Taxes, Transfers, and the Labor Supply of Single Mothers

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Abstract: How wages and non labor income affect both the decision to work and hours of work among single mothers is critical for understanding the work disincentive effects of tax and welfare policies, and the attendant design of optimal income tax and transfer schemes. I use data from the Current Population Survey and variation induced by fundamental reforms to the U.S. tax and welfare systems over the 1979-2001 period to estimate the labor-supply response of single mothers to changes in their after-tax and transfer wage rate and nonlabor income, conditional on whether or not they also participate in AFDC/TANF, food stamps, or SSI. I find that wage changes have a large effect on the decision to work (the average elasticity of employment is 1.3), but a small effect on hours of work (average compensated wage elasticity of 0.16) unless the wage change also alters the mother's decision to participate in AFDC/TANF, food stamps, or SSI. The estimates are consistent with a recent theoretical model by Saez (2002) that suggests that the optimal transfer policy is one that involves a modest income guarantee for non-workers coupled with subsidies for low-income workers much like the current EITC program.

Key Words: Conditional Labor Supply, Tax Reform, Welfare Reform, Instrumental Variables

The parameters governing labor supply at the participation (extensive) and hours worked (intensive) margins are focal for understanding the work disincentive effects of taxes and transfers (Blundell, Duncan, and Meghir 1998; Hausman 1981; Keane and Moffitt 1998; Ziliak and Kniesner 1999) and the attendant design of optimal tax and transfer schemes (Besley and Coate 1994; Kocherlakota 2005; Mirrlees 1971; Saez 2002).[1] For example, Saez (2002) demonstrates via simulation that if the bulk of the labor supply response is at the intensive margin then the optimal transfer policy is a negative income tax with a large guarantee and high phase-out rate. If instead the response is concentrated at the extensive margin, and the elasticity is at least 1, then the optimal policy is akin to an Earned Income Tax Credit with a smaller guarantee coupled with negative marginal tax rate at low incomes. Perhaps surprising, there is little empirical research providing direct estimates of net wage and nonlabor income effects at both margins to guide optimal policy discussions. Knowledge of these parameters is particularly important for understanding the dramatic changes in the labor supply of single mothers as they have been the target of much recent tax reform via EITC expansions as well as welfare reform (Blank 2002; Hotz and Scholz 2003). In this paper I use sweeping changes in U.S. tax policy, welfare policy, and the demand for skill over the 1980s and 1990s to identify the effect of taxes and transfers on the labor supply decisions of single mothers.

There is an abundance of research on labor supply at the intensive margin, especially for men (Blundell and MaCurdy 1999). The modal result is that the wage elasticity is positive, but small. While separate estimates for single mothers are less common, the typical result is that the elasticity is larger than that for men, but still inelastic (Moffitt 1992). On the contrary, research providing separate estimates for both the intensive and extensive margins is scarce (Heckman

[1] The elasticity of labor supply also plays a prominent role in real business cycle models of the macroeconomy, e.g. Kydland 1995; Prescott 2004.

1993; Meyer 2002). Kimmel and Kniesner (1998) are an exception. Using data from the 1984 Survey of Income and Program Participation they estimated a participation elasticity of 2.4 and an hours worked elasticity of 0.7 for single mothers. An important limitation of their results is that they did not account for the U.S. tax and transfer system in estimation. Heim (2006) provides structural estimates of family labor supply at both margins in the presence of income taxes, but not income transfers. Using a cross section of data from the 2001 Panel Study of Income Dynamics he finds elasticities at the extensive margin considerably smaller than typical, especially for married women, ranging from 0.1 to 0.2. Meyer and Rosenbaum (2001) did model the tax and transfer system but restricted attention to the participation margin for single mothers and did not provide a direct estimate of the wage elasticity. Inferring the participation response from changes in taxes paid, they find an average employment elasticity of just over 1. A number of reduced-form studies of the impact of tax and welfare policy changes on employment have emerged in recent years, but structural models are still rare (Moffitt 2002).

In this paper I begin to fill some of the gap in the literature by providing new structural estimates of the work disincentive effects of taxes and transfers at the extensive and intensive margins. Although the focus here is on labor supply, previous research suggests that among the population of single mothers labor supply decisions are not made in isolation of participation decisions in transfer programs (Moffitt 1983; Fraker and Moffitt 1988; Hoynes 1996; and Keane and Moffitt 1998). To admit such nonseparabilities between labor supply and welfare programs, while simultaneously maintaining transparency in model specification and identification, I adopt a conditional model of labor supply (Pollak 1969; Browning and Meghir 1991).

The basic idea of the conditional approach is to model decision-making by separating the “goods of interest,” which in this case is labor supply, from the “conditioning goods,” which here are transfer programs, including Aid to Families with Dependent Children (AFDC) and its Temporary Assistance to Needy Families (TANF), food stamps, and Supplemental Security Income (SSI). The key advantage of the conditional approach is that it is not necessary to specify the structure of constraints and preferences for the transfer programs (Browning and Meghir 1991). This implies that there is no need to model the various institutional rules governing the programs that lead to nonconvexities in budget constraints. Moreover, many families who are eligible for transfer programs do not sign up to receive benefits. The reasons for the existence of these so-called eligible nonparticipants are numerous and include information problems (not realizing they are eligible), hassles of signing up for benefits (e.g. lack of transportation, limited office hours, excessive paperwork), and the social stigma of welfare use. Indeed, Browning and Meghir (1991) mention that the conditional approach is particularly advantageous when the conditioning goods are not consumed by many households (or in this case where take-up rates in transfer programs are low). While the complication of eligible nonparticipation must be incorporated into the structure of preferences in the unconditional model, with the conditional approach one does not need to model these utility costs, and in the process may avoid a source of model misspecification.

At the same time, the conditional approach can accommodate the possibility that there are indivisible fixed costs of participating in transfer programs that leads to a discontinuity in labor supply behavior at the corner of nonparticipation in transfer programs. For example, participants in transfer programs incur fixed costs when enrolling because of the application process, which includes a detailed examination by caseworkers of the applicant’s income, assets, family structure, work readiness, and other criteria. Moreover, to qualify for SSI the applicant must undergo a medical examination to determine the extent to which a disability limits gainful employment on the part of an adult applicant or functional limitations for children. Programs also require periodic recertification to verify eligibility. For example, during the mid 1990s many states required their food stamp recipients to recertify quarterly. These transactions costs may interact with labor supply decisions, and the conditional approach allows for simple tests of such nonseparabilities. Indeed, the quasi-fixed aspect of transfer program participation and recertification may imply that for many single mothers the transfer decision is predetermined to the labor supply choice, which if true, lends naturally to the conditional model.[2]

Although the conditional approach simplifies model specification and estimation compared to the unconditional model, there are still important issues affecting estimation. Specifically, because marginal tax rates from federal and state income taxes are a function of work effort, as are transfer program eligibility and benefit levels, in estimation it is necessary to treat the net wage, virtual income, and transfer-program decisions as endogenous to labor supply choices. To identify model parameters I exploit the differential growth in marginal wages and virtual nonlabor incomes across birth-year and education cohorts of single mothers induced both by tax and welfare reforms as well as changing demands for skill in the 1980s and 1990s (Blundell, Duncan, and Meghir 1998). In addition to this differential growth in net wages I also utilize several policy variables that vary by family size, state of residence, and year to help identify the transfer-program variables. The instrumental variables estimator I employ extends the grouping estimator developed by Blundell, et al. (1998) to the dummy endogenous variable case common in the treatment effects literature (Heckman 1978; Wooldridge 2002).

[2] Pollak (1969) gave the example of housing as a quasi-fixed good because rental housing contracts typically range in duration from one to twelve months. This is akin to transfer program eligibility contracts. Browning and Meghir (1991) used a conditional model to estimate a consumption demand system. Because of possible nonseparability between consumption and leisure choices, the conditioning goods in their demand system were male and female labor supply. The CPS data I use does not contain information on consumption, and thus I am not able to model this extra margin. For the population of single mothers the nonseparability of transfer programs and labor supply is likely to take primacy over consumption decisions.

Using data on female-headed families from the Current Population Survey from 1979-2001, I find an average wage elasticity of employment of about 1.3 and a compensated hours-worked wage elasticity of 0.16, which implies that the results here are consistent with an optimal transfer policy based on an EITC with a low guarantee coupled with negative tax rates at low incomes. I also identify important heterogeneity in labor supply response to after-tax and transfer wage changes across transfer-program status. The hours-worked response to wage changes for working single mothers with no attachment to the transfer system is similar to that commonly found for married women and men (Mroz 1987; Blundell and MaCurdy 1999), but an auxiliary analysis indicates that the total labor supply response for mothers in transfer programs is highly elastic to wage changes at both margins. Finally, I find that failure to control for the fixed costs of transfer program participation results in an overstatement of intensive margin wage elasticities of labor supply by a factor of four, and an overstatement of the participation margin of about one-third.

II. A Conditional Model of Labor Supply

The most ambitious effort to date to structurally model labor supply in the presence of taxes and multiple transfer-program participation among single mothers is Keane and Moffitt (1998). They jointly model labor supply along with the decision to participate in Aid to Families with Dependent Children, the Food Stamp Program, and subsidized housing. To maintain tractability they reduce the labor-supply choice to three outcomes—no work, part-time, and full-time—and then use a simulated maximum likelihood estimator to identify utility parameters. Using a cross section of the 1984 SIPP panel Keane and Moffitt estimate an average uncompensated wage elasticity of labor supply of about 1.8, which is a convolution of both the participation and hours-worked margins much like one obtains in a Tobit model. The key advantage of their unconditional approach is that it permits out-of-sample simulations of the labor supply and transfer-program participation response to alternative tax and welfare reforms.

The drawback is that the joint modeling of labor supply and transfer program participation is a significant computational challenge, especially when it is necessary to specify federal and state-specific institutional characteristics of multiple tax and transfer programs across multiple time periods. Keane and Moffitt apply their model to a cross section, but if one wants to exploit time variation to identify model parameters then the dimension of integration grows exponentially. Moreover, the nonconvexities in the budget constraint introduced by transfer program rules imply a solution technique that requires comparing direct utility levels at all outcomes in order to find the global maximum. Among the numerous assumptions necessary to execute the joint model is the requirement that single mothers have complete knowledge of their budget frontiers, i.e. they know where each kink, corner, and hole exists due to the program rules and possible program interactions. This assumption has been challenged in the tax case with convex constraints (MaCurdy, et al. 1990), and is even more demanding in the nonconvex case. Qualitative research by Edin and Lein (1997), Leibman and Zeckhauser (2004), DeParle (2004), and Romich (2006) suggests single mothers possess some rudimentary knowledge of rules, e.g. that benefits fall with wages from work, but that deep knowledge of statutory tax rates and deductions is highly unlikely. This complete knowledge assumption is made more problematic with the 1996 welfare reform where welfare was further decentralized to the states and a multiplicity of new rules were introduced such as time limits on benefits and work requirements. A desirable alternative that maintains a structural interpretation on labor supply parameters and fosters identification of labor supply responses to wage and nonlabor income changes at both margins is to treat transfers as a set of conditioning goods.

To fix ideas consider the static model of labor supply in the presence of nonlinear income taxes and conditional on transfers. Note that the static model is not so restrictive among the population of single mothers given evidence that saving rates of this group are near zero (Hurst and Ziliak 2006). In any given period *t*, *t* = 1,…,T, the single mother *i*, *i* = 1,…, N, is assumed to have preferences $U(C_{it}, L_{it}; P_{it}^{G})$ over a composite consumption good C_{it} and leisure time L_{it}, conditional on transfer participation status P_{it}^{G}, which takes on a value of 1 if she participates in the program and 0 if not. The mother maximizes utility subject to the time constraint of $\bar{L} = L_{it} + h_{it}$, where $\bar{L}$ is total time available and h_{it} is hours of market work, and the current-period budget constraint

$$C_{it} = W_{it}h_{it} + N_{it} + P_{it}^{G}G_{it} - T_{t}(Y_{it}), \tag{1}$$

where W_{it} is the real before-tax hourly wage rate, N_{it} is real taxable non-transfer nonlabor income, $Y_{it} \equiv W_{it}h_{it} + N_{it}$ is real total taxable income, G_{it} is the real maximum benefit guarantee for welfare participants, and $T_t(Y_{it})$ is real tax payments.

The tax payment function encompasses direct taxation of wage and nonlabor income from federal (FED), state, and Social Security payroll (SS) tax systems, as well as the implicit taxation of wage and nonlabor income from the transfer system for participants

$$\begin{aligned} T_t(Y_{it}) = {} & T_t^{FED}(W_{it}h_{it}, N_{it}, E_{it}^{FED}) + T_t^{SS}(W_{it}h_{it}, E_{it}^{SS}) + T_t^{STATE}(W_{it}h_{it}, N_{it}, E_{it}^{STATE}) + \\ & P_{it}^{G} \times T_t^{G}(W_{it}h_{it}, N_{it}, E_{it}^{G}), \end{aligned} \tag{2}$$

where each component is a function of both wage and nonlabor income (except for the payroll tax) and each tax schedule consists of different deductions and exemptions (*E*). The federal tax function includes the EITC parameters, as does the state tax function for those states with state

EITC programs. Defining $\tau_{it} \equiv T_t'(Y_{it})$ as the marginal tax rate, the resulting after-tax wage rate is $\omega_{it} = W_{it}(1-\tau_{it})$, where $\tau_{it} = \tau_{it}^{FED} + \tau_{it}^{SS} + \tau_{it}^{STATE} + P_{it}^{G} \times \tau_{it}^{G}$.

Assuming that there are only two labor-market states, employed and not employed, the decision to work boils down to a comparison of utilities in the employed state, $U(C_{it}, L_{it} < \bar{L}; P_{it}^{G})$, to the not employed state, $U(C_{it}, L_{it} = \bar{L}; P_{it}^{G})$. If we define the net gain from employment as $\Delta_{it} = U(C_{it}, L_{it} < \bar{L}; P_{it}^{G}) - U(C_{it}, L_{it} = \bar{L}; P_{it}^{G})$, then the indicator variable e_{it} = 1 if $\Delta_{it} > 0$ and e_{it} = 0 otherwise. Assuming that the stochastic component of the employment decision is distributed normal then the probability of working is a structural probit model, $P_{it}^{e} \equiv P(e_{it} = 1) = \Phi(\bullet)$. Because the mother chooses to work iff the offered after-tax market wage ω_{it} exceeds the reservation wage (i.e. the inverse of the labor supply function when all time is spent in leisure, $L_{it} = \bar{L}$), the structural equation for the probability of employment has the same covariates as the structural hours-worked equation. That is, the same set of variables determines the structural extensive and intensive labor supply choices. This requirement does not apply to the reduced-form equations and this extra variation will be exploited in identification of the structural model.

For mothers choosing work, equilibrium hours worked at the intensive margin is found by equating the marginal rate of substitution of leisure for consumption to the real after-tax hourly wage, $\frac{\partial U / \partial L}{\partial U / \partial C} = \omega_{it}$. When confronted with a convex budget set such as that from progressive income taxation the equilibrium hours worked equation can be solved simultaneously with the extensive margin equation as in a Tobit-type model (Heckman and MaCurdy 1980). However, the Tobit model imposes a proportionality relationship between the coefficients on the two margins and does not easily accommodate the presence of fixed costs of work. Thus, a more robust approach is to estimate the two margins separately (Mroz 1987; Zabel 1993).

In addition, when estimating the intensive margin in the presence of nonlinear income taxes one approach is to specify the complete budget frontier and have the worker simultaneously choose the marginal tax rate segment and hours of work conditional on segment choice (Hausman 1981). MaCurdy, Green, and Paarsch (1990) argue against this approach because it effectively imposes global satisfaction of the Slutsky condition at all internal kink points, contrary to much empirical evidence. Instead, a robust alternative is to linearize the constraint by taking the net wage as given and adding a lump-sum transfer equal to $\tau_{it}W_{it}h_{it} - T_t(Y_{it})$ to nonlabor income to yield “virtual” nonlabor income, $\tilde{N}_{it}$. The role of this transfer is to compensate the worker so that they behave as if they faced a constant marginal tax rate at all income levels. In estimation one treats the net wage and virtual income terms as endogenous and applies instrumental variables. This is the approach followed here.

A. Specifying Preferences

I follow the labor supply literature that relies on repeated cross-section data and specify a base-case semi-logarithmic labor supply schedule for the intensive margin of hours worked as

(3) $$h_{it} = \alpha + \beta \ln \omega_{it} + \gamma \tilde{N}_{it} + X_{it}\varphi + P_{it}^{G}\psi + u_{it},$$

where $\tilde{N}_{it} = N_{it} + P_{it}^{G} \times G_{it} + \tau_{it}W_{it}h_{it} - T_t(Y_{it})$ is virtual nonlabor income, X_{it} is a vector of demographics affecting hours choices, P_{it}^{G} is a vector of indicator variables intended to capture the possible fixed costs of participation in transfer programs, and u_{it} is a structural error term. The intensive-margin wage elasticity of hours worked used in optimal tax and transfer rules is simply $\hat{\beta} / h_{it}$.

The corresponding specification for the participation decision assuming normality of the error term is

(4) $$P_{it}^{e} = P(h_{it} > 0) = \Phi(\alpha^{e} + \beta^{e} \ln \omega_{it} + \gamma^{e} \tilde{N}_{it} + X_{it}\varphi^{e} + P_{it}^{G}\psi^{e}) ,$$

where the '*e*' superscript denotes that the coefficients across equations (3) and (4) need not be the same, contrary to the standard Tobit model that imposes proportionality across the parameters of each margin. The associated participation elasticity with respect to the net wage is $\hat{\beta}^{e} * \frac{\hat{\phi}_{it}(\bullet)}{\hat{\Phi}_{it}(\bullet)}$, where $\hat{\phi}, \hat{\Phi}$ are the pdf and cdf of the normal distribution evaluated at the estimated parameters for each observation in the sample. A key advantage of the conditional approach is the convenience of testing for weak separability between the goods of interest and the conditioning goods. Specifically, testing for separability between labor supply and fixed transfer-program participation decisions is a t- or Wald-test of the null hypothesis that $\psi = 0$ and $\psi^{e} = 0$.

A note on interpretation of the parameters in the conditional model is warranted. When the transfer decision is predetermined to labor supply then the unconditional and conditional supply responses to wage and nonlabor income changes are the same (Pollak 1969). However, if transfer decisions are not predetermined then all labor-supply responses are conditional on the quantities of the transfer decisions. To see this note that the partial effect of the wage change on hours worked is

(5) $$\frac{\partial h_{it}}{\partial \omega_{it}} = \frac{\beta}{\omega_{it}} + \frac{\partial h_{it}}{\partial P_{it}^{G}} \frac{\partial P_{it}^{G}}{\partial \omega_{it}} + \frac{\partial h_{it}}{\partial \tilde{N}_{it}^{G}} \frac{\partial \tilde{N}_{it}^{G}}{\partial \omega_{it}} .$$

The first term is the usual uncompensated wage effect, while the second term captures the effect of a wage change on the likelihood of participation in transfer programs, and the third term captures the effect of a wage change on the size of the transfer program benefit. The latter effect can be both due to programmatic rules that tax wage income as well as due to the fact that a wage change might alter the length of stay on the transfer program. The first term in (5) comes from direct estimation of equation (3), as do the first partial derivatives on each of the next two terms, $\frac{\partial h_{it}}{\partial P_{it}^{G}}$ *and* $\frac{\partial h_{it}}{\partial \tilde{N}_{it}^{G}}$. The last two terms in equation (5) are zero if hours worked are not affected by fixed costs of transfers or if the virtual income effect is zero. Moreover, the last two terms will be zero if we treat the transfer program decision as predetermined to the labor supply decision, i.e. if $\frac{\partial P_{it}^{G}}{\partial \omega_{it}} = \frac{\partial \tilde{N}_{it}^{G}}{\partial \omega_{it}} = 0$. In this case, transfers are the default state and thus marginal decisions are made about whether to work and for how many hours. This may be applicable to some segments of the low-income population, but there is no systematic evidence to suggest that it is a defining characteristic. One way around this shortcoming is to conduct an auxiliary analysis of the transfer-program decision in response to structural wage changes which permits calculation of total labor supply responses to wage changes across various transfer-program states. I discuss this in more detail below in the results section.

B. Identification

In equations (3)–(4) the net wage and virtual income variables are endogenous to the labor supply choice. This endogeneity emanates both because the net wage and virtual incomes are a function of the marginal tax rate, which itself is a function of the labor supply choice, and because of possible non-random self-selection into the labor market. Non-random sample selection implies that we observe wages for workers only, such that even in the absence of taxes and transfers, failure to account for self selection leads to inconsistent estimates of $\hat{\beta}$ and $\hat{\beta}^{e}$.

To control for both forms of endogeneity I adopt the identification scheme proposed by

Blundell, et al. (1998) in their application to labor supply of married women in the U.K. Specifically, I assume that that the endogeneity of the net wage and virtual income arises from four sources. The first is common macroeconomic shocks, δ_t, such as federal tax and welfare reforms, that affect all mothers the same in a given year but vary over time. The second source is cohort-specific unobserved heterogeneity, δ_j, for cohort *j* = 1,…,J, under the assumption that members of the same cohort face cohort-level shocks to preferences and the effect of these shocks vary across cohorts but not over time. The third source is time-varying composition effects, λ_{it}, that arise from the fact that different groups of mothers may non-randomly choose to work in response to tax and welfare reforms. Under the standard normal distribution $\lambda_{it} = \phi_{it} / \Phi_{it}$ is the typical inverse Mills ratio (Heckman 1979). In addition to the three assumptions made by Blundell, et al. (1998), I add a fourth source of endogeneity, state-specific unobserved heterogeneity, δ_s, for state *s* = 1,…,51. This additional state-specific source of heterogeneity has been found to be important in both U.S. labor markets and welfare usage (Blanchard and Katz 1992; Ziliak, et al. 2000).

Combining these four sources leads to the expected value of the structural error conditional on time period *t*, cohort *j*, state *s*, and labor force composition P_{it}^e as

(6) $$E[u_{it} \mid t, j, s, P_{it}^e] = \delta_t + \delta_j + \delta_s + \sum_{k=1}^{K} \delta_k \lambda_{it}^{(k)} ,$$

where the last term is a generalized residual that admits possible non-linearity in labor force selection via higher order terms of the inverse Mills ratio (Lee 1984). As a matter of practice I will append to each equation (3)–(4) a series of indicator variables for year, cohort, and state. In addition, I will append a third-order expansion of the selection correction term to equation (3) and estimate the hours worked equation on workers only.[3] The selection correction terms enter the participation equation via the structural wage equation as described below.

Based on the error process described in equation (6) identification of model parameters requires that after-tax wages and virtual incomes grow differentially across cohorts over and above a fixed group effect, a fixed time effect, a fixed state effect, and (possibly nonlinear) changes in labor force composition.[4] This differential growth needs to come from tax and welfare reforms as well as secular changes in the macroeconomy such as rising returns to skill. Hence, selecting the way groups are defined is critical to identification. Following Blundell, et al. (1998) I group single mothers according to birth-year and education level. Specifically I construct thirteen 5-year birth cohorts and three education levels to create 39 birth-year by education groups. Thus, the requirement here is that tax and welfare reforms, coupled with a changing demand for skill, altered the economic rewards to work—not just the cross-sectional distribution of rewards, but also the distribution across birth-year and education cohorts.

To see that this variation is present among a sample of single mothers in the Current Population Survey (sample selection details are given in the data section), I first report in Table 1 changes in the cross-sectional distribution of marginal tax rates and gross and net hourly wages for the peak business-cycle years of 1979, 1989, and 1999. The marginal tax rates are generated by running the sample of single mothers in the CPS through the National Bureau of Economic Research's *TAXSIM* program. The *TAXSIM* tax rates are the sum of federal, state, and payroll (employee contribution only) tax rates, inclusive of federal and state EITCs. The first panel on Table 1 reveals that the distribution of marginal tax rates faced by single mothers changed

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[3] The Lee (1984) correction under normality is $E[u_{it} \mid P_{it}^{e}=1]=\rho_1 \frac{\phi(g_{it}'\xi)}{\Phi(g_{it}'\xi)}-\rho_2 \frac{g_{it}'\xi\phi(g_{it}'\xi)}{\Phi(g_{it}'\xi)}+\rho_3\left[(g_{it}'\xi)^2-1\right]\frac{\phi(g_{it}'\xi)}{\Phi(g_{it}'\xi)}$.

[4] Note that the model collapses to the standard difference-in-difference estimator if there are just two groups and two time periods, and no correction for time-varying sample selection.

dramatically over the past twenty years, especially at the 25th percentile and median. The increasing negative rates at the 25th percentile reflect expansions in the EITC and the growth of working low-income single mothers. The increase at the median is not driven by higher marginal tax rates—in fact they were cut between 1979 and 1999—but instead reflect the growing economic status of many single mothers, i.e. they are moving up the wage distribution and thus the distribution of tax rates.

[Table 1 here]

The second panel appends to the marginal tax rate the effective tax rates in AFDC/TANF, food stamps, and SSI for those single mothers participating in the respective programs. Several authors have noted that because of the widely divergent AFDC programs across states and over time, and also substantial within-state variation in program implementation across counties within a state, that the statutory benefits and marginal tax rates in AFDC (100 percent over most of this sample period) bear little resemblance to the effective guarantees and tax rates (Fraker, et al. 1985; McKinnish, et al. 1999). In the appendix I describe how I estimate these effective tax rates and guarantees, drawing on the analysis of Ziliak (2006). There are two outcomes of note in the second panel of Table 1. The first is that the effective marginal tax rate inclusive of transfers is considerably higher than the rate without transfers, especially in the bottom half of the distribution. Because the estimates in Table 1 include nonparticipants in transfer programs the effective marginal rates understate the actual marginal rates faced by participants. Indeed, the cumulative effective rates approach 80 percent at the median in the 1980s among workers who also participate in AFDC and food stamps. The second outcome of note is the substantial decline in the effective marginal tax and transfer rate in 1999. This reflects both the more generous EITC subsidy rate and the fact that most states expanded the earnings disregards and cut the statutory welfare tax rates as part of the 1990s welfare reforms, and thereby reduced effective tax rates on earned income in order to foster transitions from welfare to work (Ziliak 2006).

The remaining three panels in Table 1 show changes in the distribution of gross and net wages (with and without the extra tax imposed by transfer programs). The important developments here are the rising real before-tax and after-tax and transfer wages between 1989 and 1999, especially at the low end of the income distribution. The results in Table 1 clearly point to a rising return to work across the distribution of single mothers.

[Figures 1–4 here]

In order to identify the wage and nonlabor income effects of labor supply under the model assumptions there must be more than changes in the cross-section distribution of after-tax and transfer wage rates. Importantly, as demonstrated in Figure 1, the rising returns to work have not changed uniformly across birth-year and education cohorts. In Figure 1 I depict the life-cycle profile of net wage rates (not including transfer-income taxes) for thirteen 5-year birth cohorts of single mothers across three education categories. The figure reveals that the youngest birth cohorts have differentially benefited from social policy reforms and productivity growth (e.g. the net wage of 23 year olds in the young cohorts exceed that received by older cohorts at the same point in their life cycle), and among the young birth cohorts, mothers with fewer that 12 years of schooling have gained more than other education groups. This differential growth in after-tax wages has coincided with cohort-specific differences in participation in the labor force and in transfer programs. Figures 2–5 depict the life-cycle evolution in employment, AFDC, SSI, and food stamps for the thirteen birth cohorts by three education groups. It is clear that young mothers in the most recent birth cohorts are much more likely to work, much less likely to receive cash assistance from AFDC/TANF, more likely to receive disability assistance from SSI, and less likely to receive food stamps. The descriptive evidence in Table 1 and Figures 1–5 suggest that a promising method of identifying wage and nonlabor income elasticites in a model of labor supply conditional on transfer-program decisions is via exploiting heterogeneity in wage and income growth across cohorts.

The structural assumptions in equation (6) imply a series of exclusion restrictions to identify the first-stage parameters from the structural parameters; namely, a complete interaction of cohort and year effects, i.e. $\delta_t \otimes \delta_j$. If we followed all 39 groups over the 23 years this would provide 897 exclusion restrictions to use in the reduced-form prediction equations of wages, virtual income, transfer-program participation, and labor-force participation, though fewer restrictions are available in practice because older cohorts age out of the sample and new cohorts enter in later years.[5]

In addition to cohort-year interaction effects, identification of transfer-program participation P_{it}^{G} and virtual income $\tilde{N}_{it}^{G}$ in equations (3) and (4) is aided by exploiting macroeconomic and programmatic information that varies across states and time periods. Based on the extensive literature on the role of the economy and tax and welfare reform on transfer-program participation (e.g. Grogger 2003; Meyer and Rosenbaum 2001; Moffitt 2003; Ziliak, et al. 2000), these additional exclusion restrictions include the state unemployment rate, the log of the state minimum wage, the party affiliation of the state's governor, and an indicator for the implementation of welfare reform.

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[5] Ideally with enough data one could further interact each cohort and year by state of residence. This would result in over 45,000 exclusion restrictions. Clearly the samples in the CPS are not large enough to admit this additional source of variation.

C. Estimation

Estimation of equations (3)–(4) proceeds in four steps. The first step is to estimate the reduced-form prediction equations for net wages, virtual income, labor-force participation, and transfer-program. Define the vector of dependent variables as $d_{it}^{r} = [\ln \omega_{it}, \tilde{N}_{it}, P_{it}^{G}]$, and the vector of covariates as Z_{it}^{r}, then the reduced-form equations are

$$(7) \qquad d_{it}^{r} = Z_{it}^{r}\Theta^{r} + \delta_{t}^{r} + \delta_{j}^{r} + \delta_{s}^{r} + \delta_{t}^{r} \otimes \delta_{j}^{r} + \upsilon_{it}^{r},$$

where *r* denotes the equation being estimated (i.e. net wage, virtual income, employment, transfer program) and υ_{it}^{r} is an error term assumed to be uncorrelated with the observed covariates and latent heterogeneity.

Following Blundell, et al. (1998) the equations for the net wage and virtual income are estimated via least squares on the sample of workers only, saving the fitted residuals $\hat{\upsilon}_{it}^{\omega}$ and $\hat{\upsilon}_{it}^{\tilde{N}}$. These residuals will be included in estimating the hours worked equation (3) to control for the endogeneity of the net wage and virtual income. The reduced-form equations for employment, AFDC/TANF, food stamps, and SSI are estimated via probit maximum likelihood on the sample of workers and non-workers. The parameters of the employment equation are used in construction of the sample selection correction terms as described in footnote 3, and the parameters from the three transfer equations are used to construct fitted probabilities of participation $\hat{\Phi}_{it}^{G}$ to be used as instruments in the conditional labor supply model.

The second step of estimation produces the intensive-margin parameters by applying instrumental variables to the conditional hours worked equation (3) for workers only with the various controls for selection and endogeneity as

$$(8) \qquad h_{it} = \alpha + \beta \ln \omega_{it} + \gamma \tilde{N}_{it} + X_{it}\varphi + P_{it}^{G}\psi + \delta_{t} + \delta_{j} + \delta_{s} + \theta_{\omega}\hat{\upsilon}_{it}^{\omega} + \theta_{\tilde{N}}\hat{\upsilon}_{it}^{\tilde{N}} + \sum_{k=1}^{3}\delta_{k}\hat{\lambda}_{it}^{k} + \zeta_{it},$$

using the reduced-form fitted probabilities for transfer-program participation as instruments for the vector of participation dummies P_{it}^{G}. This estimator is a dummy endogenous variables version of the grouping estimator (Heckman 1978; Heckman and Robb 1985). Under the null hypothesis that $\theta_{\omega} = \theta_{\tilde{N}} = \delta_k = 0$, the usual asymptotic standard errors for equation (8) is valid. If the null is rejected then the standard errors should account for the additional sampling variation induced by the estimated parameters. Blundell, et al. (1998) construct asymptotic standard errors that adjust not only for the generated regressors but also for any additional within-cohort autocorrelation in hours worked. Because I am using higher-order terms for the selection correction, the asymptotic formula are more complex than in Blundell et al., and as a consequence, I instead compute regression-based cluster-bootstrap standard errors where the clusters account for within-cohort autocorrelation (Efron and Tibshirani 1993).[6]

The third step of estimation involves estimating the structural wage equation on workers only and controlling for non-random selection into the labor force

$$(9) \qquad \ln \omega_{it} = a_0 + X_{it} a_1 + \delta_t + \delta_j + \delta_s + \sum_{k=1}^{3} \delta_k \hat{\lambda}_{it}^{k} + \varsigma_{it} \; .$$

The final step produces extensive-margin parameters by estimating the structural employment equation (4) via probit maximum likelihood by replacing the actual wage with the predicted log net wage $\ln \hat{\omega}_{it}$ from (9) for both workers and non-workers (Lee 1978; Kimmel and Kniesner 1998). Because of possible endogeneity of virtual income and transfer-program status to the employment decision, I replace the actual values in equation (4) with their reduced-form predicted values $\hat{d}_{it}^{\tilde{N}}, \hat{d}_{it}^{P^G}$ for all sample members from equation (7).

[6] The cluster bootstrap standard errors are not too different from the standard heteroskedasticity robust standard errors, except for the wage coefficient where the bootstrap standard error is about 30 percent higher.

III. Data

The data come from the 1980–2002 waves (1979–2001 calendar years) of the March Annual Social and Economic Study of the Current Population Survey (CPS). The unit of observation is single female family heads between the ages of 18 and 60 who are not self employed, are not farmers, and who have children present under the age of 18. The mothers are allocated to thirteen different five-year date of birth cohorts (starting in 1919 and ending in 1983), and within each birth cohort, three separate education groups of less than high school, high school graduate, and more than high school, yielding thirty-nine separate birth-education cohorts. The five birth cohorts from 1939 to 1963 provide complete information over the entire sample period, but the earlier and later cohorts only provide partial information for identification much like one would find in a standard unbalanced panel of families. Because the consistency of the grouping estimator is based in part on the number of observations per cell being large, I follow Blundell et al. (1998) and drop cohort-education cells with fewer than 50 observations.

The mother's gross hourly wage, W_{it}, is defined as the ratio of annual earnings to annual hours of work (annual weeks worked times usual hours per week). If the respondent refuses to supply earnings information, then the Census Bureau uses a "hotdeck" imputation method to allocate earnings to those with missing data. Bollinger and Hirsch (2006) argue that including allocated data generally leads to an attenuation bias on the coefficients on imputed data. Hence, I follow their recommendation and drop those mothers with allocated earnings, resulting in a reduced sample of about 10% of observations in a typical year.[7] To construct the after-tax wage I estimate marginal tax rates across the federal, state, payroll, and EITC tax schedules from 1979 to 2001 for each of the female heads using the NBER *TAXSIM* program. The *TAXSIM* module

[7] Indeed, in results not tabulated, including mothers with allocated wages results in a 10–15% attenuation in the wage elasticities of labor supply.

uses basic information on labor income, nonlabor income (defined as family income less mother's earnings and nontaxable transfers), dependents, and certain deductions such as property tax payments and child care expenses, and from this information calculates a federal marginal tax rate, the state marginal tax rate, and the payroll tax rate.[8] The federal and state marginal tax rates include the respective EITC code for each tax year and state, thus allowing for the possibility of negative marginal rates. The *TAXSIM* payroll rate assumes that the worker bears the full burden of the payroll tax (employer and employee share), which implies perfectly inelastic labor supply. Since the latter is a behavioral response estimated in this paper, and not simply assumed, I only assess the employee share. For workers who participate in AFDC/TANF, food stamps, and/or SSI I append the respective effective marginal tax rate on earnings described in the Appendix to the marginal rate produced by *TAXSIM*. All wage and income data were deflated by the 2001 personal consumption expenditure deflator. There were 9 women with real after-tax hourly wage rates exceeding $500 per hour but with inconsistent data; thus, those observations were deleted. There remain 78,851 observations for estimation.

I link the transfer-program benefit guarantees used in constructing virtual income for transfer participants and state-level instruments used for identification to the CPS data using unique state identifiers for each family in the CPS. The AFDC/TANF benefit varies by state, year, and family size (defined here for two, three, and four or more family members); the SSI benefit I use is applicable for individuals, is federally set and updated for inflation, and also includes the state supplementation benefit for those states with a supplemental SSI program; the food stamp benefit is federally set and updated for inflation and varies by family size (again

[8] The CPS does not have information on certain inputs to the *TAXSIM* program such as annual rental payments, child care expenses, or other itemized deductions. I set these values to zero when calculating the marginal tax rate, but I do not expect these omissions to impart much bias among the sample of single mothers who tend to use the standard deduction.

defined for two, three, and four or more person families). The unemployment rates are obtained from the Bureau of Labor Statistics (URL: http://www.bls.gov/lau/home.htm), the data on state minimum wages are from annual issues of the Bureau of Labor Statistics *Monthly Labor Review* (URL: http://www.bls.gov/opub/mlr/mlrhome.htm), data on AFDC/TANF, SSI, and food stamp benefits, as well as EITC tax parameters, are from the U.S. Congress Committee on Ways and Means *Green Book* (URL: http://waysandmeans.house.gov/Documents.asp?section=813 and http://aspe.hhs.gov/2000gb/), data on implementation dates of welfare waiver policies are from the Office of the Assistant Secretary for Planning and Evaluation in the U.S. Department of Health and Human Services (URL: http://www.aspe.hhs.gov/hsp/Waiver-Policies99/policy_CEA.htm), and data on party affiliation of state governors is from the *Statistical Abstract of the United States* (http://www.census.gov/prod/www/abs/statab.html). Appendix Table 1 contains summary statistics for the variables used in estimation.

IV. Results

In Table 2 I present the base case estimates of the conditional labor supply model of equation (8) for the intensive margin, and for the extensive margin in equation (4) after substituting in the predicted structural wage from equation (9). Each equation controls for a complete set of linear cohort, year, and state effects, but these are suppressed for ease of presentation. The first two columns are based on the flexible selection correction proposed by Lee (1984), while the last two columns are based on the standard Heckman (1979) correction. Before discussing the structural estimates there are a few results of note in the reduced-form transfer-program participation equations in Appendix Table ? (to be added later). Both AFDC/TANF and food stamp participation are highly countercyclical over the business cycle, consistent with the aggregate welfare caseload literature (Ziliak, et al. 2000; Blank 2002). In addition, participation in both AFDC/TANF and food stamps declines with increases in the state minimum wage, though the effect is only significant in the case of food stamps. One final comment on the first stage is merited. While the reduced-form models explain AFDC/TANF and food stamp participation well, the quality of the first stage SSI model is less strong. Given that only 5% of single-mother families participate in SSI over the sample period compared to 33% in AFDC and 40% in food stamps (see Appendix Table 1), it is not surprising that explaining the variation in SSI is more difficult.

[Table 2 here]

The parameters on the hours worked equation in Table 2 conform well with economic theory—a positive uncompensated wage effect and negative nonlabor income effect, which guarantees satisfaction of Slutsky integrability required for welfare and optimal tax analysis. Moreover, the estimates indicate that mothers with young children work fewer hours than those with adolescents and teenagers, and that white mothers work about 50 more hours per year on average than non-white mothers. There is strong rejection of the exogeneity of the net wage (note that this test is a simple t-test on the wage residual coefficient), as well as strong rejection of the null of no non-random sample selection. Simple t-tests on the AFDC/TANF and food stamp participation indicator variables strongly reject the null of separability between transfer-program decisions and labor supply decisions. At the intensive margin, a single mother on AFDC/TANF works 540 fewer hours per year than a mother not on the program. If the working mother combines AFDC with food stamps, as 15% of working AFDC moms do in this sample (between 80 and 90% of working and unemployed AFDC moms also receive food stamps), then she works about 938 hours less per year than a working single mother not on those programs. Allowing for separate effects of food stamps and AFDC is important because over 10% of working single mothers in the sample receive food stamps but not AFDC/TANF. Collectively, the results suggest that there are large fixed costs of transfer-program participation and these costs reduce labor-market effort.

The results of the structural employment participation equation are reported in the second column of Table 2. Again, the estimates align with theory; namely, a positive substitution effect at the extensive margin (the nonlabor income effect is weakly zero). It is also clear from the structural employment equation that participation in AFDC/TANF and/or food stamps significantly reduces the probability of working. There is no statistical evidence that SSI affects labor supply decisions at either the intensive or extensive margins, though as noted above identification of SSI participation is difficult. In results not tabulated, I treated SSI as exogenous and in that case the SSI coefficient at the intensive margin is about -250 hours and statistically significant.

The remaining two columns of Table 2 offer a sensitivity check on modeling of the selection process. Specifically I impose linearity in the selection process as proposed originally by Heckman (1979). The base case results are qualitatively the same under linear selection, though the uncompensated wage effect is considerably larger with the coefficient rising from 79 to 104. While the results in the first column clearly reject the linear selection correction model of Heckman in statistical terms, the misspecification of using the linear correction also has nontrivial economic consequences by imparting too much explanatory power to the wage effect when in fact it is selection.

[Table 3 here]

In Table 3 I tabulate the attendant the uncompensated and compensated wage elasticities of hours worked from the parameters in Table 2, along with the wage elasticity of employment at the extensive margin. At the mean the uncompensated wage elasticity is an inelastic 0.14, and the corresponding compensated elasticity is 0.16, reflecting the small nonlabor income effect found in much labor supply research (Blundell and MaCurdy 1999). Because of the influence of outliers, the median elasticities are less than half the mean. The wage elasticity of employment is 1.34 at the means and 1.0 at the median. The base case results indicate clearly that the wage elasticity at the extensive margin dominates the intensive margin, and given that the employment elasticity is at least 1, the results are consistent with an optimal transfer scheme akin to the EITC program.

A. Total Labor Supply Elasticities

As highlighted in equation (5) a possible limitation of the conditional approach is that unless transfer participation and transfer income is treated as predetermined (or that the effect of transfers on labor supply is zero) it is necessary to interpret behavioral responses conditional on the quantities of those goods. Browning and Meghir (1991) suggest that one way to relax this assumption is to conduct an auxillary analysis on the conditioning goods. I do so here by estimating structural transfer-program participation equations. For simplicity I focus on the direct effect of participation and assume that virtual income is predetermined with respect to the wage, implying that I set the third term in equation (5) to zero. For the structural transfer decisions I estimate via probit the model

$$(10)\qquad P_{it}^{G} = P(G_{it} > 0) = \Phi(\alpha^{G} + \beta^{G}\ln\hat{\omega}_{it} + \gamma^{G}\hat{\tilde{N}}_{it} + X_{it}\varphi^{G} + \delta_t + \delta_j + \delta_s)\,,$$

where G =[AFDC/TANF, SSI, food stamps], $\ln\hat{\omega}_{it}$ is the predicted structural wage and $\hat{\tilde{N}}_{it}$ is the predicted virtual income.

Estimation of equation (10) yields $\hat{\beta}^{G}$ and $\hat{\gamma}^{G}$ that are plugged into equation (7) to yield the total uncompensated and compensated wage effect. The expectation is that these coefficients are negative, i.e. higher wages and nonlabor income reduce transfer program participation, and given that transfer participation reduces hours worked, the second term in equation (5) will be positive. In other words, workers reliant on transfers will be more responsive to wage changes than those not reliant on these programs. The results of the structural transfer participation equations and attendant wage elasticities are reported in Appendix Table 3. I conduct a similar analysis for the structural employment equation to generate total elasticities at the work participation margin.

[Table 4 here]

In Table 4 I record the total wage elasticities of hours worked and participation based on the estimates from Lee (1984) selection correction reported in Table 2. It is important to recognize that the intensive-margin elasticities are mixtures of distributions—a continuous hours response plus a discrete participation response via changes in transfer program participation. I report the uncompensated and compensated elasticities for working single mothers across six separate transfer-program states: no transfers, AFDC/TANF alone, food stamps alone, AFDC/TANF and food stamps, SSI and food stamps, and all three programs. The corresponding employment participation elasticities are computed for both workers and non-workers. For working mothers not on any transfers (just over 70% of working moms fall into this group) the average uncompensated wage elasticity is a positive but small 0.07 and the compensated elasticity is 0.10. These estimates suggest that single mothers not receiving assistance from three of the primary transfer programs have small hours worked responses to wage changes much like their married counterparts (Mroz 1987) and like prime-age men in general (Blundell and MaCurdy 1999).

On the contrary, single mother's who participate in transfer programs are more responsive to wage changes than those not reliant on transfers, and their hours-worked responses are in general highly elastic at the means. For those on AFDC/TANF alone the uncompensated wage elasticity is 1.14 and for those on AFDC/TANF and food stamps the elasticity is 4.24. Recall that the elasticity is computed with hours worked in the denominator, and average annual hours worked for single mothers on both programs is less than half (860 hours) the average hours of mothers not on any programs (1900 hours). Thus, the elasticity at the median is perhaps more instructive but is still a substantial 1.07 for those on both AFDC and food stamps. At the extensive margin it is clear that mothers not on income or food assistance have a robust participation elasticity of 1.0 at the means, but this is considerably lower than the comparable responses for single mothers receiving assistance. Collectively, these results suggest that work and transfer-program participation are substitutes and that policies that increase after-tax wages will lead to lower transfer use and significantly higher labor supply effort.

B. Robustness

In Table 4 I presented results reflecting the heterogeneity of labor supply response to wage changes across transfer program status. Because the family head is the sole caregiver among the population of single mothers, it is widely believed that mothers with young children are less responsive to wage changes, and that responsiveness might be less for women with many children. As a check on the base case assumption I reestimate the nonlinear selection model in Table 2 but add interactions between the after-tax wage and the dummy variable for the presence of young kids and the number of children under age 18. Prior to interacting the variables I demean the log wage which means that the direct wage coefficient yields the so-called average treatment effect on the treated and the interaction terms yield heterogeneous treatment effects (Wooldridge 2002).

[Table 5 here]

In the first two columns of Table 5 I record the parameter estimates for the hours of work and participation equations. Although the average uncompensated wage effect is little changed from the base case, single mothers with young children and mothers with many children are economically and statistically significantly less likely to alter labor supply behavior in response to a wage change, especially at the intensive margin. The hours-worked wage coefficient is less than half the average among mothers with children under the age of 6.

The second specification check recorded in the last two columns of Table 5 examines the importance of controlling for the fixed costs of transfer program participation, or rather, the bias from ignoring such fixed costs. I return to the base case specification in Table 2 but zero out the coefficients on the transfer program indicator variables. The results in Table 5 reveal that conditioning on fixed participation decisions has a substantial impact on the estimated wage and nonlabor income parameters at both the intensive and extensive margins. In terms of elasticities, at the means the intensive margin uncompensated and compensated wage elasticities are 0.59 and 0.69 compared to the base case of 0.14 and 0.16; that is, ignoring the fixed costs of transfer participation generates an upward bias of a factor of 4. The extensive margin elasticities are 1.77 at the mean and 1.36 at the median, which is a third larger than that base case estimates. reduced The results clearly indicate that assuming separability between the labor supply choices and transfer-program decisions of single mothers is a misspecification and overstates the work disincentive effects of income taxation for the typical single mother.

C. Welfare Analysis

To be added…..

V. Conclusion

I use sweeping changes in the U.S. tax and transfer system, coupled with changes in the demand for skill, to identify the wage elasticities of labor supply for single mothers at the extensive and intensive margins in a conditional model of labor supply. In the base case I estimate a wage elasticity of employment of about 1.3 and a compensated wage elasticity of hours worked of about 0.16. Moreover, the responses at both the intensive and extensive margins are magnified significantly if the single mother moves off of transfer programs (especially cash and food assistance programs) and into work. The estimates strongly reject the separability of transfer-program decisions from labor supply choices, and the evidence is conclusive that ignoring the fixed costs of transfer program participation in the labor supply decisions of single mothers is a misspecification with nontrivial implications for tax policy. Failure to condition on transfer-program status imparts an upward bias on the wage elasticity of hours worked by a factor of 4, and an upward bias on the wage elasticity of employment by about one-third.

The implications for optimal transfer policy along the lines suggested by Saez (2002) are clear. Based on his model, if the government has modest redistributive tastes then the optimal policy is an EITC-type program that is characterized by a guaranteed income level that is smaller than that found in a classic NIT program, but with negative marginal tax rates at low incomes so that the size of the transfer rises with income initially and then gets taxed away at higher income levels. This is akin to the structure of the current EITC program in the U.S. and the Working Families Tax Credit in the U.K., but with the addition of an income guarantee for non-workers that is absent in the current EITC and WFTC. The estimates presented here suggest that there is scope for welfare-improving tax and transfer reforms, especially those that draw more workers into the labor force.

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Appendix: Estimating Effective Tax Rates and Guarantees

To estimate effective guarantees and rates Fraker, et al. (1985), McKinnish, et al. (1999), and Ziliak (2006) use quality control data by state from the AFDC program to run truncated regressions of the following form:

(A1) $$B_t = \rho_0 + \rho_1 K2_t + \rho_3 K3_t - \tau_t^{c,1}(W_t h_t) - \tau_t^{c,2} N_t + \upsilon_t,$$

where B_t is the actual monthly benefit payment of the family in the survey month, $K2_t$ is an indicator variable equal to one if there are two or more children under age 18 in the family, $K3_t$ is the number of children greater than two, $W_t h_t$ is labor-market earnings, and N_t is nonlabor income. Estimates of effective guarantees (i.e. benefits for those with no additional income, $W_t h_t = N_t = 0$) for two-, three-, or four-person families are found from the estimated coefficients $\hat{\rho}_0, \hat{\rho}_0 + \hat{\rho}_1, \hat{\rho}_0 + \hat{\rho}_1 + \hat{\rho}_2$, respectively, while estimates of the effective tax rates on labor income and nonlabor income are $\hat{\tau}_t^{c,1}$ and $\hat{\tau}_t^{c,2}$. Ziliak (2006) updates the estimates from McKinnish, et al. (1999) through 2002, and also provides the first estimates of this kind for the Food Stamp Program.

The comparable quality control data for the SSI program to estimate effective SSI tax rates is available only for a single year in 2001 (http://www.ssa.gov/policy/docs/microdata/ssr/). I use this data to construct effective state-specific SSI tax rates and assume these rates are applicable for the whole sample period. While it would be preferred to have data available akin to that from the AFDC program, the assumption of time-invariant effective tax rates for SSI is likely to be reasonable. Because of the much greater federal oversight of the SSI program, aside from state supplementation of benefit payments, and the fact that the statutory rates (50 percent for earned income, 100 percent for nonlabor income) and deductions ($65 for monthly earnings, $20 for monthly nonlabor income) were constant over the 1979 to 2001 period, there is likely to be much more stability in SSI effective rates over time.[9] Hence, in Table 1 I use the estimated effective tax rates in lieu of the statutory rates because the former are more likely to reflect actual rates faced by the family owing to the fact that SSI claims are handled at local Social Security offices.

[9] Strictly the first $20 of income from any source is disregarded, but in this case I assess it first to nonlabor income. Many types of unearned income are exempt from implicit taxation by the SSI program, including AFDC benefits, and the dollar value of federal food and housing assistance benefits. See "Understanding Supplemental Security Income" (2004) at http://www.ssa.gov/notices/supplemental-security-income/text-income-ussi.htm for details.

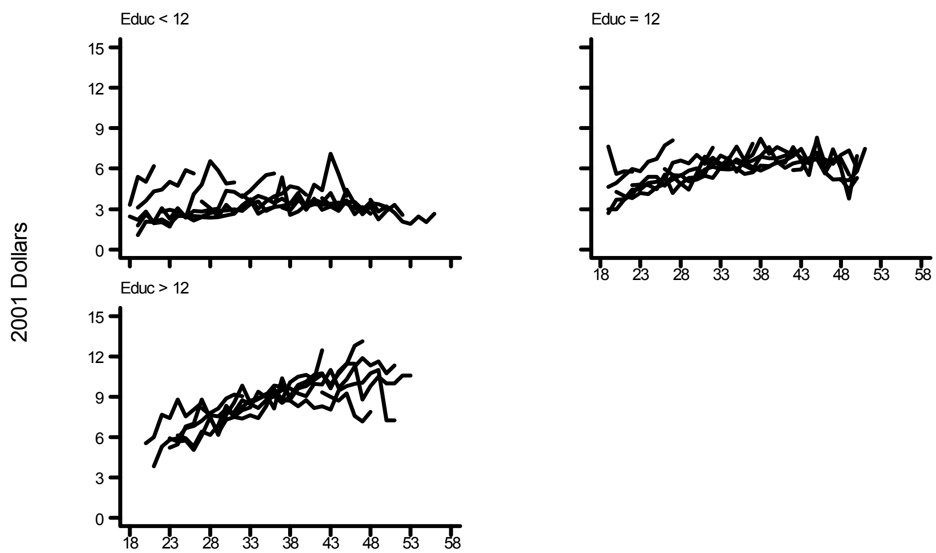

Figure 1: Life-Cycle Net Wage Rate by Education

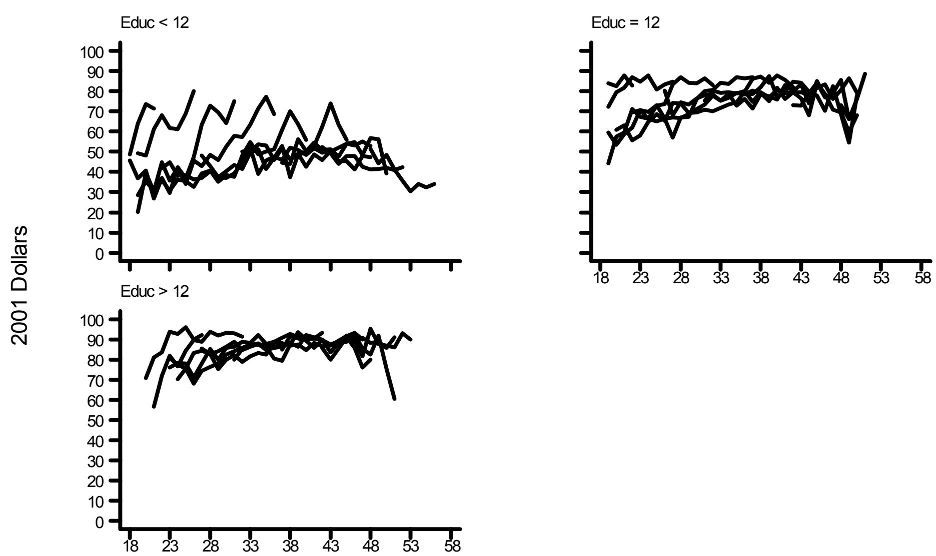

Figure 2: Life-Cycle Employment Rate by Education

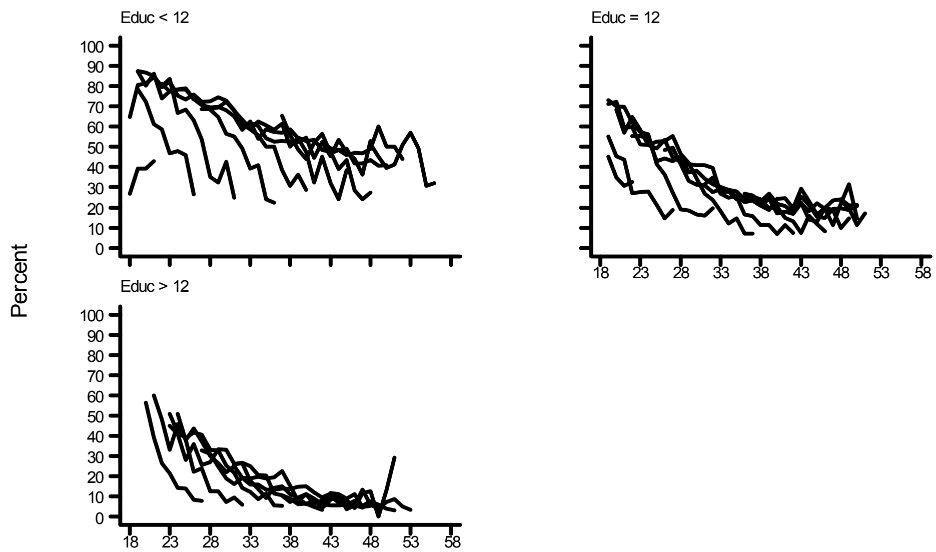

Figure 3: Life-Cycle AFDC Participation by Education

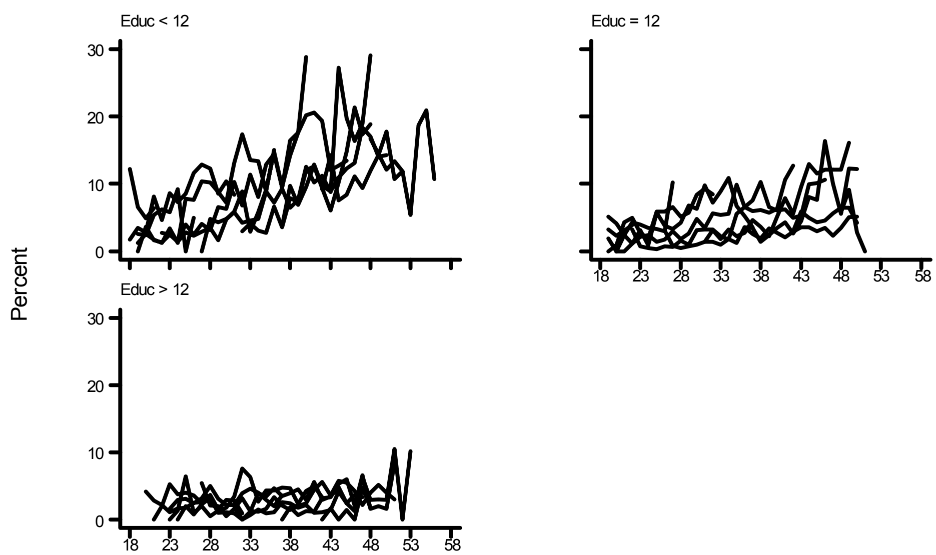

Figure 4: Life-Cycle SSI Participation by Education

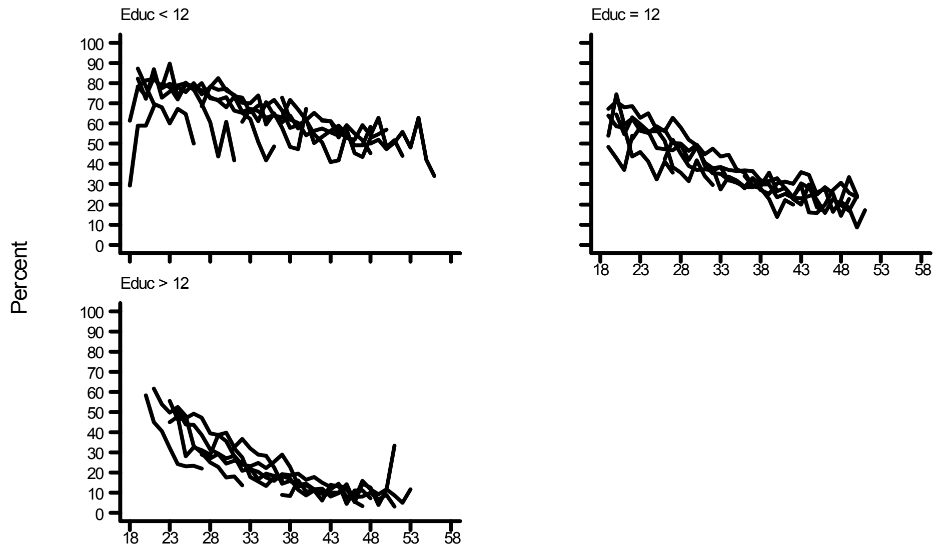

Figure 5: Life-Cycle Food Stamp Participation by Education

Table 1: Distribution of Marginal Tax Rates and Gross and Net Wages in Peak Business Cycle Years

	1979	1989	1999
25th Percentile MTR	–3.87	–6.49	–26.35
50th Percentile MTR	–0.37	9.51	25.65
75th Percentile MTR	33.20	32.51	37.65
25th Percentile MTR w/ Transfers	25.13	24.51	7.65
50th Percentile MTR w/ Transfers	35.13	34.00	27.75
75th Percentile MTR w/ Transfers	41.13	43.11	40.50
25th Percentile Gross Hourly Wage	0.00	0.00	5.32
50th Percentile Gross Hourly Wage	7.51	7.59	8.88
75th Percentile Gross Hourly Wage	11.90	12.70	13.79
25th Percentile After-Tax Hourly Wage	0.00	0.00	4.79
50th Percentile After-Tax Hourly Wage	6.04	6.02	6.58
75th Percentile After-Tax Hourly Wage	8.94	9.13	10.25
25th Percentile After-Tax/Transfer Hourly Wage	0.00	0.00	4.03
50th Percentile After-Tax/Transfer Hourly Wage	4.92	5.26	6.16
75th Percentile After-Tax/Transfer Hourly Wage	8.38	8.53	9.68

NOTE: All income data are deflated by the personal consumption expenditure deflator with 2001 base year. Observations in birth-education cohorts with fewer than 50 observations are dropped, as are observations with allocated earnings. There are 78,853 observations in the full sample. The summary statistics are weighted by the family weight provided in the CPS and include non-workers and transfer-program nonparticipants.

Table 2: Instrumental Variables Estimates of Conditional Labor Supply at the Intensive and Extensive Margins

	Nonlinear Selection Correction		Linear Selection Correction	
	Hours of Work	Participation	Hours of Work	Participation
After-Tax Wage	79.17	2.79	104.48	2.77
	(42.68)	(0.17)	(52.83)	(0.17)
Virtual Non-labor Income	–2.54	0.009	–3.53	0.005
	(2.15)	(0.005)	(2.22)	(0.005)
Kids < Age 6	–25.25	–0.17	–49.30	–0.15
	(10.22)	(0.02)	(11.72)	(0.02)
Number of Kids < Age 18	14.43	0.05	18.12	0.07
	(8.97)	(0.01)	(9.12)	(0.01)
Race (1=white)	–49.65	–0.31	–47.32	–0.32
	(17.57)	(0.03)	(14.25)	(0.03)
AFDC/TANF Participation	–540.27	–0.50	–468.91	–0.27
	(88.91)	(0.15)	(96.43)	(0.15)
SSI Participation	264.80	0.12	313.91	0.05
	(268.35)	(0.23)	(249.95)	(0.23)
FSP Participation	–398.68	–0.65	–593.12	–0.96
	(69.93)	(0.16)	(81.80)	(0.16)
Wage Residual	–234.87		–294.14	
	(33.60)		(39.11)	
Virtual Income Residual	1.51		2.56	
	(1.91)		(1.95)	
Selection	–447.68		–146.43	
	(116.24)		(53.64)	
Selection^2	194.55			
	(57.28)			
Selection^3	–27.32			
	(41.65)			

NOTE: There are 56,732 observations used in the hours worked equation and 78,853 observations in the participation equation. The Nonlinear Selection Correction model is based on the Lee (1984) specification, while the Linear Selection Correction is based on the Heckman (1978) model. The standard errors in the participation equation are robust to heteroskedasticity of unknown form, while the standard errors in the hours worked equation are estimated by the method of cluster bootstrap to account for the residual terms and possible additional within-cohort autocorrelation. Each specification controls for linear year, cohort, and state fixed effects.

Table 3: Distribution of Wage Elasticities of Labor Supply at the Intensive and Extensive Margins

	Nonlinear Selection Correction		Linear Selection Correction	
	Hours of Work	Participation	Hours of Work	Participation
Uncompensated Wage Elasticity				
Average	0.14		0.18	
25th Percentile	0.04		0.05	
Median	0.04		0.05	
75th Percentile	0.06		0.08	
Compensated Wage Elasticity				
Average	0.16		0.21	
25th Percentile	0.05		0.07	
Median	0.06		0.09	
75th Percentile	0.09		0.11	
Participation Wage Elasticity				
Average		1.34		1.34
25th Percentile		0.61		0.62
Median		1.01		0.98
75th Percentile		1.81		1.77

NOTE: Parameter estimates used in construction of elasticities are found in Table 2.

Table 4: Total Intensive and Extensive Wage Elasticities of Labor Supply by Transfer Program Status

	AFDC=0 SSI=0 FSP=0	AFDC=1 SSI=0 FSP=0	AFDC=0 SSI=0 FSP=1	AFDC=1 SSI=0 FSP=1	AFDC=0 SSI=1 FSP=1	AFDC=1 SSI=1 FSP=1
Uncompensated Wage Elasticity						
Average	0.07	1.14	0.58	4.24	1.26	5.48
25th Percentile	0.04	0.25	0.17	0.58	0.18	0.56
Median	0.04	0.38	0.20	1.07	0.26	1.30
75th Percentile	0.04	0.84	0.35	2.56	0.57	3.14
Compensated Wage Elasticity						
Average	0.10	1.17	0.60	4.26	1.28	5.50
25th Percentile	0.05	0.28	0.18	0.59	0.19	0.57
Median	0.06	0.40	0.22	1.09	0.27	1.31
75th Percentile	0.07	0.87	0.37	2.58	0.60	3.16
Participation Wage Elasticity						
Average	1.04	1.99	1.50	2.41	1.69	2.16
25th Percentile	0.52	0.95	0.73	1.33	0.83	1.09
Median	0.78	1.75	1.23	2.29	1.40	1.98
75th Percentile	1.29	2.84	2.01	3.35	2.29	2.98

NOTE: Estimates based on nonlinear selection correction results in Table 2.

Table 5: Robustness of Conditional Labor Supply Estimates at the Intensive and Extensive Margins

	Heterogeneity in Wage Response by Children		No Fixed Costs of Transfer Participation	
	Hours of Work	Participation	Hours of Work	Participation
After-Tax Wage	81.76 (48.45)	3.10 (0.17)	340.05 (39.23)	3.69 (0.13)
Wage*Kids < Age 6	–47.55 (23.04)	–0.12 (0.04)		
Wage*Kids < Age 18	–19.93 (8.82)	–0.11 (0.02)		
Virtual Non-labor Income	–2.90 (2.73)	0.009 (0.005)	–12.06 (2.62)	0.001 (0.004)
Kids < Age 6	–24.21 (14.80)	–0.17 (0.02)	–46.14 (10.48)	–0.25 (0.01)
Number of Kids < Age 18	15.92 (9.26)	0.03 (0.01)	–3.22 (5.24)	0.02 (0.01)
Race (1=white)	–52.16 (18.18)	–0.32 (0.03)	2.26 (10.02)	–0.27 (0.02)
AFDC/TANF Participation	–579.01 (98.64)	–0.74 (0.15)		
SSI Participation	322.97 (277.45)	0.12 (0.23)		
FSP Participation	–425.77 (74.93)	–0.32 (0.16)		
Wage Residual	–235.55 (45.65)		–266.39 (39.55)	
Virtual Income Residual	1.90 (2.45)		9.19 (2.61)	
Selection	–445.57 (104.27)		–553.71 (83.62)	
$Selection^2$	170.34 (39.42)		186.33 (38.69)	
$Selection^3$	–32.89 (34.76)		16.21 (32.94)	

NOTE: All estimates based on nonlinear selection correction. See notes to Table 2 for additional details.

Appendix Table 1: Weighted Sample Means and Standard Deviations

	Total	Education < 12	Education = 12	Education > 12
Employment Rate	72.37	47.38	75.61	86.32
	(44.72)	(49.93)	(42.94)	(34.36)
Annual Hours of Work	1224.06	658.18	1267.72	1574.28
	(967.19)	(876.67)	(939.67)	(873.35)
AFDC Participation Rate	32.50	58.69	30.59	16.17
	(46.84)	(49.24)	(46.08)	(36.82)
SSI Participation Rate	5.09	8.74	4.48	3.21
	(21.98)	(28.25)	(20.70)	(17.62)
FSP Participation Rate	39.63	66.60	38.68	21.62
	(48.91)	(47.16)	(48.70)	(41.16)
Net Hourly Wage	6.34	3.29	5.97	8.92
	(7.71)	(5.57)	(6.05)	(9.62)
Virtual Nonlabor Income (1000s)	11.63	11.41	10.63	12.95
	(11.12)	(9.73)	(9.58)	(13.34)
Number of Kids Under 6	0.41	0.47	0.42	0.34
	(0.49)	(0.50)	(0.49)	(0.47)
Number of Kids Under 18	1.85	2.20	1.80	1.65
	(1.02)	(1.23)	(0.96)	(0.83)
Race (=1 if white)	63.71	58.39	62.93	68.38
	(48.08)	(49.29)	(48.30)	(46.50)
AFDC Maximum Benefit	462.21	499.18	459.08	439.65
	(214.69)	(230.77)	(210.46)	(203.99)
SSI Maximum Benefit	588.40	592.90	584.74	589.43
	(94.98)	(98.25)	(92.71)	(95.06)
FSP Maximum Benefit	321.35	345.14	318.73	307.52
	(79.85)	(83.68)	(78.86)	(74.27)
Effective AFDC Tax on Earnings	31.78	32.44	32.21	30.82
	(14.71)	(14.23)	(14.76)	(14.92)
Effective AFDC Tax on Nonlabor	23.78	25.68	24.94	21.09
	(20.76)	(19.91)	(20.86)	(20.98)
Effective FSP Tax on Earnings	18.86	18.70	18.98	18.84
	(4.26)	(4.53)	(4.30)	(3.99)
Effective FSP Tax on Nonlabor	21.66	21.13	21.81	21.87
	(6.81)	(7.43)	(6.78)	(6.37)
State Unemployment Rate	6.29	6.64	6.37	5.96
	(2.01)	(2.04)	(2.07)	(1.86)
Log of State Minimum Wage	1.71	1.72	1.71	1.69
	(0.10)	(0.11)	(0.10)	(0.09)
EITC Phase-In Tax Rate	21.70	19.60	20.59	24.46
	(11.52)	(11.23)	(11.30)	(11.46)
Welfare Waiver	30.35	22.80	26.51	40.13
	(45.17)	(41.30)	(43.35)	(48.09)
Party of Governor (1=Democrat)	48.06	50.15	48.94	45.56
	(49.96)	(50.00)	(49.99)	(49.80)

NOTE: Means with standard deviations in parentheses. All income and price data are deflated by the personal consumption expenditure deflator with 2001 base year. Observations in birth-education cohorts with fewer than 50 observations are dropped, as are observations with allocated earnings. There are 78,853 observations in the full sample, consisting of 20,398 observations with less than high school, 31,442 with a high school diploma, and 27,013 with more than high school. The summary statistics are weighted by the family weight provided in the CPS.

Appendix Table 2: Structural Log Wage Equation Estimates
(Workers Only with Correction for Sample Selection)

	Nonlinear Selection Correction	Linear Selection Correction
Kids < Age 6	0.062	0.042
	(0.009)	(0.009)
Number of Kids < 18	–0.005	–0.013
	(0.005)	(0.004)
Race (1=white)	0.077	0.089
	(0.008)	(0.008)
Selection	–0.721	–0.433
	(0.080)	(0.034)
$Selection^2$	0.171	
	(0.037)	
$Selection^3$	–0.085	
	(0.037)	
F-Statistic	96.27	96.79
	[0.000]	[0.000]
Adjusted R^2	0.17	0.17

NOTE: Estimation is for workers only. All specifications control for state, year, cohort, and cohort by year fixed effects. The F-Statistic is of the null that all slope coefficients are jointly zero, with p-value in square brackets.

Appendix Table 3: Structural AFDC/TANF, SSI, and FSP Participation Equation Estimates

	AFDC/TANF	SSI	Food Stamps
After-Tax Wage	–2.529	0.481	–1.793
	(0.141)	(0.184)	(0.135)
Virtual Non-labor Income	0.022	–0.005	0.006
	(0.005)	(0.007)	(0.004)
Kids < Age 6	0.254	–0.020	0.205
	(0.014)	(0.022)	(0.013)
Number of Kids < Age 18	0.053	0.081	0.187
	(0.010)	(0.014)	(0.009)
Race (1=white)	–0.117	–0.317	–0.196
	(0.024)	(0.034)	(0.023)
Participation Wage Elasticity			
Average	–3.15	1.05	–1.91
25^{th} Percentile	–4.21	0.94	–2.57
Median	–3.15	1.05	–1.89
75^{th} Percentile	–2.05	1.17	–1.22
LR Statistic	17,015.26	2,101.95	16,500.88
	[0.000]	[0.000]	[0.000]
Pseudo R^2	0.24	0.08	0.21

NOTE: All specifications control for state, year, cohort, and cohort by year fixed effects. The LR-Statistic is of the null that all slope coefficients are jointly zero, with p-value in square brackets.