The Intertemporal-Substitution Hypothesis is Alive and Well
(But Hiding in the Data)

Upjohn Institute Staff Working Paper 93-19

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April 1993

Revised draft entitled New Evidence on Labor Supply: Employment Versus Hours Elasticities by Sex and Marital Status appears in *Journal of Monetary Economics*, Vol. 42 (1998)

We are grateful to Wei-Jang Huang and Rebecca Jacobs for research assistance. Thanks for helpful comments go to Ben Craig, Theresa Devine, Anthony D. Hall, V. Joseph Hotz, Michael P. Keane, Thomas Mroz, Pravin K. Trivedi, Christopher J. Waller, and James P. Ziliak. Valuable criticisms were also received from audience members at presentations of our research at the annual meetings of the Canadian Economic Association and the Econometric Society and seminars at Arizona State University, Indiana University, Bloomington, Indiana University Purdue University at Indianapolis, Sydney University, and The W.E. Upjohn Institute for Employment Research. Special thanks go to Alberto Martini for much advice on how to use the Survey of Income and Program Participation data. Financial support from the Office of the Vice-President for Research and the University Graduate School of Indiana University, Bloomington is gratefully acknowledged.

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Abstract

According to the intertemporal-substitution hypothesis, which underlies the typical empirical real business cycle model, cyclical fluctuations in employment and hours of work are optimizing labor-supply responses to short-run aggregate demand shifts. We demonstrate that previous empirical labor-supply research has used inappropriate data to test the intertemporal-substitution hypothesis. We estimate a fixed-effects life-cycle labor-supply model with more informative data, the triannual micro data of the Survey of Income and Program Participation. We find economy-wide wage elasticities of employment and hours worked per employee of +1.55 and +0.51, which support the intertemporal-substitution hypothesis and give econometric credibility to the labor-market specification of empirical real business cycle models.

JEL Classification: C33, E24, J22

Key Words: intertemporal-substitution hypothesis, empirical real business cycle models, life-cycle labor supply, fixed effects, panel data, Heckit, Survey of Income and Program Participation

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1. Introduction

According to the intertemporal-substitution hypothesis employment and work hours fluctuate cyclically because workers want to increase their leisure and non-market work during recessions when real wages are relatively low and reduce their leisure and non-market work during macroeconomic expansions when real wages are relatively high (Lucas and Rapping 1968). Intertemporal substitution is the core of the labor-market specification of empirical real business cycle models (Hansen and Wright 1992). There is a conflict between the econometric labor-supply literature and the real business cycle literature in that the labor-supply elasticities used in the typical empirical real business cycle model exceed those found by econometric research. We contend that econometric labor-supply research has used inappropriate (aggregate or annual micro) data to capture short-run labor-supply dynamics. We show that when appropriate (sub-annual micro) data are used estimated short-run labor-supply elasticities emerge supporting the intertemporal-substitution hypothesis and empirical real business cycle models.

What must the aggregate labor-supply curve look like to support the intertemporal-substitution hypothesis? First, employment status and hours worked per employee must both reflect a labor-supply schedule fitting the stylized aggregate labor-market facts. For example, non-farm employment falls about three percent during the typical postwar U.S. recession; the aggregate average real wage is more acyclical, falling one to two percent during a recession (Kniesner and Goldsmith 1987). If movements along short-run aggregate labor supply describe cyclical employment fluctuations then the short-run aggregate labor-supply function for the United States must be wage elastic in employment. Finally, because fluctuations in the average workweek account for about one-fourth the aggregate fluctuations in U.S. employment hours the short-run supply elasticity of hours of work should be about one-third the short-run wage elasticity of employment if equilibrium labor- supply responses are driving labor-market dynamics (Cho and Cooley 1992). There is an enormous amount of empirical research examining the wage elasticity of labor supply in the United States. The conclusion emerging from econometric studies is that labor supply is too inelastic to support an equilibrium interpretation of labor-market dynamics and empirical real business cycle models (Kniesner and Goldsmith 1987, Card 1990, Heckman 1993). We now describe the econometric model producing our evidence that the intertemporal-substitution hypothesis is alive and well, but masked by the data used in previous empirical labor-supply research.

2. Econometric Model

There are three aspects of an informative test of the intertemporal-substitution hypothesis (MaCurdy 1990). The econometric labor-supply model must incorporate short-run cyclical (unexpected) real-wage effects within the context of life-cycle decision making. The model must also include decisions at both the extensive (employment status) and intensive (hours of work) margins. Most important, aggregate data do not identify the short-run aggregate labor-supply curve (Kennan 1988). The researcher should use *sub- annual* micro-household data to identify short-run labor-supply functions, which can then be aggregated to form the economy-wide elasticities needed to examine the intertemporal- substitution hypothesis (Heckman 1984).[1] Existing labor-supply research has used data that are uninformative to the intertemporal-substitution hypothesis: macro data (Ashenfelter 1980; Altonji 1982; Mankiw, Rottenberg, and Summers 1985; Eichenbaum, Hansen and Singleton 1988) or annual micro data smoothing over short-run labor-supply fluctuations (Heckman and MaCurdy 1980, 1982; Browning, Deaton, and Irish 1985; Nakamura and Nakamura 1985; Altonji 1986; Mroz 1987; Hotz, Kydland, and Sedlacek 1988; Altug and Miller 1990). Our research is the first to meet the three criteria for an informative test of the intertemporal- substitution hypothesis.

2.1 A Life-Cycle Labor-Supply Model with Latent Heterogeneity

The simplest labor-supply model encompassing a test of the intertemporal-substitution hypothesis is MaCurdy's (1987) life-cycle model estimated with sub-annual data. The model contains a two-equation recursive system of annual hours worked (n) and the offered hourly wage (w) of person i in period t

$$\log n_{it} = \varpi_{1i} + \delta \log \varpi_{it} + \gamma Z_{it} + \mu_{1it}, \tag{1}$$

$$\log w_{it} = \varpi_{2i} + \beta X_{it} + \mu_{2it}, \tag{2}$$

where the vector Z_{it} includes exogenous variables conditioning labor-supply decisions, such as personal and family characteristics, and the vector X_{it} contains exogenous variables determining the market wage, such as schooling. The wage rate is exogenous to the worker, playing the role of the demand for a person's labor.[2] A person uses the competitively offered real wage to decide employment status and hours of work. Notice that in addition to the usual additive and independently normal random error terms, μ_1 and μ_2, both the labor-supply and wage equations include non-stochastic person-specific heterogeneity, ϖ_{1i} and ϖ_{2i}.[3] Time effects and nonlinearities in labor supply and wages are allowed by including a quadratic trend and interaction terms in Z and X. Using an instrumented wage based on (2) means that the estimated labor-supply wage

[1] Sub-annual data collected via retrospective survey questions at annual interviews are inadequate because the recall period is too long to produce trustworthy information, and people tend to under report variations in economic behavior for sub-interview time periods.

[2] Richer micro-econometric models of demand for an individual worker's labor are in their infancy (Card 1990).

[3] We rule out specifying the intercepts in the wage and labor-supply equations as random. Random-effects estimators are inconsistent if the effects are not independent of the regressors, which is the case in a life-cycle labor-supply model where the intercepts generally reflect interpersonal differences in wealth.

coefficient δ in (1) is a response of hours worked to an expected wage change. Because anticipated wage changes produce no wealth effects the estimated intertemporal-substitution effect should be positive, $\delta > 0$.

In our research we consider two possible labor-force states, employed and not employed (unemployed or out of the labor force). The person compares utility if working for pay, $U(n>0)$, with utility if not employed, $U(n=0)$. If I_{it} is an indicator of employment status, where $I_{it}=1$ if employed and $I_{it}=0$ if not employed, then the probability of employment (e_{it}) is $P(I_{it}=1) = P[U(n>0)\text{-}U(n=0)]_{it} = F(\mu_{3it})$, where $F(\cdot)$ is the cumulative distribution function for the random error component of $[U(n>0)\text{-}U(n=0)]$. Because I_{it} is implied by a comparison of the offered wage in (2) with the reservation wage, which is the inverse of the labor-supply function (1) evaluated at zero hours of work, the model's structural equation for the probability of employment has the same independent variables as the hours-of-work equation (1). To maintain internal consistency of the model concerning distribution assumptions we estimate the structural employment-probability equation as a fixed-effects probit[4]

$$P(e_{it}) \equiv P(n_{it}>0) = P(I_{it}=1) = F(\varpi_{3i} + \delta' \log w_{it} + \gamma' Z_{it}). \tag{3}$$

The estimated wage coefficient in the employment-probability equation, δ, should be positive because higher wages draw people into employment and make no one leave employment because higher potential earnings are only realized if employed (Ben Porath 1973).

2.2 Examining the Intertemporal-Substitution Hypothesis

The estimated hours-of-work elasticity we use to examine the intertemporal-substitution hypothesis is

$$\hat{\eta}_n = \partial \log \hat{n}_t / \partial \log w_t = \hat{\delta} + \partial \hat{\varpi}_1 / \partial \log w_t, \tag{4}$$

which is the intertemporal substitution effect plus the estimated wealth effect of an unanticipated wage change, $\partial \hat{\varpi}_1/\partial \log w_t$. The person-specific intercepts in the labor supply function include the marginal utility of lifetime wealth so that ϖ_1 depends on initial wealth plus expected wages. Because our labor-supply model assumes life-cycle foresight ω_1 is disturbed by unanticipated economic events, such as transitory wage changes during a recession or an economic expansion. To close the econometric model and examine the intertemporal-substitution hypothesis we must explain how we obtain $\partial \hat{\omega}_1/\partial w_t$ in (4).

[4]Heckman (1981) presents Monte Carlo evidence that fixed-effects probits are well behaved (consistent) if there are at least eight time-series observations. We have nine observations per person.

To estimate the wealth effect of a transitory wage change we first retrieve the person-specific intercepts in the hours-of-work equation (1), $\hat{\omega}_{1i}$, then regress them on determinants of expected wealth (MaCurdy 1987, p. 154). We adopt a specification for the ancillary equation explaining $\hat{\omega}_{1i}$ that includes personal characteristics, the expected wage profile from (2), and estimated initial wealth from a regression similar to (2) for non-wage income (y_{it})

$$y_{it} = \omega_{4i} + \alpha Y_{it} + \mu_{4it}, \tag{5}$$

where Y_{it} is a vector of exogenous variables including time effects and nonlinearities in personal and family characteristics, ω_{4i}, is an individual-specific intercept, and μ_{4it} is an independently normally distributed error term. Expected wealth then depends on the capitalized value of estimated initial wealth from (5), $\hat{\omega}_{4i}/r$, and the estimated parameters of the wage profile in (2), or and $\hat{\omega}_{2i}$ and β. The wealth-effect equation we use to compute the wage elasticity of hours of work then is

$$\hat{\omega}_{1i} = \gamma_0 + \gamma_1(\hat{\beta}X_{it}) + \gamma_2(\hat{\omega}_{2i}) + \gamma_3\Pi_{it} + \gamma_4(\hat{\omega}_{4i}/r) + \mu_{5i}, \tag{6}$$

where Π_{it} is a vector of personal and family characteristics.

An unexpected permanent wage change shifts the lifetime wage profile (2) via the intercept term, $\hat{\omega}_{2i}$. The wealth effect of a temporary (one-period duration) unexpected wage change is γ_2/T in (6), where T is the number of sample time periods, and the estimated elasticity of hours of work with respect to an unexpected transitory wage change is then $\hat{\eta}_n = \hat{\delta} + \hat{\gamma}_2/T$.

In our empirical results we report separate micro labor-supply results for men and women. We then form economy-wide labor supply elasticities for the United States. Given the cyclical economy-wide fluctuations in real wages, employment, and average hours worked noted in Section 1 the intertemporal-substitution hypothesis requires an economy-wide elasticity of hours worked per employee with respect to a temporary wage change, $\hat{\eta}_n$, of at least +0.5. The aggregate elasticity of the effect of a temporary wage change on the probability of employment in a period, $\hat{\eta}_e = \hat{\delta}'/P(e)$, must be about +1.5 to support the intertemporal-substitution hypothesis.

3. Data

We used data from the Survey of Income and Program Participation (SIPP), which covers about 20,000 households surveyed once every four months for three years beginning in May 1983 (David, Robin, and Flory 1988; *Survey of Income and Program Participation Users' Guide*, 1987). Of all U.S. micro data the SIPP's nine triannual interviews best capture the short-run dynamics of wages, employment status, and hours worked needed for an informative test of the intertemporal-substitution hypothesis. See Appendix A for variable means.

The dependent variables of interest are a binary indicator of paid employment during a survey period and hours of work per employee. Hours worked is the product of usual hours worked per week and the number of weeks worked. Because the number of weeks in a survey period or wave varies from 17 to 18 depending on the interview window, using weeks worked in a wave builds false variation into labor supplied. To eliminate false variation in weeks worked due to unequal wave lengths we normalized maximum weeks worked at 17.33. Hours worked in a wave is then the product of normalized weeks worked and usual hours worked per week.[5,6]

Constructing a wage rate from the Survey of Income and Program Participation information also requires some discussion because the hourly wage of salaried workers is not obvious. Moreover, we want to minimize the wage-coefficient (division) bias that arises when average hourly earnings (earnings ÷ hours worked) is a regressor (Borjas 1980). We constructed a wage for all workers with a technique similar to the Panel Study of Income Dynamics, the mode data set for recent U.S. micro labor supply research. The hourly wage in our regressions is total labor earnings in a survey period divided by the product of reported weeks worked and a two-tiered norm for usual hours worked per week: 40 hours for full-time workers (usual weekly hours worked $>$ 25) and 20 hours for part-time workers (usual weekly hours worked $\leq$ 25).[7] The hourly wage rate in our regressions is then instrumented normalized average hourly earnings, or (earnings ÷ normalized hours worked).

4. Empirical Results

Our five-step estimation procedure incorporates a fixed-effects Heckit model. First, we estimated a reduced-form fixed-effects probit equation for employment status using as regressors all exogenous variables determining the offered wage and hours worked. The estimated reduced-form probit coefficients then form the inverse Mills ratio used to purge the selection bias from subsequent wage and hours-worked regressions estimated with data for workers. Second, we estimated a selectivity-bias-corrected fixed-effects wage equation to instrument the wage, which corrects for measurement errors in wage rates (Bound, et al. 1990) and permits imputing

[5]For workers who held two non-overlapping jobs during a wave we created a composite hours of work equal to hours worked in the two jobs weighted by the proportion of total weeks in the period worked on each job. The wage on the composite job is a similarly weighted average of wages. Because there was no obvious way to form a composite job for 250 workers with two jobs that briefly overlapped we excluded them from our sample.

[6]We ignored labor supplied on secondary jobs of 127 men and 133 women who held two jobs simultaneously during any survey period possibly eliminating some cyclical fluctuation in labor supplied. In our defense the number of moonlighters is small, modeling the mooonlighting labor-supply decision would excessively complicate our econometric model, and any bias in our results should work against supporting the intertemporal-substitution hypothesis.

[7]Persons with brief periods of non employment during a wave can have their weeks employed overstated because of misreported job start and end dates in the SIPP's monthly records. Extensive data checks verified that the possibly understated hours of work (and possibly overstated wages) for persons briefly without jobs is of no empirical importance to our results. We thank Theresa Devine for mentioning the subtleties of the SIPP's monthly records.

offered wages in periods when no work for pay was performed. Third, we estimated a selectivity-bias-corrected hours-of-work equation on observations of work for pay, which produces an estimate of the intertemporal-substitution effect.[8] Fourth, we regressed the estimated fixed effects from the hours-of-work structural equation on determinants of wealth to infer the wealth effect of a temporary wage change. The estimated wealth and intertemporal-substitution effects then provide the overall effect of a transitory wage change on hours worked. Finally, we estimated a structural fixed-effects probit for employment-status, which yields an estimate of the elasticity of an unexpected one-period wage change on the probability of employment.

As discussed earlier, to mimic the cyclical patterns of wages, employment, and average working hours and to support the intertemporal-substitution hypothesis the economy-wide employment-probability elasticity must be at least +1.5 and the conditional hours-of-work elasticity at least +0.5. The northwest quadrant of Table 1 presents estimated values of labor-supply wage elasticities from our fixed-effects employment-probability and conditional hours-of-work equations separately for men and women.[9] Men's estimated employment elasticity is +0.86, and women's estimated employment elasticity is +2.39. Using the relative proportions of men (0.55) and women (0.45) in U.S. employment during the sample period as weights implies an economy-wide elasticity of employment with respect to a temporary (four month) wage change of +1.55. In Table 1 the estimated transitory hours-of-work elasticities for men and women are +0.39 and +0.66, for an aggregate hours-worked elasticity of +0.51. Both the employment and hours-worked equations in our life-cycle labor-supply model incorporating temporary wage changes and latent worker-specific heterogeneity support the intertemporal-substitution hypothesis.

For comparison purposes Table 1 presents fixed-effects Tobit wage elasticities paralleling the seminal econometric research on life-cycle labor supply of married women by Heckman and MaCurdy (1980, 1982). The economy-wide (unconditional) wage elasticity implied by the Tobit results in Table 1 for men and women is +1.57, which exceeds the wage elasticity of per capita

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[8]We weighted both the selectivity-bias-corrected structural hours-worked and wage equations to correct for the heteroskedasticity caused by the inverse-Mills ratio (generated) regressor.

[9]In a fixed-effects discrete-choice model of employment only persons changing employment status can be involved in parameter estimation (Hsiao 1986, Chapter 7). We did not adjust our probit estimates for the required omission of persons either not employed in any period or employed during all periods. Heckman and MaCurdy (1980) found that adjusting their fixed-effects Tobits for people who were never employed during their nine-year sample made no difference, and our data run only 2.5 years. A simple experiment demonstrated that trying to condition for the probability of continuous employment would also make no difference. Specifically, we estimated employment probits with common intercepts (no fixed effects) on two samples: employment switchers and employment switchers plus the continuously employed. In both alternative samples the wage elasticities were similar to each other but much different than the fixed effects results in Table 1 ($\hat{\eta}_E$(women) = +0.25 and $\hat{\eta}_E$(men) not significantly different from zero). The similarity of the two common-intercept probits and their difference from the fixed-effects probits indicates that it is the fixed effects causing the difference between results with latent employment-probability heterogeneity versus latent homogeneity, not the necessarily different samples used in estimation.

hours worked of +1.29 used in recent empirical real business cycle research (Cho and Cooley 1992).[10]

We also estimated labor-supply regressions where the wage elasticities were allowed to vary by marital status. Appearing in the southwest quadrant of Table 1 are separate employment-status, hours worked per employee, and Tobit regressions for married men, single men, married women, and single women. Disaggregating by marital status has little effect on the estimated economy-wide conditional hours elasticity; most marital differences appear in the employment probits and Tobits. Employment and Tobit elasticities of women again exceed those of men. Employment elasticities for married men exceed single men, and single women have more elastic employment probabilities with respect to temporary wage changes than married women. Most important, the economy-wide employment elasticity implied by the separate estimates by sex/marital status is +1.44, and the economy-wide conditional hours-of-work elasticity is +0.53. Disaggregating by marital status does not change the conclusion that labor-supply estimated with sub-annual micro data support the intertemporal-substitution hypothesis.

Comparing the northeast and northwest quadrants of Table 1 implies the time aggregation effects in micro labor supply estimated with annual data. We took our nine triannual observations, used them to create three annual observations, then reestimated our labor-supply regressions with the three annualized observations.[11] Time aggregation critically reduces the estimated fixed-effects probit and Tobit wage elasticities. The largest impact of time aggregation is on the results for women. Women's employment probability elasticity is six times larger in the triannual data than in the annualized data, +2.39 versus +0.37. The annualized data imply an aggregate employment elasticity of only +0.48, which is smaller than the aggregate elasticity of hours worked per employee estimated with the quadramester data.[12] Because hours per worker fluctuate relatively less from quadramester to quadramester annual data mirror short-run movements in labor supply as measured by hours worked per employee. Employment in any of the three quadramesters in a year classifies one as employed during the year, however, and annual data mask a critical amount of the short-term fluctuations in labor supply as measured by employment status.

[10]Because it does not impose a rigid connection between the parameters determining employment versus hours of work, which may differ due to fixed costs of employment, Heckit is preferable to the simpler Tobit labor-supply model (Killingsworth 1983, Chapter 4; Mroz 1987; MaCurdy 1987, p. 163). Likelihood ratio tests rejected the Tobit against the alternative of the more general two-equation labor-supply model in Table 1. We thank Tom Mroz for help with the likelihood-ratio test.

[11]Because there is less recall error our annualized data should be more accurate than data from the typical annual survey such as the Panel Study of Income Dynamics.

[12]A reduced elasticity due to the smoothing inherent in annual data also appears in the southeast and southwest quadrants of Table 1, where three of four employment elasticities and all four Tobit elasticities are smaller in the annualized data.

5. Conclusion

The intertemporal-substitution hypothesis attributes cyclical movements into and out of employment and cyclical fluctuations in hours worked by employees to optimizing labor-supply decisions in response to short-run fluctuations in real wages. Movements along short-run labor-supply functions during recessions and economic expansions also are part of the structure of empirical real business cycle models. Because the aggregate real wage is relatively acyclical in the United States and about three-fourths of the fluctuations in aggregate hours worked come from movements into and out of employment the intertemporal-substitution hypothesis requires an aggregate short-run wage elasticity of employment of about $+1.5$ and an aggregate elasticity of hours worked per employee of about $+0.5$.

The labor-supply literature has not generally produced elasticities large enough to support the intertemporal-substitution hypothesis because it has used aggregate time-series data, where labor supply is not identified, or has used annual micro data, which masks short-run dynamics. Attempts to rescue the intertemporal-substitution hypothesis developed sophisticated econometric models involving intratemporal and intertemporal nonseparabilities and formalizing the role for economic uncertainty (Browning, Deaton, and Irish 1985). The increased econometric complexity did not generally produce the elastic short-run labor supply that the intertemporal-substitution hypothesis and empirical real business cycle models need because previous empirical research used data that is uninformative on short-run labor supply.

What has been missing in the empirical literature is labor supply estimated with sub-annual data. Our theoretical approach is the Frisch labor-supply model of MaCurdy (1987), which generalized Heckman and MaCurdy (1980,1982). Our five-stage estimation procedure incorporates latent person-specific heterogeneity and yields elasticities of employment status and hours of work per employee with respect to temporary wage changes. Estimating separate labor-supply functions for men and women with the triannual data from the Survey of Income and Program Participation we found aggregate wage elasticities of employment and hours worked per employee supporting the intertemporal-substitution hypothesis. We demonstrated the importance of time aggregation by annualizing the triannual data then re-estimating labor supply. Aggregate employment-status wage elasticities shrunk by a factor of three and no longer support the intertemporal-substitution hypothesis when we re-estimated with annualized data.

Our results demonstrate that adding econometric structure is an inadequate substitute for informative data and that annual micro data mask the short-term variability of employment status characterizing intertemporal substitution in labor supply. The intertemporal-substitution hypothesis has not been tested and found lacking, rather it has not been tested informatively until now, and empirical real business models should no longer be criticized for using what has been claimed are unreasonably high labor-supply elasticities.

References

Altonji, Joseph G., "The Intertemporal Substitution Model of Labour Market Fluctuation: An Empirical Analysis, " *Review of Economic Studies*, Special Issue, 1982, 49(5), pp. 783-824.

Altonji, Joseph G., "Intertemporal Substitution in Labor Supply: Evidence from Micro Data," *Journal of Political Economy*, June 1986, 94(3, pt. 2), pp. S176-S215.

Altug, Sumru, and Miller, Robert A., "Household Choices in Equilibrium," *Econometrica*, May 1990, 58(3), pp. 543-570.

Ashenfelter, Orley, "Unemployment as Disequilibrium in a Model of Aggregate Labor Supply," *Econometrica*, April 1980, 48(3), pp. 547-564.

Ben Porath, Yoram, "Labor Force Participation Rates and the Supply of Labor," *Journal of Political Economy*, 81, pp. 697-704.

Borjas, George J., "The Relationship Between Wages and Weekly Hours of Work: The Role of Division Bias," *Journal of Human Resources*, Summer 1980, 15(3), pp. 666-689.

Bound, Charles; Brown, Charles; Duncan, Greg J.; and Rodgers, Willard L., "Measurement Errors in Cross-Sectional and Longitudinal Labor Market Surveys: Validation Study Evidence," in *Panel Data And Labor Market Studies*, editors: Joop Hartog, Geert Ridder, and Jules Theeuwes, Amsterdam: North-Holland Publishing Co., 1990, pp. 1-20.

Browning, Martin, Deaton, Angus, and Irish, Margaret, "A Profitable Approach to Labor Supply and Commodity Demands over the Life Cycle," *Econometrica*, May 1985, 53(3), pp. 503-543.

Card, David, "Intertemporal Labor Supply: An Assessment," Industrial Relations Section, Princeton University, Working Paper No. 269, September 1990.

Cho, Jang-Ok, and Cooley, Thomas F., "Employment and Hours Over The Business Cycle," Department of Economics, University of Rochester, Working Paper, April 21, 1992, forthcoming in the *Journal of Monetary Economics*.

David, Martin, Robbin, Alice, and Flory, Thomas, *SIPP ACCESS Handbook*, Volumes One and Two, revised May 1988.

Eichenbaum, Martin, Hansen, Lars, and Singleton, Kenneth, "A Times Series Analysis of Representative Agent Models of Consumption and Leisure Choice Under Uncertainty," *Quarterly Journal of Economics*, 1988, 103(1), pp. 51-78.

Hansen, Gary D., and Wright, Randall, "The Labor Market in Real Business Cycle Theory," Federal Reserve Bank of Minneapolis *Quarterly Review*, Spring 1992, pp. 2-12.

Heckman, James J., "The Incidental Parameters Problem and the Problem of Initial Conditions in Estimating a Discrete-Time Data Stochastic Process," in *Structural Analysis of Discrete Data with Econometric Applications*, Editors: Charles Manski and Daniel McFadden, Cambridge, MA: MIT Press, 1981, pp. 114-178.

Heckman, James J., "Comments on the Ashenfelter and Kydland Papers," in *Carnegie-Rochester Conference Series on Public Policy*, 21, 1984, pp. 209-224.

Heckman, James J., "A Survey of Labor Supply Estimates with Implications for Government Expenditure and Tax Policy in the United States," *American Economic Review,* May 1993, forthcoming.

Heckman, James J., and MaCurdy, Thomas E., "A Life Cycle Model of Female Labour Supply," *Review of Economic Studies*, 47, 1980, pp. 47- 74, and "Corrigendum on a Life Cycle Model of Female Labour Supply," *Review of Economic Studies*, 49, 1982, pp. 659-660.

Hotz, V. Joseph, Kydland, Finn, and Sedlacek, Gulherme, "Intertemporal Preferences and Labor Supply," *Econometrica*, 1988, 56(2), pp. 335-360.

Hsiao, Cheng, *Analysis of Panel Data*, New York: Cambridge University Press, 1983.

Kennan, John A., "An Econometric Analysis of Fluctuations in Aggregate Labor Supply and Demand," *Econometrica*, 56, 1988, pp. 317-334.

Killingsworth, Mark R., *Labor Supply*, New York: Cambridge University Press, 1983.

Kniesner, Thomas J., and Goldsmith, Arthur H., "A Survey of Alternative Models of the Aggregate US Labor Market," *Journal of Economic Literature*, XXV, 1987, pp. 1241-1280.

Lucas, Robert E., and Rapping, Leonard, "Real Wages, Employment, and Inflation," *Journal of Political Economy*, 77, 1969, pp. 721-754.

MaCurdy, Thomas E., "A Framework for Relating Microeconomic and Macroeconomic Evidence of Intertemporal Substitution," in *Advances in Econometrics -- Fifth World Congress of the Econometric Society Vol. II*, Ed.: Truman Bewley, New York: Cambridge University Press, 1987, pp. 149-176.

MaCurdy, Thomas E., "Appraising Tests of the Intertemporal Substitution Hypothesis," in *Panel Data and Labor Market Studies*, Eds.: Joop Hartog, Geert Ridder, and Jules Theeuwes, Amsterdam: North Holland, 1990, pp. 215-230.

Mankiw, N. Gregory, Rottenberg, Julio, and Summers, Lawrence, "Intertemporal Substitution in Macroeconomics," *Quarterly Journal of Economics*, 1985, 100(1), pp. 225-252.

Mroz, Thomas, "The Sensitivity of an Empirical Model of Married Women's Hours of Work to Economic and Statistical Assumptions," *Econometrica*, July 1987, 55(4), pp. 765-799.

Nakamura, Alice, and Nakamura, Masao, *The Second Paycheck, A Socioeconomic Analysis of Earnings*, Orlando, FL: Academic Press, Inc., 1985.

Survey of Income and Program Participation Users' Guide, U.S. Department of Commerce, Bureau of the Census, July 1987.

Table 1

Estimated Labor-Supply Wage Elasticities: Fixed-Effects Heckit and Tobit Models[a]

	Data Frequency: Triannual[b]			Data Frequency: Annualized[c]		
	Employment	Hours Worked[d]	Tobit[e]	Employment	Hours Worked[d]	Tobit[e]
Men[f]	0.86	0.39	1.05	0.57	0.45	0.69
Women[g]	2.39	0.66	2.25	0.37	0.88	1.06
Married Men[h]	1.08	0.38	1.14	1.37	0.46	0.84
Married Women	1.85	0.66	1.82	0.02	0.86	0.99
Single Men	0.65	0.42	0.70	0.59	0.43	0.42
Single Women	2.41	0.68	1.67	1.32	0.92	1.20

Equation[i]	**Regressor List**
Reduced-Form Employment	Education, t, t^2, young children, children, marital status, age, age^2, black, and interactions of t and t^2 with all other regressors
Structural Log Wage	Age, age^2, t, t^2, education, young children, children, marital status, black, interactions with t and t^2, and estimated inverse Mills' ratio
Structural Employment and Log Hours of Work	Instrumented log wage, t, t^2, education, young children, children, marital status, and estimated inverse Mills' ratio

Footnotes

[a]All estimated wage coefficients are significant at the 0.01 level.
[b]Data are the nine triannual observations in the Survey of Income and Program Participation, May 1983 to April 1986. Summary statistics appear in Appendix A.
[c]The nine triannual observations were summed or averaged to create three annual values.
[d]Based on estimated wealth elasticities of -0.02 for men and -0.01 for women.
[e]Fixed-Effects specification with same regressors as the corresponding Heckit.
[f]Number of observations = 20,763.
[g]Number of observations = 21,852.
[h]Only the wage coefficient was permitted to vary by marital status.
[i]All equations have person-specific non-stochastic intercepts.

Appendix A

Summary Statistics: Means (Standard Deviation)

Variable	Men (T=9)	Men(T=3)	Women(T=9)	Women(T=3)
Age	36.56	36.56	36.24	36.24
	(9.44)	(9.44)	(9.58)	(9.57)
Black	0.11	0.11	0.14	0.14
	(0.32)	(0.32)	(0.35)	(0.35)
Children	0.48	0.48	0.50	0.52
(1=yes)	(0.50)	(0.50)	(0.50)	(0.50)
Children<6 yrs.	0.26	0.28	0.25	0.27
(1=yes)	(0.44)	(0.44)	(0.44)	(0.44)
Education	12.97	12.97	12.79	12.79
	(2.86)	(2.86)	(2.57)	(2.56)
Employed	0.93	0.96	0.83	0.90
(1=yes)	(0.26)	(0.19)	(0.38)	(0.30)
Log Hours	6.05	7.33	5.18	6.58
	(1.74)	(1.31)	(2.43)	(2.01)
Log Real Wage	2.04	2.07	1.38	1.42
	(0.80)	(0.72)	(0.82)	(0.76)
Married	0.73	0.74	0.68	0.70
(1=yes)	(0.44)	(0.44)	(0.46)	(0.46)
Time	5.0	2.0	5.0	2.0
	(2.58)	(0.82)	(2.58)	(0.82)