of the structural parameter that distinguishes the contracting and labor supply models. The covariance structure of earnings and hours changes is remarkably similar in the two surveys. Our main finding is that productivity variation affects earnings at least as much as hours. This is true for individuals who have the same employer in all years and for those who change employers. The data therefore provide some evidence against a contracting interpretation, although they suggest that productivity-related changes in earnings and hours occur at more or less fixed wage rates.

I. Earnings and Hours Under Long Term Contracting Models and Life Cycle Labor Supply Models

In this section we present a simple dynamic model of earnings and hours determination under long term employment contracts. We also present a model of earnings and hours determination under a standard life cycle labor supply framework. We make identical environmental and preference assumptions in both models. For the contracting model we assume that employers have access to complete capital and insurance markets. For the labor supply model we assume that individuals have direct access to these markets. The resulting empirical models encompass existing symmetric information contracting models and dynamic labor supply models. Our empirical models, therefore, contrast a widely-used version of the intertemporal labor supply model with a class of testable contracting models.

Individual productivity is modeled as a random variable drawn from a sequence of distributions that are common knowledge for both workers and firms. Productivity is the only source of uncertainty in the model. Apart from firm-specific training and recruiting costs, individuals are equally productive at all firms. Long term attachments between workers and firms arise from two sources: the desire to avoid recurrent training costs, which occurs in either the contracting or labor supply model; and the desire to smooth consumption vis-a-vis productivity, which is associated with long term attachments in the contracting model.

Preferences for consumption and leisure within periods are modeled as a general function of consumption, hours of work, and age. Preferences are assumed to be additively separable over time and across states of productivity. The worker's intertemporal objective is to maximize the expected discounted value of life-time utility. In the contracting model the expectation is taken over the distribution of individual productivities. In the labor supply model the expectation is taken over the distribution of market wages, which is assumed to be identical to the distribution of individual productivities.

Let θ_t represent the productivity of a given individual in period t.[9/] Assume that θ_t is distributed on the interval (θ_ℓ, θ_u) according to a known distribution function $F_t(\theta_t \mid \theta_0)$, given productivity in a planning period $t=0$. Let $u(c_t(\theta_t), h_t(\theta_t), t)$ represent a concave von Neumann-Morgenstern utility function over consumption (c) and hours of work (h) in period t. Let the utility discount rate be ρ. The worker's objective is to maximize expected utility denoted by:

$$(1) \quad \sum_{t=0}^{T} \left(\frac{1}{1+\rho}\right)^t \int_{\theta_\ell}^{\theta_u} u(c_t(\theta_t) , h_t(\theta_t) , t) \, dF_t(\theta_t \mid \theta_0) ,$$

where T represents a fixed planning horizon.

Consider the long term contracting model first. Firms offer contracts consisting of contingent labor demand functions $h_t(\theta_t)$ and contingent earnings functions $g_t(\theta_t)$ for $t=1, \ldots, T$. Since workers have no access to capital markets, $g_t(\theta_t) = c_t(\theta_t)$ for all t. If productivity is θ_t in period t, the firm's revenues are $\theta_t h_t(\theta_t)$ and its costs are $g_t(\theta_t)$. We assume that θ_t is observable and, therefore, contracts are fully enforceable. We also assume that firms are risk neutral and can borrow and lend at the constant real interest rate r.[10/] Competition among firms for the services of a worker with the sequence of productivity distributions $\{F_t(\theta_t \mid \theta_o)\}$ implies that contracts offered to that worker have expected present value equal to the training costs, R, for that worker:

$$(2) \quad \sum_{t=0}^{T} \left(\frac{1}{1+r}\right)^t \int_{\theta_\ell}^{\theta_u} [\theta_t h_t(\theta_t) - g_t(\theta_t)] \, dF_t(\theta_t \mid \theta_0) = R .$$

Pointwise optimization of the Lagrangian expression for the maximization of (1), subject to (2), leads to the first order conditions:

$$(3a) \quad \left(\frac{1+r}{1+\rho}\right)^t u_c(c_t(\theta_t) , h_t(\theta_t) , t) - \lambda = 0$$

$$(3b) \quad \left(\frac{1+r}{1+\rho}\right)^t u_h(c_t(\theta_t) , h_t(\theta_t) , t) - \lambda\theta_t = 0 ,$$

where u_c and u_h represent the partial derivatives of $u(.,.,.)$ with respect to c and h, and λ represents the multiplier associated with the constraint (2). Equations (3a) and (3b) have the familiar implications that the marginal utility of consumption follows a deterministic trend, while the marginal rate of substitution between consumption and leisure equals θ_t for each realization of productivity.

Differentiation of the first order conditions (3a) and (3b) yields:

$$(4) \quad \frac{\partial \log h_t}{\partial \log \theta_t} - \frac{\partial \log h_t}{\partial \log \nu_t} = \frac{c_t}{\theta_t h_t} \frac{\partial \log c_t}{\partial \log \theta_t}$$

where $\nu_t \equiv \lambda((1+\rho)/(1+r))^t$. To understand the implications of equation (4), consider the log-linear approximation to the solution of equations (3a) and (3b):

$$(5a) \quad \log c_t = \phi \log \theta_t - \alpha \log \nu_t + a_t ,$$

$$(5b) \quad \log h_t = \eta \log \theta_t + \delta \log \nu_t + b_t ,$$

where a_t and b_t are terms in the log-linear approximation that do not depend on θ_t or ν_t. The parameter ϕ represents the substitution elasticity between consumption and leisure holding constant the marginal utility of wealth: the sign of ϕ depends on the sign of u_{ch}. If the permanent income hypothesis is correct, for example, then $\phi=0$ and consumption is independent of productivity. The parameter η represents the elasticity of substitution of labor supply over time and across states of θ; therefore, $\eta > 0$. The parameter $-\alpha$ represents the elasticity of consumption demand and respect to the marginal utility of wealth; if consumption is a normal good, then $\alpha > 0$.[11/] Finally, the parameter δ represents the elasticity of labor supply with respect to the marginal utility of wealth; if leisure is a normal good, then $\delta > 0$. Since $E[c_t] \cong E[\theta_t h_t]$ by constraint (2),[12/] the restriction (4) implies (to a first order approximation):

$$(6) \quad \mu \equiv \frac{\phi}{\eta} \cong 1 - \delta/\eta \ .$$

The parameter μ represents the relative sensitivity of consumption and hours choices to changes in productivity. Even in the absence of direct information on productivity, μ is identifiable from information on the relative variability of earnings and hours. If $\mu > 1$, then $\delta < 0$; that is, if consumption is more variable than hours with respect to changes in productivity, then leisure is an inferior good. If $\delta > 0$ is treated as a maintained hypothesis, then the intertemporal contracting model presents one testable implication: namely, that changes in productivity influence hours at least as much as earnings, on average.

Now consider the intertemporal labor supply model. We assume that workers have access to risk-neutral insurance and capital markets so that the life cycle budget constraint can be replaced by its expectation:[13/]

$$(7) \quad \sum_{t=0}^{T} \left(\frac{1}{1+r}\right)^t \int_{\theta_\ell}^{\theta_u} [\theta_t h_t(\theta_t) - c_t(\theta_t)] \, dF_t(\theta_t \mid \theta_0) = 0 \ .$$

The first order conditions for the maximization of (1) subject to the constraint (7) are identical to (3a) and (3b). Labor earnings, however, are now described by $g_t(\theta_t) = \theta_t h_t(\theta_t)$. The log-linear form of the solution for g_t and h_t becomes:

$$\text{(8a)} \quad \log g_t = (1+\eta) \log \theta_t + \delta \log \nu_t + b_t$$

$$\text{(8b)} \quad \log h_t = \eta \log \theta_t + \delta \log \nu_t + b_t \; .$$

Under the labor supply interpretation of earnings and hours the parameter μ is given by:

$$\text{(9)} \quad \mu \equiv \frac{1+\eta}{\eta} \; .$$

Since earnings represent the product of wages and hours in the labor supply model, earnings must respond <u>more</u> than hours to changes in productivity.

Our analysis of the contracting model shows that the elasticity of earnings with respect to productivity is less than the elasticity of hours with respect to productivity if leisure is a normal good. Our analysis of the intertemporal labor supply model shows that the relation between these elasticities is reversed under identical assumptions.[14/] In the next section we develop a statistical model for estimating the critical parameter μ, the ratio of the two elasticities.

II. Econometric Models for the Covariance Structure of Earnings and Hours Changes

Our empirical strategy is to use equations (5) and (8) as the basis for a description of the sources of variation in earnings and hours over time. Individual productivity enters as an unobserved component of variance in both earnings and hours. Other components include variation in preferences for consumption and leisure, and survey measurement error. We derive the implications of this variance components model for the covariance structure of earnings and hours changes in longitudinal survey data. Since the sample covariances are easily computed, it is straightforward to summarize the empirical success or failure of the model in terms of its actual fit to the data.

The first step is to express equations (5a) and (5b) in first difference form taking account of individual-specific components. Since earnings are identical to consumption in the contracting model, we substitute $\log g_t$ for $\log c_t$. Let $\Delta \log g_{it}$ and $\Delta \log h_{it}$ represent the changes in the logarithms of real annual earnings and annual hours for individual i between periods $t-1$ and t, respectively. Append a survey measurement error u^*_{it} to the expression for for $\log g_{it}$ and a survey measurement error v^*_{it} to the expression for for $\log h_{it}$. Then, equations (5) imply:

(10a) $\Delta \log g_{it} = \phi \, \Delta \log \theta_{it} - \alpha \, (\rho - r) + \Delta \, a_{it} + \Delta \, u^*_{it}$

(10b) $\Delta \log h_{it} = \eta \, \Delta \log \theta_{it} + \delta \, (\rho - r) + \Delta \, b_{it} + \Delta \, v^*_{it}.$

Since employers can perfectly insure individual productivity variation, changes in the discounted marginal utility of wealth only contribute the constant $(\rho - r)$ to equations (10a) and (10b). In the labor supply model the equation for the change in hours is identical to (10b). The equation for the change in earnings in the labor supply model, however, is

(11) $\Delta \log g_{it} = (1+\eta) \, \Delta \log \theta_{it} + \delta \, (\rho - r) + \Delta \, b_{it} + \Delta \, u^*_{it}$

Equations (10a) and (11) are very similar. The statistically identifiable difference between the models arises from the different coefficients on the change in individual productivity. To clarify this point, we complete the model by specifying the covariance structure of $\log \theta_{it}$, a_{it} , b_{it} , u^*_{it} , and v^*_{it} .

We adopt a linear specification for individual productivity consisting of a permanent individual effect (θ_i) , an aggregate time effect (d_t) , a quadratic labor force experience effect, and a purely stochastic component (z_{it}):

$$\log \theta_{it} = \theta_i + d_t + \zeta_\theta x_{it} + 1/2\ \xi_\theta x_{it}^2 + z_{it} ,$$

where x_{it} represents the labor force experience of individual i at the beginning of year t. Since labor force experience increases by one each year, the change in the logarithm of individual productivity is:

$$(12)\quad \Delta \log \theta_{it} = \kappa_{\theta t} + \xi_\theta x_{i0} + \Delta z_{it} ,$$

where x_{i0} represents the labor force experience of individual i at the beginning of the survey and $\kappa_{\theta t}$ is a time effect that incorporates the change in the aggregate productivity shock as well as the change in average labor force experience.[15]

In a similar fashion, we assume that the preference variations (a_{it} and b_{it}) contain permanent individual effects, aggregate time effects, quadratic experience effects, and stationary, serially uncorrelated random components:

$$a_{it} = a_i + a_t + \zeta_a x_{it} + 1/2\ \xi_a x_{it}^2 + \varepsilon_{ait}$$

$$b_{it} = b_i + b_t + \zeta_b x_{it} + 1/2\ \xi_b x_{it}^2 + \varepsilon_{bit} .$$

These specifications permit individual preferences for consumption and leisure to exhibit homogeneous curvature over the lifecycle. The vector of deviations from the life cycle profile of preferences $(\varepsilon_{ait}, \varepsilon_{bit})$ is assumed to be independent and identically distributed for all i and t with an unrestricted contemporaneous covariance matrix. The first differences of the preference variations can be written as:

(13a) $\Delta a_{it} = \kappa_{at} + \xi_a x_{i0} + \Delta \varepsilon_{ait}$

(13b) $\Delta b_{it} = \kappa_{bt} + \xi_b x_{i0} + \Delta \varepsilon_{bit}$,

where κ_{at} and κ_{bt} are composite time effects that incorporate changes in a_t and b_t as well as changes in average labor force experience.[16/]

Finally, we assume that the vector of survey measurement errors (u^*_{it}, v^*_{it}) contains permanent and purely transitory errors:

$$u^*_{it} = u^*_i + \varepsilon_{uit}$$

$$v^*_{it} = v^*_i + \varepsilon_{vit} .$$

The permanent errors, represented by u^*_i and v^*_i, model systematic deviations of the survey instrument from the theoretically appropriate concepts. We assume that the vector of transitory errors, $(\varepsilon_{uit}, \varepsilon_{vit})$, is independent and identically distributed with an unrestricted contemporaneous covariance matrix. The first differences of the measurement errors can be written as:

(14a) $\Delta u^*_{it} = \Delta \varepsilon_{uit}$

(14b) $\Delta\, v^*_{it} = \Delta\, \varepsilon_{vit}$.

Equations (14a) and (14b) indicate that only the transitory measurement errors contribute to the covariance structure of earnings and hours changes. Permanent response biases are eliminated by first-differencing.

Apart from time effects, preference variation and survey measurement errors are statistically indistinguishable, since the first differences of both components represent first differences of uncorrelated vectors. For simplicity, we combine the preference variation components, $\Delta\, \varepsilon_{ait}$ and $\Delta\, \varepsilon_{bit}$, with the survey measurement error components, $\Delta\, \varepsilon_{uit}$ and $\Delta\, \varepsilon_{vit}$ to form a single vector of variance components $(\Delta\, u_{it}\, , \Delta\, v_{it})$. In the labor contract model, the preference variation and measurement error components of variance in earnings and hours changes is given by:

(15a) $\Delta\, u_{it} = \Delta\, \varepsilon_{ait} + \Delta\, \varepsilon_{uit}$

(15b) $\Delta\, v_{it} = \Delta\, \varepsilon_{bit} + \Delta\, \varepsilon_{vit}$.

In the labor supply model, on the other hand, the preference variation and measurement error component of variances in earnings and hours is given by:

(15a') $\Delta\, u_{it} = \Delta\, \varepsilon_{bit} + \Delta\, \varepsilon_{uit}$

(15b') $\Delta\, v_{it} = \Delta\, \varepsilon_{bit} + \Delta\, \varepsilon_{vit}$.

In either case, the vector $(\Delta\, u_{it}\, , \Delta\, v_{it})$ is independently and identically distributed across individuals with an arbitrary contemporaneous covariance matrix and a known autocovariance structure. Specifically, the vector $(\Delta u_{it}, \Delta v_{it})$ is a bivariate first order moving average process with first order autocorrelations equal to $-1/2$.[17/] This simple autocorrelation structure reflects the following observation: if y_t is serially uncorrelated with variance σ^2, then the variance of Δy_t is $2\sigma^2$, the covariance of Δy_t with Δy_{t-1} is $-\sigma^2$, and changes in y_t more than one period apart are uncorrelated.

Combining equations (12)-(15), the equations for the changes in log earnings and log hours in the labor contracting models can be simplified to:

$$\text{(16a)} \quad \Delta \log g_{it} = \kappa_{gt} + \xi_g x_{i0} + \phi \Delta z_{it} + \Delta u_{it}$$

$$\text{(16b)} \quad \Delta \log h_{it} = \kappa_{ht} + \xi_h x_{i0} + \eta \Delta z_{it} + \Delta v_{it},$$

where κ_{gt} and κ_{ht} combine the aggregate time effects of equations (12) and (13); ξ_g and ξ_h combine the linear labor force experience effects of equations (12) and (13); Δu_{it} and Δv_{it} combine the preference variation and survey measurement errors as in equation (15); and Δz_{it} represents the individual productivity variation from equation (12). For the labor supply model, the hours equations is the same as (16b). The equation for earnings, on the other hand, becomes

$$\text{(17)} \quad \Delta \log g_{it} = \kappa'_{gt} + \xi'_g x_{i0} + (1+\eta) \Delta z_{it} + \Delta u_{it},$$

where κ'_{gt} combines the aggregate time effects of equations (12) and (13), and ξ'_g combines the linear labor force experience effects of changes in productivity and preferences. In general, the year effects κ_{gt} and κ'_{gt} and the experience slopes ξ_g and ξ'_g are different in (16a) and (17).

Neither the labor supply model nor the labor contracting model, however, imposes any restrictions on the year effects or experience slopes of equations (16) and (17). Under our assumptions, individual productivity changes and preference variations contribute three unrestricted time effects ($\kappa_{\theta t}$, κ_{at}, and κ_{bt}) to the changes in log earnings and log hours in the labor contract model, or two unrestricted time effects ($\kappa_{\theta t}$, κ_{bt}) in the labor supply model. The cross-sectional means of $\Delta \log g_{it}$ and $\Delta \log h_{it}$ in period t (controlling for experience) are sufficient to estimate only two linear combinations of these effects (κ_{gt} and κ_{ht}). Similarly, there are three unrestricted labor force experience effects (ξ_θ, ξ_a, and ξ_b) in the labor contract model, or two unrestricted experience effects (ξ_θ, ξ_b) in the labor supply model. Again, however, we can only identify two experience slopes (ξ_g and ξ_h).[18/] Therefore, the coefficients of the multivariate regression of individual i's changes in log earnings and log hours on time effects and initial labor force experience are unrestricted by either model.[19/]

Equations (16) and (17) do, however, provide a simple two-factor model for the residuals from the regression of changes in individual earnings and hours on time effects and labor force experience. According to these equations, unpredicted changes in earnings and hours contain a time-stationary preference and measurement error component, with a known autocorrelation structure, and a productivity component, with an arbitrary autocorrelation structure.

The relative contribution of productivity changes to earnings and hours changes depends on the parameters ϕ and η. In the absence of direct information on the variance of individual productivity shocks these parameters are not separately identifiable from the covariance structure of earnings and hours changes. The critical parameter μ, which measures the relative contribution of productivity changes to earnings as compared to hours is over-identified, however. First, μ is identifiable if changes in earnings and hours exhibit second-order or higher autocorrelation, since the preference variation and measurement error component only contributes first order autocorrelation. Second, μ is identifiable if the first order autocorrelations of earnings and hours changes are not identically equal to $-1/2$, since the preference variation and measurement error component has all first order autocorrelations equal to $-1/2$. Third, μ is identifiable if the autocovariances and cross-covariances of earnings and hours changes are not time-stationary, since the preference variation and measurement error component is assumed to be stationary.

While μ is identifiable from the covariance structure of earnings and hours changes, the variance contributions of changes in productivity, preference shifts and measurement errors are not separately identifiable. All components contribute to the variances and first-order autocovariances of changes in earnings and hours. It is impossible to determine their separate contributions without further assumptions on either the serial correlation properties of the productivity shocks, or the correlations of the measurement errors and preference variations.

Table 1 displays the theoretical formulas for the autocovariances and cross-covariances of earnings and hours changes implied by equations (16) and (17). The variables $\Delta \log \tilde{g}_{it}$ and $\Delta \log \tilde{h}_{it}$ are defined as the deviations of $\Delta \log g_{it}$ and $\Delta \log h_{it}$, respectively, from their conditional means given t and x_{i0}. We refer to these variables as experience-adjusted changes in log earnings and log hours. The formulas are written in terms of the parameter μ so that they apply to either the contracting or labor supply model.[20/] Table 1 shows how the covariance structure of earnings and hours changes depends on the covariance structure of individual productivity changes (Δz_{it}), the covariance structure of the preference variation and measurement error process (Δu_{it} and Δv_{it}) and μ. The formulas in Table 1 form the basis for our empirical test of the contracting model versus the labor supply model.

III. A Test of the Contracting Model Versus the Labor Supply Model Using Longitudinal Data on Adult Males

The longitudinal earnings and hours data used in this paper are drawn from the Panel Study of Income Dynamics and the National Longitudinal Survey of Older Men. From the PSID we selected 1448 male household heads whose records indicate nonzero earnings and hours in each year from 1969 to 1979 (the third through thirteenth waves of the survey). We included only those male household heads who were between the ages of 21 and 64 in all eleven sample years. The "one-employer" subsample was defined on the basis of answers to the questions about present employment status and reason for changing employment status. If an individual was currently employed or temporarily laid off and reported having the same job at least one year (including promotions), then the individual was considered to have the same employer as in the previous year. An individual with the same employer as in the previous year for all years from 1970 to 1979 was included in the one-employer subsample. There were 618 individuals who satisfied this condition. The remaining 830 individuals were included in the "multiple-employers" subsample. Every member of the multiple-employers subsample experienced at least one change of employer during the period from 1969 to 1979. Table 2 presents means and standard deviations of the changes in log real annual earnings, and log annual hours, as well as basic demographic variables for the PSID sample and subsamples.

From the National Longitudinal Survey of Older Men we selected 1309 men whose records indicate nonzero earnings and hours for each of the years 1966, 1967, 1969, 1971, 1973, and 1975.[21/] We included only those males who were between the ages of 45 and 64 in all six sample years. The one-employer subsample was defined on the basis of the number of years the individual had worked for his current employer in 1971 and whether or not the individual worked for a different employer in 1973 or 1975. An individual who had worked for his current employer at least 5 years in 1971 and who did not change employers in either 1973 or 1975 was included in the one-employer subsample. All others were included in the multiple-employers subsample. Means and standard deviations for the NLS sample are also presented in Table 2. For the interpretation of the NLS data, it is important to note that later waves of the survey were administered biennially. The changes in earnings and hours from 1969 to 1975 refer to changes in annual totals differenced over two-year intervals. These changes are not reported at annual rates in Table 2.

Table 2 shows that average age and potential labor force experience (age minus years of education minus five) differ substantially between the PSID and NLS samples because of design differences in the underlying surveys. The NLS workers are an average of 13.3 years older and 15.5 years more experienced than the PSID workers. We experience-adjust all subsequent calculations in this paper to correct for systematic differences between the PSID and NLS samples arising from this difference in labor force experience. Both surveys also over-sampled nonwhites. The percentage of nonwhites is similar in our two samples, however, and we make no further adjustments to account for the small difference in racial composition between them.[22/] There are no important differences in age, labor force experience or percentage nonwhite between the one-employer and multiple-employers subsamples of either survey.

Table 2 reveals three striking features of the individual earnings and hours data from our two samples. First, the overall pattern of changes in earnings and hours is similar in the two surveys. This conclusion applies when comparing all individuals, individuals with one employer, and individuals with multiple employers. The older sample (NLS) experienced slightly larger changes (in absolute value) during the 1973 to 1975 period than the younger sample (PSID). Individuals in the multiple-employer subsample of each survey experienced substantially larger changes during this period than those in the one-employer subsamples. Second, there is significant nonstationarity in the standard deviations of changes in earnings and hours. In the PSID sample earnings and hours changes are most variable in the 1975-1976 period and least variable in the 1972-1973 period. In the NLS sample these changes are most variable in the 1973-1975 period and least variable in the 1969-1971 period. This pattern of nonstationarity is apparent in the one-employer and multiple-employers subsamples of both surveys. Third, the standard deviations of earnings and hours changes for the one-employer subsample are much smaller than the standard deviations for the multiple-employers subsample of both surveys. Individuals who do not change employers experience less variability in earnings and hours compared to individuals who change employers.[23/]

Our theoretical analysis of the contracting and labor supply models focuses on their implications for the autocovariances and cross-covariances of earnings and hours changes. Table 3 presents the average cross-covariances of the PSID and NLS samples.[24/] The similarity between the two samples extends to their covariance structure. Both samples and all the subsamples exhibit strong positive correlations between contemporaneous changes in earnings and hours, and strong negative autocorrelation in earnings and hours changes. This similarity is even more remarkable since the PSID data represent year-to-year changes, while the NLS data represent changes in annual data over two-year intervals.

In contrast to the first-order autocovariances of earnings and hours changes, the second-order autocovariances are relatively small, although nonzero in the PSID at least. The higher-order autocovariances (not reported in Table 3) are generally small and mixed in sign. Row 12 of Table 3 contains the test statistics for a test that the third- and higher-order autocovariances of earnings and hours changes are jointly equal to zero. This hypothesis is not rejected for any of the NLS samples or the complete PSID sample. These samples are therefore consistent with a (nonstationary) bivariate second-order moving average (MA(2)) model of earnings and hours changes.[25/] There is some evidence of third- and higher-order serial covariation in the one-employer and multiple-employers subsamples of the PSID. These covariances are of trivial magnitude, however, and we choose to assume that they are zero in the interest of parameteric simplicity.[26/]

For both complete samples and for all the subsamples except the one-employer subsample of the NLS there is strong evidence of nonstationarity in the covariances of earnings and hours changes. The goodness-of-fit of a stationary model of the cross-covariances of earnings and hours (up to second order) is recorded in the last row of Table 3. Judging by these test statistics, at least one of the variance components generating the changes in earnings and hours in the PSID and NLS surveys is nonstationary.

Table 3 also shows that the first-order autocorrelations of earnings and hours changes are negative but smaller than 1/2 in absolute value for both samples and all the subsamples.[27/] Similarly, the ratios of the first-order cross-covariances of earnings and hours changes to their corresponding zero-order covariances are all negative and smaller than 1/2 in absolute value.[28/] In the framework of our two factor model, the fact that these autocorrelations are smaller than 1/2 in absolute value is evidence of a productivity component in earnings and hours. A pure measurement error model of the data implies that these autocorrelations are all exactly equal to -1/2.

To summarize the evidence in Table 3, the covariance structure of changes in earnings and hours is consistent with a second-order bivariate moving average model. Third- and higher-order autocovariances and cross-covariances are approximately zero in both the PSID and NLS surveys. In addition, both samples and all the subsamples (i) exhibit second-order serial correlation, (ii) exhibit covariance nonstationarity, and (iii) have first-order autocorrelations less than 1/2 in absolute value. Since any one of these three conditions is sufficient to identify the relative contribution of productivity shocks to earnings as compared to hours, the parameter μ is empirically identified.

Table 1 describes the expected values of the variances, autocovariances, and cross-covariances of experience-adjusted earnings and hours changes in terms of the autocovariance structure of individual productivity and the covariance structure of preference variation and measurement error. Estimation of μ and tests of the goodness-of-fit of the statistical model described in Table 1 require that we parameterize the autocovariance structure of individual productivity changes. We use two different parameterizations. In the first case we assume that Δz_{it} is a stationary second-order moving average.[29/] In the second case we assume that Δz_{it} is a nonstationary second-order moving average.[30/] If individual productivity is stationary, the bivariate process for earnings and hours changes described in Table 1 is stationary. While we have strong evidence against a stationary covariance structure, the advantage of a stationary model is that the sufficient statistics for estimation of the structural parameters are just the average variances and covariances reported in Table 3. If individual productivity is a nonstationary second-order moving average, on the other hand, the sufficient statistics for estimation of the structural parameters are all the elements of the complete covariance matrix of earnings and hours changes up to second order. In both cases, we use the method of moments estimator based on minimizing the distance between the sample covariance matrix and the theoretical covariance matrix implied by Table 1 to estimate μ and the goodness-of-fit of the structural models.[31/]

Table 4 reports the goodness-of-fit and the estimates of μ from both samples and all subsamples.[32/] The upper panel of the Table contains the estimates for a stationary parameterization of individual productivity changes. The goodness-of-fit statistics are large, even in comparison to the goodness-of-fit statistics for an unrestricted stationary covariance model (reported in the last row of Table 3). The estimates of μ are all in excess of one, and are actually larger for the one-employer subsamples than for the multiple-employer subsamples or the overall samples. The estimates of μ for the one-employer samples are relatively imprecise, however, and one is within two standard errors of both estimates.

The lower panel of Table 4 contains the estimates of μ and the goodness-of-fit statistics for a non-stationary parameterization of individual productivity changes. This model fits the data better in all cases, although the estimates of μ are not much affected. The non-stationary model actually provides an acceptable fit to the one-employer subsample of the NLS. For the other subsamples and the two complete samples the two factor model of the covariance structure of earnings and hours changes is rejected.

The point estimates of μ from the one-employer subsamples provide evidence against the intertemporal contracting model of earnings and hours changes, and in favor of the intemporal labor supply model. The associated estimates of the intemporal substitution elasticity (η) are recorded in rows 2 and 5 of Table 4.[33/] In the PSID one-employer sample, the estimates of η from the stationary and nonstationary models are 1.84 and .68, respectively. These estimates are larger than the instrumental variables estimates reported by Altonji (1986) and MaCurdy (1981) for PSID males, although they are based on a very different methodology.[34/] In the NLS one-employer sample, the estimates of η are .29 for the stationary model and .32 for the nonstationary model. These estimates are comparable to other estimates based on individual longitudinal data.

While the results from the one-employer subsamples are relatively favorable to the labor supply interpretation of earnings and hours changes, the results from the multiple-employer samples and the complete samples reveal a difficulty with the labor supply interpretation. In the contracting model, changes in employer represent changes between contracts. The contract model therefore offers a simple explanation for the greater variability of earnings and hours for those who change employers than those who do not. The labor supply model, on the other hand, applies the same model to changes in earnings and hours within and across jobs. The labor supply model by itself does not explain the higher variation in earnings and hours changes for those who change jobs. The labor supply model also predicts the same relative effect of productivity shocks on earnings and hours for job changers and stayers. The point estimates of μ for the multiple-employer subsamples, however, are very different from the estimates based on the one-employer subsamples. In both the PSID and NLS multiple-employer subsamples, μ is precisely estimated and close to, but greater than, one. The implied estimates of the intertemporal substitution elasticity are large and imprecise.

The estimates of μ for individuals who change employers suggest that productivity changes affect earnings and hours proportionately. In other words, for these individuals, hours vary at fixed wage rates. One simple explanation for this finding in the framework of a labor supply model is that individuals cannot fully insure productivity risks. In this case, our estimation strategy confounds changes in productivity and changes in the marginal utility of wealth. Since changes in the marginal utility of wealth influence earnings and hours proportionately in the labor supply model, μ is biased towards one if we incorrectly impose the assumption of complete insurance. In other work, however, we have found that estimates of μ are unaffected by controlling for changes in the marginal utility of wealth (Abowd and Card (1985)). The evidence that changes in earnings and hours occur at constantwage rates is inconsistent with either labor supply models or the contracting models considered in this paper. Fixed wage contract models have been considered by Abowd and Orley Ashenfelter (1981), and applied in the macroeconomics literature by Stanley Fischer (1977) and John Taylor (1980), among others. Our results for the job changers suggest that these models may be useful in the empirical analysis of individual data as well.

Finally, Table 4 also reports parameter estimates for the complete PSID and NLS samples. It is clear from these estimates that the characteristics of the multiple-employer subsamples carry over to the complete samples. In the complete samples changes in productivity have slightly larger effects on earnings than hours, although we cannot easily reject the hypothesis that productivity-induced changes in hours occur at fixed wage rates (i.e., $\mu=1$).

IV. Conclusion

Our goal in this paper was to develop an empirical strategy for testing between intertemporal contracting models and labor supply models. Such a test must rely on the fundamental distinction between contracting and labor supply models: in contracting models earnings represent optimal consumption whereas in labor supply models earnings represent the product of wage rates and hours of work. We derive a testable contrast between the two models based on the relative variability of changes in earnings and changes in hours. If the contracting models is correct, earnings are less variable than hours with respect to changes in productivity. If the labor supply model is correct, the reverse is true.

In order to apply the test, we specify a complete model of earnings and hours variation, including productivity components and components due to changes in tastes and measurement errors. The statistical model implied by either theory is itself testable. This test provides a check on the ability of either theory to explain the covariance properties of earnings and hours changes in longitudinal data.

We apply the model to longitudinal data from the PSID and NLS surveys. Generally speaking, the data are inconsistent with the simple covariance structure implied by either the labor supply or contracting model. Contrary to the implications of the contracting model, the contribution of productivity shocks to earnings as at least as large as the contribution to hours. This is true for individuals with the same employer over the entire period of the PSID and NLS surveys, and also more generally. From the point of view of the labor supply model, however, the implied intertemporal substitution elasticities are large and imprecise. A simpler interpretation of the data is that productivity-related changes in hours occur at fixed wage rates. We conclude that the specification and testing of fixed wage contracting models for individual earnings and hours data should be a high priority for future research.

FOOTNOTES

1/ The recent surveys by Oliver Hart and Sherwin Rosen (1985) contain detailed summaries of the theoretical foundations of implicit contract theory.

2/ See especially Robert Hall (1982) and Katherine Abraham and Henry Farber (1985) for estimates of the distribution of completed job durations in the U.S. economy.

3/ Recent surveys by Mark Killingsworth (1983) and John Pencavel (1985), for example, focus exclusively on auction-market models of labor supply.

4/ All of the symmetric information models reviewed by Hart (1983) and Rosen(1985) take this form. Hall (1980) presents a model in which contractual earnings represent average lifetime productivity.

5/ This point is stressed by Rosen (1985). James N. Brown (1982) analyses the implications of implicit savings and insurance components in earnings. Brown applies his model to aggregate labor market data.

6/ See Killingsworth (1983, pp. 296-301) in particular.

7/ Studies of life cycle labor supply and consumption originate in Franco Modigliani and Richard Brumberg's (1954) analysis of the divergence between planned consumption and earnings over the life cycle and in Milton Friedman's (1957) study of the consumption function.

Robert E. Lucas, Jr. and Leonard Rapping (1969) use a two period model in their influential study of intertemporal substitution and labor supply. Multiperiod labor supply is considered by James Heckman (1974, 1976), Gilbert Ghez and Gary Becker (1975), and many subsequent authors (see in particular Thomas MaCurdy (1981)). The modern analysis of implicit contract models begins with Walter Oi (1962) and Sherwin Rosen (1968). The macroeconomic implications of employment contracts are emphasized by Martin N. Baily (1974), Donald Gordon (1974) and Costas Azariadis (1975).

8/ In our paper "On the Covariance Structure of Earnings and Hours Changes" (1985) we find that this conclusion is not altered by controlling for wealth effects arising from uninsured productivity changes.

9/ For notational simplicity, we suppress the dependence of θ_t on the individual. Randomness of θ_t is over ex ante identical individuals, conditional on θ_0.

10/ Implicitly we are assuming that productivity risks are fully diversifiable. See Rosen (1985, pp. 1153-4) for a discussion of aggregate versus idiosyncratic productivity risks and the implications of nondiversifiability.

11/ A concave utility function implies that λ is a decreasing function of wealth, and therefore that the sign of the derivative of the demand for consumption goods with respect to λ is the same as the sign of the derivative of demand for consumption goods with respect to income.

[12/] This approximation holds for small training costs, R.

[13/] Robert Topel and Finis Welch (1983) refer to this model as a contracting model with self insurance.

[14/] If the worker does not have access to complete insurance markets, the testable implications of intertemporal labor supply models are unchanged, provided that the marginal utility of wealth is held constant. Since changes in productivity may be correlated with changes in the marginal utility of wealth, estimation of μ requires additional structure. (See Abowd and Card, 1985.)

[15/] The effect $\kappa_{\theta t} = \Delta d_t + -1/2\ \xi_\theta + \xi_\theta t$, since $x_{it} - x_{it-1} = 1$ and $x_{it}^2 - x_{it-1}^2 = 2x_{i0} + 2t - 1$, where x_{i0} = labor force experience at the beginning of the first survey period.

[16/] The term $\kappa_{at} = \Delta a_t + \zeta_a + \xi_a t - 1/2\ \xi_a$ and similarly for κ_{bt} .

[17/] This model also implies that the ratio of either first-order cross-covariance (Cov($\Delta \log g_{it}$, $\Delta \log h_{it+1}$) or Cov($\Delta \log g_{it}$, $\Delta \log h_{it-1}$)) to the zero-order covariance (Cov($\Delta \log g_{it}$, $\Delta \log h_{it}$)) is $-1/2$.

[18/] In MaCurdy (1981) and Joseph Altonji (1986), curvature in preferences for hours is ignored and the labor market is assumed to function as a spot market. Under those assumptions, the ratio of the labor force experience coefficient of earnings to the labor force experience coefficient of hours, ξ_g/ξ_h , equals $(1+\eta)/\eta$. This is precisely the instrumental variable estimator for η using labor supply equation (16b), assuming that productivity equals average hourly earnings, and using labor force experience as the instrument for average hourly earnings. For the two samples considered in this paper, the PSID yields an estimate of η equal to 1.52 (with a standard error of .44) and the NLS yields an estimate of η equal to -1.62 (with a standard error of .61) when these assumptions are used.

19/ The experience slopes of earnings and hours changes are actually restricted to be constant over time. Both the contracting model and the labor supply model imply this restriction, given our model for individual productivity and preference variations. The experience slopes from the PSID are consistent with this restriction (χ^2 = 25.80 with 18 degrees of freedom, probability value = .104). The experience slopes from the NLS are not consistent with this restriction (χ^2 = 40.96 with 8 degrees of freedom, probability value $\cong$ 0).

20/ Expressing the covariances as functions of μ requires the definition of $\Delta\tilde{z}_{it} \equiv \eta\, \Delta z_{it}$.

21/ These six survey years were the only waves in which comparable earnings and hours data were collected.

22/ Our PSID sample includes the Survey of Economic Opportunity subsample, which over-sampled low income households. The requirement of eleven years of continuous earnings and hours data, however, eliminates proportionately more low income households from the sample.

[23/] One might ask if variability of earnings and hours changes for the multiple-employers subsamples is similar to the one-employer subsamples if we consider only those years that do not involve employer changes. The answer is yes. In the PSID sample, in which we have annual data sampled at an annual rate, individuals experience substantial variability in earnings and hours changes during the three year period surrounding the change in employer. For the NLS sample, in which we cannot perform such a detailed year-to-year analysis because we have annual data sampled at a biennial rate, it is still true that most of difference in variation between the multiple-employer and one-employer subsamples occurs because of the variability contributed by the period in which the employer change actually occurred. Put differently, most of the added variability in earnings and hours changes for the many-employers sample occurs around the time of employer changes. There is no substantial difference between the one-employer and multiple-employer subsamples when data from employer changes are excluded. See Altonji and Paxson (1985) for a detailed comparison of hours variability between job changers and stayers in the PSID.

[24/] The complete covariance matrix of earnings and hours changes for the PSID contains 210 unique elements; the complete covariance matrix for the NLS contains 55 unique elements. Estimates of these matrices (with standard errors) for the complete samples are contained in Abowd and Card (1985). The covariances reported in Table 3 represent simple averages of the covariances for each year of the PSID or NLS survey.

25/By a nonstationary second order moving average representation we mean that $\mathrm{Cov}(\Delta \log g_{it}, \Delta \log g_{it-j}) = 0$, $\mathrm{Cov}(\Delta \log h_{it}, \Delta \log h_{it-j} = 0)$, $\mathrm{Cov}(\Delta \log g_{it}, \Delta \log h_{it+j}) = 0$, and $\mathrm{Cov}(\Delta \log g_{it}, \Delta \log h_{it-j}) = 0$, for all $j \geq 3$; and all other variances and covariances are unrestricted.

26/One explanation for the lower-order serial correlation of the NLS data as compared to the PSID data is the fact that the NLS data are sampled biennially. If an MA(2) model is appropriate for year-to-year changes, for example, then biennial changes follow an MA(1) model.

27/In the PSID sample the first-order autocorrelations of earnings changes are -.35 (overall), -.42 (one-employer), and -.33 (multiple-employers). In the NLS sample the first-order autocorrelations of earnings changes are -.27 (overall), -.39 (one-employer), and -.27 (multiple-employers). Similarly, the PSID first-order autocorrelations of hours changes are -.30 (overall), -.40 (one-employer), and -.29 (multiple-employers). The NLS first order autocorrelations of hours changes are -.35 (overall), -.46 (one employer), and -.35 (multiple-employers).

28/In the PSID sample the ratios $\mathrm{Cov}(\Delta \log g_{it}, \Delta \log h_{it+1}) / \mathrm{Cov}(\Delta \log g_{it}, \Delta \log h_{it})$ and $\mathrm{Cov}(\Delta \log g_{it}, \Delta \log h_{it-1}) / \mathrm{Cov}(\Delta \log g_{it}, \Delta \log h_{it})$ are -.32 and -.27 (overall), -.46 and -.27 (one-employer), and -.31 and -.28 (multiple-employers), respectively. In the NLS sample these ratios are -.24 and -.16 (overall), -.25 and

-.25 (one-employer), and -.26 and -.18 (multiple-employers), respectively.

29/ In the PSID this results in the addition of three parameters for the productivity process. In the NLS, because of the irregular timing of the survey, this results in the addition of six parameters.

30/ In the PSID this results in 27 parameters for the productivity process. In the NLS this results in twelve parameters for the productivity process.

31/ See Chamberlain (1984) for a discussion of the statistical theory of these estimators, and the comparison between these estimators and the maximum likelihood estimators. Our goodness-of-fit measures are derived in Newey (1985).

32/ Estimation of μ requires one arbitrary normalization of the variance parameters in Table 1. We set the correlation of Δu_{it} and Δv_{it} to 0. All statistics reported in Table 4, including the estimate of μ, are invariant to the choice of normalization.

33/ The estimates of η are obtained from the formula $\eta = 1/(\mu-1)$. If μ is near one, η will be imprecisely estimated and the point estimate of η will fluctuate substantially with relatively small changes in the point estimate of μ.

34/ MaCurdy's and Altonji's estimates of the intertemporal substitution elasticity are based on the relative covariances of changes in earnings and changes in hours with instrumental variables like age and education.

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Table 1

Implied Covariances of Experience-Adjusted Changes in Log Earnings and Log Hours: Contracting and Labor Supply Models

1.	$\mathrm{var}\,(\Delta \log \tilde{g}_{it})$	$\mu^2\,\mathrm{var}\,(\Delta \tilde{z}_{it}) + 2\sigma_u^2$
2.	$\mathrm{var}\,(\Delta \log \tilde{h}_{it})$	$\mathrm{var}\,(\Delta \tilde{z}_{it}) + 2\sigma_v^2$
3.	$\mathrm{cov}\,(\Delta \log \tilde{g}_{it}, \Delta \log \tilde{h}_{it})$	$\mu\,\mathrm{var}\,(\Delta \tilde{z}_{it}) + 2\rho_{uv}\sigma_u\sigma_v$
4.	$\mathrm{cov}\,(\Delta \log \tilde{g}_{it}, \Delta \log \tilde{g}_{it-1})$	$\mu\,\mathrm{cov}\,(\Delta \tilde{z}_{it}, \Delta \tilde{z}_{it-1}) - \sigma_u^2$
5.	$\mathrm{cov}\,(\Delta \log \tilde{h}_{it}, \Delta \log \tilde{h}_{it-1})$	$\mathrm{cov}\,(\Delta \tilde{z}_{it}, \Delta \tilde{z}_{it-1}) - \sigma_v^2$
6.	$\mathrm{cov}\,(\Delta \log \tilde{g}_{it}, \Delta \log \tilde{h}_{it-1})$, $\mathrm{cov}\,(\Delta \log \tilde{h}_{it}, \Delta \log \tilde{g}_{it-1})$	$\mu\,\mathrm{cov}\,(\Delta \tilde{z}_{it}, \Delta \tilde{z}_{it-1}) - \rho_{uv}\sigma_u\sigma_v$
7.	$\mathrm{cov}\,(\Delta \log \tilde{g}_{it}, \Delta \log \tilde{g}_{it-2})$	$\mu^2\,\mathrm{cov}\,(\Delta \tilde{z}_{it}, \Delta \tilde{z}_{it-2})$
8.	$\mathrm{cov}\,(\Delta \log \tilde{h}_{it}, \Delta \log \tilde{h}_{it-2})$	$\mathrm{cov}\,(\Delta \tilde{z}_{it}, \Delta \tilde{z}_{it-2})$
9.	$\mathrm{cov}\,(\Delta \log \tilde{g}_{it}, \Delta \log \tilde{h}_{it-2})$, $\mathrm{cov}\,(\Delta \log \tilde{h}_{it}, \Delta \log \tilde{g}_{it-2})$	$\mu\,\mathrm{cov}\,(\Delta \tilde{z}_{it}, \Delta \tilde{z}_{it-2})$

Notation: $\Delta \log \tilde{g}_{it} \equiv \Delta \log g_{it} - \kappa_{gt} - \xi_g x_{i0}$,

$\Delta \log \tilde{h}_{it} \equiv \Delta \log h_{it} - \kappa_{ht} - \xi_h x_{i0}$,

$\Delta \tilde{z}_{it} \equiv \eta\, \Delta z_{it}$, $\rho_{uv} \equiv$ Correlation (Δu_{it} , Δv_{it}) ,

$\sigma_u^2 \equiv \mathrm{Var}(\Delta u_{it})$, $\sigma_v^2 \equiv \mathrm{Var}(\Delta v_{it})$.

Table 2

Sample and Subsample Characteristics for the Panel Study of Income Dynamics (PSID) and the National Longitudinal Survey (NLS) of Older Men: Means (and Standard Deviations) for the Indicated Years

Year	PSID All	PSID One Employer	PSID Multiple Employers	Year	NLS[a] All	NLS[a] One Employer	NLS[a] Multiple Employers
Change in Log Real Earnings[b]							
1969-70	2.5 (40.)	1.8 (24.)	3.0 (49.)	1966-67	4.4 (31.)	2.6 (20.)	6.7 (41.)
1970-71	3.0 (40.)	2.5 (24.)	3.4 (48.)	1967-69	4.6 (31.)	4.0 (23.)	5.3 (39.)
1971-72	6.9 (41.)	5.8 (30.)	7.7 (48.)	1969-71	2.5 (31.)	3.2 (23.)	1.6 (38.)
1972-73	4.7 (37.)	3.5 (29.)	5.6 (41.)	1971-73	-1.2 (38.)	1.2 (29.)	-4.4 (47.)
1973-74	-5.5 (36.)	-3.8 (26.)	-6.8 (42.)	1973-75	-16.4 (54.)	-6.9 (32.)	-28.7 (72.)
1974-75	-4.2 (43.)	-2.8 (28.)	-5.3 (51.)				
1975-76	4.1 (47.)	2.7 (30.)	5.2 (57.)				
1976-77	2.5 (44.)	2.8 (25.)	2.3 (54.)				
1977-78	0.2 (44.)	0.0 (27.)	0.4 (53.)				
1978-79	-5.5 (42.)	-4.4 (28.)	-6.4 (51.)				
Change in Log Annual Hours[b]							
1969-70	-0.8 (35.)	1.8 (21.)	-0.1 (42.)	1966-67	-0.1 (29.)	-0.8 (19.)	0.8 (37.)
1970-71	0.3 (34.)	0.6 (18.)	-0.0 (42.)	1967-69	-0.3 (27.)	-0.5 (21.)	-0.2 (33.)
1971-72	2.0 (34.)	0.1 (19.)	3.6 (42.)	1969-71	-0.9 (26.)	-0.3 (19.)	-1.6 (33.)
1972-73	1.9 (28.)	2.1 (19.)	1.7 (34.)	1971-73	-1.2 (29.)	0.9 (18.)	-3.9 (38.)
1973-74	-4.1 (27.)	2.5 (18.)	-5.3 (32.)	1973-75	-10.9 (46.)	-3.0 (22.)	-21.1 (64.)
1974-75	-2.4 (33.)	1.1 (20.)	-3.4 (41.)				
1975-76	0.6 (38.)	0.2 (22.)	1.2 (47.)				
1976-77	0.3 (38.)	0.6 (20.)	0.1 (47.)				
1977-78	0.5 (37.)	0.9 (21.)	1.6 (45.)				
1978-79	-4.2 (37.)	1.3 (24.)	6.4 (44.)				
Age (1969)	35.8 (9.)	38.2 (8.)	34.1 (9.)	1966	49.1 (4.)	48.9 (4.)	49.5 (5.)
Potential Experience (1969)	18.9 (11.)	21.4 (10.)	17.1 (11.)	1966	34.4 (6.)	33.8 (5.)	35.2 (5.)
Percent Nonwhite	27.3	27.7	27.0		29.6	30.8	28.2
Sample Size	1448[c]	618	830		1309[d]	735	574

[a] Statistics from the NLS are not at annual rates.

[b] Means and standard deviations times 100.

[c] Eight outliers with average hourly earnings greater than $100/hour (1967 dollars) have been deleted.

[d] Nine outliers with absolute changes in log earnings or log hours in excess of 3.5 have been deleted.

Table 3

Stationary Cross-Covariance Structure for PSID and NLS Samples and Subsamples (Standard Errors in Parentheses)[a]

Sample Cross-Covariance	PSID All	PSID One Employer	PSID Multiple Employers	NLS[b] All	NLS[b] One Employer	NLS[b] Multiple Employers
Earnings Autocovariances						
1. Var $[\Delta \log \tilde{g}_t]$	.172 (.011)	.074 (.006)	.245 (.017)	.158 (.011)	.074 (.010)	.259 (.020)
2. Cov $[\Delta \log \tilde{g}_t, \Delta \log \tilde{g}_{t-1}]$	-.060 (.006)	-.031 (.004)	-.081 (.009)	-.043 (.006)	-.028 (.006)	-.069 (.011)
3. Cov $[\Delta \log \tilde{g}_t, \Delta \log \tilde{g}_{t-2}]$	.007 (.003)	-.002 (.002)	-.010 (.004)	-.001 (.003)	.002 (.002)	-.004 (.008)
Hours Autocovariances						
4. Var $[\Delta \log \tilde{h}_t]$	.117 (.007)	.040 (.003)	.174 (.012)	.108 (.010)	.039 (.005)	.191 (.020)
5. Cov $[\Delta \log \tilde{h}_t, \Delta \log \tilde{h}_{t-1}]$	-.035 (.003)	-.016 (.002)	-.050 (.006)	-.038 (.006)	-.018 (.003)	-.066 (.014)
6. Cov $[\Delta \log \tilde{h}_t, \Delta \log \tilde{h}_{t-2}]$	-.011 (.002)	-.000 (.001)	-.019 (.003)	.008 (.005)	.001 (.003)	.017 (.011)
Earnings/Hours Cross-covariances						
7. Cov $[\Delta \log \tilde{g}_t, \Delta \log \tilde{h}_{t+2}]$	-.006 (.002)	-.001 (.001)	-.010 (.004)	.001 (.004)	.000 (.001)	.002 (.009)
8. Cov $[\Delta \log \tilde{g}_t, \Delta \log \tilde{h}_{t+1}]$	-.023 (.004)	-.005 (.001)	-.037 (.007)	-.015 (.004)	-.002 (.001)	-.033 (.010)
9. Cov $[\Delta \log \tilde{g}_t, \Delta \log \tilde{h}_t]$	.073 (.007)	.011 (.001)	.119 (.012)	.063 (.007)	.008 (.002)	.126 (.014)
10. Cov $[\Delta \log \tilde{g}_t, \Delta \log \tilde{h}_{t-1}]$	-.020 (.004)	-.003 (.001)	-.033 (.007)	-.010 (.004)	-.002 (.001)	-.022 (.009)
11. Cov $[\Delta \log \tilde{g}_t, \Delta \log \tilde{h}_{t-2}]$	-.002 (.003)	.001 (.001)	-.004 (.005)	.007 (.005)	.000 (.002)	.015 (.010)
12. Goodness-of-fit for nonstationary MA(2)[c]	137.19 (.053)	168.09 (.000)	153.54 (.006)	15.15 (.233)	11.84 (.459)	16.09 (.187)
13. Goodness-of-fit for stationary MA(2)[d]	143.69 (.000)	201.96 (.000)	148.63 (.000)	79.11 (.000)	33.21 (.043)	742.27 (.000)

[a] Covariance matrix and standard errors based on equally weighted minimum distance estimates of cross-covariances.

[b] NLS estimates based on the four changes with gaps of two years: 67-69, 69-71, 71-73, 73-75.

[c] Wald χ^2 statistic for nonstationary bivariate MA(2) versus arbitrary process for the bivariate cross-covariance function. The statistic has 112 degrees of freedom for the PSID sample and 12 degrees of freedom for the NLS sample. Probability values in parentheses.

[d] Wald χ^2 statistic for stationary bivariate MA(2) verus nonstationary bivariate MA(2) process for cross-covariance function. The statistic has 87 degrees of freedom for the PSID sample and 21 degrees of freedom for the NLS sample. Probability values in parentheses.

Table 4

Estimated Relative Contribution of Productivity Variance to Earnings and Hours Change Variance

For PSID and NLS Samples and Subsamples Using Stationary and Nonstationary Specifications

Parameter Estimates (and Standard Errors in Parentheses)

Denfintion of Parameter	PSID All	PSID One Employer	PSID Multiple Employers	NLS[b] All	NLS[b] One Employer	NLS[b] Multiple Employers
Stationary Model:						
1. Relative Contribution of Productivity to Variance of Change in Log Earnings (μ)	1.05 (.078)	1.54 (.439)	1.02 (.079)	1.56 (.174)	4.39 (2.19)	1.39 (.154)
2. Elasticity of Intertemporal Labor Supply (η)	19.96 (30.9)	1.84 (1.50)	51.86 (213.)	1.77 (.563)	.29 (.190)	2.53 (.980)
3. Goodness-of-Fit for Structural Model[a]	335.90 (.000)	229.64 (.000)	304.32 (.000)	143.54 (.000)	50.23 (.036)	144.47 (.000)
Nonstationary Model:						
4. Relative Contribution of Productivity to Variance of Change in Log Earnings (μ)	1.14 (.091)	2.46 (.781)	1.16 (.089)	1.23 (.100)	4.10 (2.15)	1.14 (.080)
5. Elasticity of Intertemporal Labor Supply (η)	7.27 (4.81)	.68 (.365)	6.40 (3.63)	4.34 (1.89)	.32 (.220)	7.14 (4.08)
6. Goodness-of-Fit for Structural Model[b]	261.15 (.000)	142.13 (.000)	223.01 (.000)	127.02 (.000)	33.84 (.206)	97.80 (.000)

[a] χ^2 statistic for stationary structural model versus nonstationary bivariate MA(2) model. The statistic has 92 degrees of freedom for the PSID sample and 34 degrees of freedom for the NLS sample. Probability values in parentheses.

[b] χ^2 statistic for nonstationary model versus nonstationary bivariate MA(2) model. The statistic has 68 degrees of freedom for the PSID sample and 28 degrees of freedom for the NLS sample. Probability values in parentheses.