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Abstract: The wage elasticities of labor supply at the participation and hours worked margins are focal parameters of interest for understanding the work disincentive effects of taxes and transfers and the attendant design of optimal tax and transfer schemes. 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 wage elasticity of labor supply of single mothers at the extensive and intensive margins. Using data from the Current Population Survey from 1979-2001 along with a conditional-on-transfer-program participation model of labor supply, I estimate uncompensated, compensated, and participation wage elasticities of labor supply using a grouping dummy-endogenous variables instrumental variables estimator. The results strongly reject the separability of labor supply and transfer-program participation. Failure to control for the fixed costs of transfer program participation overstates the uncompensated and compensated wage elasticities of hours worked by a factor of three, and overstates the participation elasticity by two-thirds. I estimate an average wage elasticity of employment of about 2.0 and a compensated wage elasticity of hours worked of about 0.15, though the labor-supply response to wage changes of women on welfare and food assistance programs is considerably higher. Because the elasticity at the extensive margin is larger than that found at the intensive margin, the optimal transfer policy based on the Saez (2002) model suggests an EITC-type program with a small guarantee and negative tax rates at low incomes.

The wage elasticities of labor supply at the participation (extensive) and hours worked (intensive) margins are focal parameters of interest 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] It is well known that the efficiency cost of nonlinear tax and transfer schedules is increasing in proportion to the square of the marginal tax rate (Auerbach 1985). Less well known is the importance of the labor supply response at the extensive margin *relative* to the intensive margin for optimal tax and transfer policy. 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 (NIT) 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 (EITC) with a smaller guarantee coupled with negative marginal tax rate at low incomes. Knowledge of these elasticities 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 wage elasticities of labor supply of single mothers at the extensive and intensive margins.

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

[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.

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 1993; Meyer 2002). Kimmel and Kniesner (1998) are an important exception. Using data from the Survey of Income and Program Participation they estimated wage elasticities separately for men and women by marital status. For single mothers they report a participation elasticity of 2.4 and an hours worked elasticity of 0.7. A limitation of their results is that they did not account for the U.S. tax and transfer system in estimation. Meyer and Rosenbaum (2001) did model the tax and transfer system but restricted attention to the participation margin and did not provide a direct estimate of the wage elasticity. Inferring the participation response from changes in taxes paid, they find an average 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 rare (Moffitt 2002). To better understand the labor supply effects of taxes and transfers and to inform optimal tax policy, structural estimates of the labor supply response to wage changes at both margins in the presence of income taxes and transfers are needed.

Robust estimates of structural labor supply parameters in models with progressive income taxes are readily obtained via instrumental variables because the convex budget set permits linearization of the budget constraint around the chosen segment (MaCurdy, Green, and Paarch 1990). That is, with convex constraints the researcher can assign a lump-sum virtual-income transfer to the worker so that they act as if they face a constant marginal tax rate at all earnings levels and then treat the net wage and virtual income as endogenous. However, the prevalence of transfer-program participation among single mothers makes estimation of their labor supply decisions substantially more complicated owing to the nonconvexities introduced by program rules that tax wage and nonlabor income (Moffitt 1983).

The most ambitious effort to date to structurally model labor supply in the presence of taxes and multiple transfer-program participation 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 they estimate an average uncompensated wage elasticity of labor supply of about 1.8. The key advantage of this approach is that it permits out-of-sample simulations of alternative tax and welfare reforms. The drawback is that identification of model parameters is notoriously difficult, it requires that agents have complete knowledge of their budget frontiers, and it is not straightforward to separate the intensive from extensive margin elasticities. Indeed, the elasticity estimated by Keane and Moffitt (1998) is a convolution of both margins (much like one obtains in a Tobit model). Moreover, if one is interested in labor-supply trends over time the computation challenges of a structural model akin to Keane and Moffitt increase exponentially.

In a bid to increase transparency of model identification and to provide separate estimates at both the participation and hours worked margins I model labor supply choices in a conditional supply framework (Pollak 1969; Browning and Meghir 1991).[2] The conditioning goods include both indicators for transfer program participation as well as the dollar amounts of transfers received, where the participation indicators account for the fact that recipients may face large fixed costs of program entry due to excessive paperwork, hassles, or possible stigma. The programs in the conditioning set are Aid to Families with Dependent Children (and its

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[2] Browning and Meghir (1991) used a conditional model to estimate a consumption demand system. Because of possible non-separability 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.

replacement Temporary Assistance to Needy Families, i.e. AFDC/TANF), food stamps, and Supplemental Security Income (SSI). Emphasis on cash welfare and food assistance is justified because of the high prevalence of participation in these programs among single mothers, while SSI, which is a program for the aged poor, the blind, and the disabled, is included because of the growing utilization of the program (especially among low-income disabled children), the lack of research on the program (Daly and Burkhauser 2003; Moffitt 2002), and the unique programmatic interactions between AFDC, SSI, and work (Kubik 1999).

As lucidly described in Browning and Meghir (1991), there are several advantages to the conditional approach. First, it is not necessary to specify the constraints for the conditioning goods or the structure of preferences for those goods. The large savings here is that I do not have to model the various nonconvexities in the budget constraint that arise from transfer-program rules nor is it necessary to write an explicit specification for how 'welfare stigma' enters utility preferences. This allows me to combine a structural approach with standard instrumental variables methods found in both the taxation and treatment effects literatures. Second, as the conditional model is valid even in the presence of corner solutions in the transfer-program decisions, it is convenient to test for weak separability between work and transfer-program participation. Third, it is straightforward to model the labor-force participation decision separately from the hours worked decision, which fosters identification of elasticities at both margins. Importantly, if the transfer decision is predetermined to labor supply then the ordinary and conditional supply responses to wage and nonlabor income changes are the same (Pollak 1969). However, if transfer decisions are not predetermined then the drawback of the conditional model compared to the unconditional approach is that all behavioral responses are conditional on the quantities of the transfer decisions. As a consequence I supplement the conditional model with 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.

In estimation I 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 across birth-year and education cohorts of single mothers induced both by tax and welfare reforms as well as changing demands for skill (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).

Using data from the Annual Social and Economic File of the Current Population Survey for 1980 to 2002, 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 three, and an overstatement of the participation margin of about two-thirds. 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 the auxiliary analysis indicates that the total labor supply response for mothers in transfer programs is highly elastic to wage changes at both margins. Overall, with an average wage elasticity of labor force participation of 2 and a compensated hours-worked wage elasticity of 0.15 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.

II. The Rise in Work and Disability and the Decline in Welfare

To motivate the conditional labor supply model developed in the next section I begin with a discussion of trends in employment and transfer-program participation among single mothers along with the economic and social policy reforms that have been attributed as underlying causes of the changes. Excellent summaries of recent tax and welfare reforms are found in Blank (2002), Hotz and Scholz (2003), Meyer and Rosenbaum (2001), and Moffitt (2003). As described below the data for the figures and tables come from the Annual Social and Economic File of the Current Population Survey for the 1980–2002 interview years.

Figure 1 depicts time-series trends in the employment rate by education status (less than high school, high school, and more than high school) for calendar years 1979–2001. After falling in the early 1980s employment remained fairly steady until about 1994 when there was a dramatic increase. This rise in employment was especially pronounced among low-skilled mothers with 12 or fewer years of schooling where employment rose 25 percentage points by 1999. While employment grew, Figure 2 shows that participation in the primary cash (AFDC) and food assistance (food stamps) programs plummeted by over 60 percent from the mid 1990s to 2000. Interestingly, while participation in AFDC and food stamps declined, usage of disability programs such as SSI grew rapidly. That the trends in AFDC and food stamps are mirror images of the trend line of employment suggests that work and welfare decisions are not likely to be separable. Figure 3 examines this possible nonseparability more closely by depicting trends in simultaneous participation in work and welfare, in work and food assistance, and in work and SSI. During the 1990s single mothers increasingly combined work and food assistance, and to lesser extent combined welfare and work and SSI and work. However, all three combinations tapered off during the 2001 recession.

[Figures 1–3 here]

Several explanations have been proffered in recent years to help understand the surprising trends in low-income mother's decisions to work and/or participate in AFDC/TANF, food stamps, and SSI. One strand of research emphasizes structural changes in the macroeconomy, including shocks to resource markets such as coal (Black, Daniel, and Sanders 2002), rising wage inequality (Autor and Duggan 2003), and/or productivity-induced economic growth (Katz and Krueger 1999; Krueger and Solow 2001; Ziliak, Figlio, Davis, and Connolly 2000). Another strand focuses on tax reform and/or welfare reform, notably expansions in the EITC in 1986, 1990, and 1993 and passage of the 1996 Welfare Reform Act (Blank 2002; Grogger 2003; Meyer and Rosenbaum 2001; Moffitt 2003). While still yet a third area emphasizes judicial and legislative changes that relaxed disability program eligibility criteria (Bound and Burkhauser 1999; Kubik 1999; Schmidt and Sevak 2004). There is considerable controversy in the literature as to the relative importance of each factor in accounting for the time series changes in work and transfer-program participation.

The purpose of this project is not to weigh in on the debate on the relative importance of the business cycle compared to social policy reforms in explaining trends in work and transfer program participation. Rather, the changes in the U.S. economic and social policy landscapes over the past two decades will play a central role in identification of the structural wage and nonlabor income effects, as well as identification of the effects of transfer-program participation on labor supply. Specifically 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 in Table 1 I first report changes in the cross-sectional distribution of marginal tax rates, gross and net hourly wages, and effective monthly benefits in AFDC/TANF, food stamps, and SSI 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 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 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 (2005). 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 2005).

The remaining six panels in Table 1 show changes in the distribution of gross and net wages (with and without the extra tax imposed by transfer programs), along with the predicted AFDC/TANF, food stamp, and SSI benefits based on equation (1). 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, and the significant real declines in effective benefits (note that these summary statistics include the large number of zeros from nonparticipation in work and transfer programs). The results in Table 1 clearly point to a rising return to work relative to transfer program participation.

[Figures 4–8 here]

Importantly for identification, as demonstrated in Figures 4–8 the rising returns to work have not changed uniformly across birth-year and education cohorts. In Figure 4 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 5–8 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 4–8 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.

III. A Conditional Model of Labor Supply

I begin with the canonical static model of labor supply in the presence on nonlinear income taxes, and then introduce the conditioning goods. In any given period t, t = 1,…,T, the single mother i, i = 1,…, N, is assumed to have preferences $U(C_{it}, L_{it})$ over a composite consumption good C_{it} and leisure time L_{it}. She 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

(1) $$C_{it} = W_{it}h_{it} + N_{it} - T_t(Y_{it}),$$

where W_{it} is the real before-tax hourly wage rate, N_{it} is real taxable nonlabor income, $Y_{it} \equiv W_{it}h_{it} + N_{it}$ is real total taxable income, 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

(2) $$T_t(Y_{it}) = T_t^{FED}(W_{it}h_{it}, N_{it}, E_{it}^{FED}) + T_t^{SS}(W_{it}h_{it}, E_{it}^{SS}) + T_t^{STATE}(W_{it}h_{it}, N_{it}, E_{it}^{STATE}),$$

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*). In addition, 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 $\omega_{it} = W_{it}(1-\tau_{it})$.

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, $U(C_{it}, L_{it} < \bar{L})$, to the not employed state, $U(C_{it}, L_{it} = \bar{L})$. If we define the net gain from employment as $\Delta_{it} = U(C_{it}, L_{it} < \bar{L}) - U(C_{it}, L_{it} = \bar{L})$, 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 (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 semi-logarithmic labor supply schedule for the intensive margin hours worked equation (Blundell, et al. 1998; Browning, Deaton, and Irish 1985)

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

where X_{it} is a vector of demographics affecting hours choices and u_{it} is a structural error term. The intensive-margin wage elasticity of hours worked is simply $\hat{\beta} / h_{it}$. Because economic theory informs us that the same set of covariates enters both the intensive and extensive margin labor supply decisions, the corresponding equation for the structural employment-status decision is

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

where the 'e' superscript denotes that the coefficients across equations (3) and (4) need not be the same. Under normality, 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 structural parameters for each observation in the sample. In the sections below I discuss the identification and estimation of equations (3) and (4) in detail.

B. Transfer Programs as Conditioning Goods

Previous structural research by Moffitt (1983), Hoynes (1996), and Keane and Moffitt (1998), along with Figures 1–3 above, suggest that decisions to work are not made in isolation of decisions to participate in transfer programs. The joint modeling of labor supply and transfer program participation is a significant computational challenge, especially when it is necessary to specify state-specific institutional characteristics of multiple transfer programs across multiple time periods. The nonconvexities in the budget constraint introduced by 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) and DeParle (2004) 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 is to model transfers as a set of conditioning goods. 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. While the fully structural model must incorporate this complication in the structure of preferences, the conditional approach does not need to model these utility costs, and in the process may avoid a source of model misspecification.

At the same time, while being agnostic on the effect of eligible nonparticipation on direct utility preferences, 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 certification 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.

In the absence of fixed costs of transfer-program participation the conditioning goods are entered straightforwardly as another form of nonlabor income. Let *G* denote income derived from transfer programs (including the implicit dollar value of in-kind benefits such as food stamps), then the modified virtual nonlabor income in equations (3) and (4) is $\tilde{N}_{it}^{G} = N_{it} + G_{it} + \tau_{it} W_{it} h_{it} - T_{t}(Y_{it})$. This specification imposes a form of Ricardian equivalence in that the effect of a \$1 increase in transfers *G* has the same marginal effect on hours worked as a \$1 increase in non-transfer non-labor income *N*. This is a standard assumption across several decades of labor supply research and I make a similar assumption here. To incorporate fixed costs of transfer-program participation I include a vector of indicator variables that take a value of 1 if the mother participates in the program and 0 if not. Let P^{G} denote the vector of transfer-program participation indicators, then the modified intensive and extensive models of labor supply are

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

and

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

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 $\psi^{e} = 0$.

The drawback of the conditional model compared to the unconditional approach in equations (3) and (4), or from the complete budget set approach with simultaneous work and transfer decisions, is that all behavioral responses are conditional on the quantities of the conditioning goods (Pollak 1969; Browning and Meghir 1991). To see this note that the partial effect of the wage change on hours worked is

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

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 (7) comes from direct estimation of equation (5), 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 (7) 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.

C. Identification

In equations (3)–(6) 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 sources 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 three sources: (1) common macroeconomic shocks, δ_t, such as federal tax and welfare reforms; (2) cohort-specific unobserved heterogeneity, δ_j, for cohort $j = 1,\ldots,J$; and (3) and 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 $s = 1,\ldots,51$. 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 permits me to express the expected value of the structural error conditional on time period *t*, cohort *j*, state *s*, and labor force composition P_{it}^{e} as

$$(8)\qquad E[u_{it} \mid t, j, s, P_{it}^{e}] = \delta_t + \delta_j + \delta_s + \sum_{k=1}^{K} \delta_k \lambda_{it}^{(k)} ,$$

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)–(6) 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 equations (3) and (5) 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 assumptions summarized in equation (8) 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. Figure 4 is suggestive that such differential growth in wages did occur across

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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.

these groups, and in a figure not displayed, a similar differential growth pattern arises with virtual income. The structural assumptions in equation (8) 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 (5) and (6) is aided by exploiting programmatic and macroeconomic 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 phase-in rate for the EITC by number of children, the maximum benefit guarantee for AFDC/TANF, SSI, and Food Stamps, the effective tax rates on labor and nonlabor income in AFDC/TANF and food stamps from Ziliak (2005), the party affiliation of the state's governor, and an indicator for the implementation of welfare reform. 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

[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.

SSI program; the food stamp benefit is federally set and updated for inflation and varies by family size (again I define this for two, three, and four or more person families). I use the effective guarantee for AFDC/TANF, but I use the statutory benefits for food stamps and SSI given the reduced cross-state variation.

D. Estimation

Estimation of equations (3)–(6) proceeds in multiple steps. The first step is to estimate the reduced-form prediction equations for net wages, virtual income, labor-force participation, and participation in AFDC/TANF, food stamps, and SSI. 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

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

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 equations (3) and (5) 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, and the parameters from the three transfer equations are used to construct fitted probabilities of participation to be used as instruments in the conditional labor supply model.

The second step of estimation is to run least squares on the unconditional hours worked equation (3) for workers only with the various controls for selection and endogeneity as

(10) $$h_{it} = \alpha + \beta \ln \omega_{it} + \gamma \tilde{N}_{it} + X_{it}\varphi + \delta_t + \delta_j + \delta_s + \theta_\omega \hat{\upsilon}_{it}^{\omega} + \theta_{\tilde{N}} \hat{\upsilon}_{it}^{\tilde{N}} + \sum_{k=1}^{3} \delta_k \hat{\lambda}_{it}^{k} + \zeta_{it}$$

and instrumental variables on the conditional hours worked equation (5) for workers only

(11) $$h_{it} = \alpha + \beta \ln \omega_{it} + \gamma \tilde{N}_{it}^{G} + X_{it}\varphi + P_{it}^{G}\psi + \delta_t + \delta_j + \delta_s + \theta_\omega \hat{\upsilon}_{it}^{\omega} + \theta_{\tilde{N}} \hat{\upsilon}_{it}^{\tilde{N}} + \sum_{k=1}^{3} \delta_k \hat{\lambda}_{it}^{k} + \zeta_{it}$$

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 equations (10) and (11) are 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

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

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[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.

and then estimating the structural employment equations (4) and (6) via probit maximum likelihood by replacing the actual wage with the predicted log net wage $\ln \hat{\omega}_{it}$ from (12) for both workers and non-workers (Lee 1978; Kimmel and Kniesner 1998). This step yields the wage elasticity at the extensive margin. Because of possible endogeneity of virtual income and transfer-program status to the employment decision, I replace the actual values in equations (4) and (6) with the reduced-form predicted values of virtual income and transfer participation for all sample members from equation (10), $\hat{d}_{it}^{\tilde{N}}, \hat{d}_{it}^{P^G}$.

IV. 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 (2005) 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 calculate estimates of 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 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. 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 state-level instruments described in the previous section to the CPS data using unique state identifiers for each family in the CPS. The unemployment rates are obtained from

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

[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.

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.

V. Results

To fix ideas I begin with the unconditional labor supply model that includes the progressive income tax system but ignores transfers either in the form of nonlabor income or as fixed participation effects. I estimate equation (10) for the intensive margin and using the predicted structural wage from equation (12) and predicted virtual income from equation (9) I estimate equation (4) for the extensive margin. The first-stage results for the net wage and virtual income are presented in the first two columns of Appendix Table 2 (with the cohort, time, and state dummies suppressed), and the first-stage results for the employment decision are presented in the first column of Appendix Table 3. The base case model does not use any of the state-level data on transfers to identify the net wage and virtual income, but does allow for wages and income to respond to state business cycles, state minimum wages, and the federal EITC phase-in rate (recall that this is identified off of family-size variation). Of particular note in the first stage, and which corroborates Meyer and Rosenbaum (2001) and Grogger (2003), is the strong positive impact that the EITC has on economic outcomes—employment, wages, and virtual income. The first-stage F-tests of over 18 indicate that the net wage and virtual income are not likely to suffer from the weak instrument problem.

[Table 2 here]

The unconditional model results are recorded in Table 2. The first two columns are based on the flexible selection correction proposed by Lee (1984). The parameters on the hours worked equation conform well with economic theory—a positive uncompensated wage effect and negative nonlabor income effect, which guarantees satisfaction of Slutsky integrability required for welfare analysis. Moreover, the estimates indicate that mothers with young children work fewer hours than those with adolescents and teenagers, and that white mothers work more hours than non-white mothers. There is strong rejection of the exogeneity of the net wage and virtual income (note that this test is a simple t-test on the respective coefficients), as well as strong rejection of the null of no non-random sample selection.[9] I calculate the uncompensated and compensated wage elasticities of hours worked for each worker and display the elasticities at various points of the distribution. At the mean the uncompensated wage elasticity is an inelastic 0.3, and the corresponding compensated elasticity is 0.34. Because of the influence of outliers, the median elasticities were less than half the mean.

The results of the structural employment participation equation are reported in the second column. Again, the estimates align with theory; namely, a positive substitution effect at the extensive margin and a (weakly) negative nonlabor income effect. The wage elasticity of employment is 2.76 at the means and 2.27 at the median. The average elasticity aligns with the

[9] Indeed, in results not recorded, failure to control for endogeneity and sample selection resulted in a negative uncompensated wage effect, a positive income effect, and thus violation of Slutsky integrability.

estimate of 2.4 reported in Kimmel and Kniesner (1998) in the absence of taxation, but does suggest that ignoring taxes understates the mean elasticity by about 15% at the extensive margin (and overstates the average intensive-margin elasticity by nearly 100%).

The remaining four columns of Table 2 offer sensitivity checks on the base-case results to modeling of the selection process. The middle two columns use a suggestion made by Deaton (1997) that if one wants to relax the normality assumption underlying Lee's (1984) results, but still admit nonlinearity, one could instead use a powered-up version of Olsen's (1980) correction based on the linear probability model, i.e. $(\hat{P}_{it}^{e} - 1)$. The last two columns are based on the original Heckman (1979) correction. The base case results are little changed when using the Deaton correction, with the exception of a slight increase in elasticites at the intensive margin and a decrease at the extensive margin. However, the hours-worked elasticities increase by about 50% with the Heckman correction, and double at the participation margin. While the results in the first column clearly reject the linear 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. Regardless of specification, the participation elasticity is considerably larger than the hours elasticity.

A. Transfer Income as a Conditioning Good

I first break the assumption of non-separability between labor supply and transfers by adding transfer income to the virtual nonlabor income term. This specification is standard in the literature, and while the researchers have typically instrumented nonlabor income, they have not altered the economic interpretation as a conditional supply function as I do here. The first-stage estimates are presented in the middle columns of Appendix Tables 2 and 3. Because transfer income is added to the model I include the additional time-varying covariates to the first-stage prediction equations such as benefit guarantees, effective tax rates, and welfare reform indicators. A couple of results are of note in the reduced forms. The implementation of welfare waivers weakly reduced virtual nonlabor income, but labor force participation was significantly increased by welfare reform. The generosity of the AFDC/TANF program increased virtual income, but significantly reduced the probability of working. This suggests that work and welfare are substitutes. In addition, the higher the rate that earnings are taxed by the AFDC program the lower are the chances of working. This effect is only weakly statistically significant, which corroborates the consistent finding in the earlier research on AFDC that changes in effective tax rates did not have large effects on labor supply (Moffitt 1992, 2003). On the other hand, the benefit generosity of SSI appears to stimulate the likelihood of working. This positive association is net of cohort, time, and state fixed effects, as well as a full interaction of cohort and year effects.

[Table 3 here]

In Table 3 I record the structural labor supply estimates conditional on transfer program income. Failing to control for transfer income in Table 2 results in a substantial downward bias in the absolute value of the virtual income effect and thus a downward bias of over 25% in the average compensated wage elasticity (and a bias of about 40% at the median). In addition the wage elasticity at the extensive margin is downward biased by over 10% at both the mean and median elasticity estimate. The results in Table 3 provide preliminary evidence that failing to control for transfer income as a conditioning good is a misspecification.

B. Incorporating Fixed Transfer-Program Participation Costs

I now introduce the possibility that fixed transactions costs of transfer program participation that may induce additional nonseparabilities in labor supply decisions. Because the effect of AFDC/TANF on female labor supply has received the bulk of research interest over the past two decades, I first present estimates only admitting fixed costs associated with AFDC/TANF participation in Table 4, and then extend the model in Table 5 to include fixed costs of food stamps and SSI. The first-stage estimates are recorded in the last two columns of Appendix Table 2, the last column of Appendix Table 3, and Appendix Table 4. There is one additional identifying instrument added to the first stage in this specification. Based on the welfare caseload literature I append the party affiliation of the state's governor to the instrument set. The hypothesis made in the literature is that the party affiliation of the governor may affect program-entry decisions, e.g. states with Democratic governors may impart less social stigma to participation and/or may design policies that reduce entry barriers.

There are number of interesting results in the reduced-form transfer-program participation equations in Appendix Table 4. Both AFDC/TANF and food stamp participation are highly countercyclical over the business cycle. 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. Participation in all three programs declines with increases in the EITC subsidy rate, and likewise, welfare reform was associated with declines in participation in all three programs. There is also evidence that AFDC and SSI are substitutes because AFDC participation declines with increases in the generosity of SSI benefits and vice versa. This is consistent with research reported in Kubik (1999) and Schmidt and Sevak (2004). 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.

[Tables 4 and 5 here]

I focus discussion on the instrumental variables results in Table 5 that control for possible fixed participation costs in all three programs, though I do draw distinctions with the more restrictive model in Table 4. The results in Table 5 are striking in comparison to those in Table 3. 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 463 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 950 hours less per year than a working single mother not on those programs. In comparison, note that the results in column 1 of Table 4 impart too large of a labor-supply effect to AFDC for those families on AFDC but not on food stamps, and too small of an hours effect for those on both food stamps and welfare. 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. It is also clear from the structural employment equation in column (2) of Table 5 that participation in AFDC/TANF and/or food stamps significantly reduces the probability of working.

Also of note in Table 5 is that the instrumental variables estimates cannot reject the null of no fixed participation effects in SSI. Qualitatively the estimates indicate that working mothers receiving SSI work about 280 hours more than mothers not on SSI, which is consistent with the reduced form estimates in Appendix Table 3 that show that higher SSI benefits increase the likelihood of working. Combining SSI and food stamps results in about 200 fewer hours worked compared to those not on SSI and food stamps, while for working mothers receiving assistance from all three programs reduce hours by about 670 hours. Collectively, the results suggest that there are large fixed costs of transfer-program participation and these costs reduce labor-market effort.

Conditioning on fixed participation decisions also has a substantial impact on the estimated wage elasticities of labor supply at both the intensive and extensive margins. At the means the intensive margin uncompensated and compensated wage elasticities are reduced by about two-thirds compared to the parallel estimates in Table 3 that only condition on transfer income. The extensive margin elasticities are reduced by over a third once one conditions on fixed participation effects. The impact on the participation elasticity is even more dramatic with the Deaton correction. However, this is due in part to the fact that the linear probability assumption on the selection term makes identification of the structural participation model more tenuous in the conditional model given the additional three predicted regressors in the model. That is, the additional nonlinearity of the normal distribution appears to be important for identification in the conditional participation model. The results clearly indicate that assuming separability between the labor supply choices and transfer-program decisions of single mothers is a misspecification and the separability assumption imparts an upward bias on the order of a factor of 3 at the intensive margin and by about two-thirds at the extensive margin.

C. Total Labor Supply Elasticities

As highlighted in equation (7) 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 assume that virtual income is predetermined with respect to the wage and thus I set the third term in equation (7) to zero. For the structural transfer decisions I estimate via probit the model

$$(13) \qquad P_{it}^{G} = P(G_{it} > 0) = \Phi(\alpha^{G} + \beta^{G} \ln \hat{\omega}_{it} + \gamma^{G} \hat{\tilde{N}}_{it}^{G} + X_{it}\varphi^{G} + \delta_{t} + \delta_{j} + \delta_{s}),$$

where G =[AFDC/TANF, SSI, food stamps], $\ln \hat{\omega}_{it}$ is the predicted structural wage from equation (12), and $\hat{\tilde{N}}_{it}$ is the predicted virtual income from equation (9).

Estimation of equation (13) 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 (8) 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 6. I conduct a similar analysis for the structural employment equation to generate total elasticities at the work participation margin.

[Table 6 here]

In Table 6 I record the total wage elasticities of hours worked and participation based on the estimates from Lee (1984) selection correction reported in Table 5. 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 0.05 and the compensated elasticity is 0.11. 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 highly elastic. For those on AFDC/TANF alone the uncompensated wage elasticity is 1.67 and for those on food stamps alone the elasticity is 1.12. The average elasticity for those on both AFDC/TANF and food stamps is a huge 7.40, but clearly this is driven by outliers as the median is a more plausible 1.86. 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). The median elasticity for those on SSI and food stamps is about 0.47 and for those on all three programs it is about 2.3. At the extensive margin it is clear that mothers not on income or food assistance have a robust participation elasticity of 1.68 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.

VI. 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. 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 economic policy. Failure to condition on transfer-program status imparts an upward bias on the wage elasticity of hours worked by a factor of 3, and an upward bias on the wage elasticity of employment by about two-thirds.

In the preferred specification I estimate a wage elasticity of employment of about 2.0 and a compensated wage elasticity of hours worked of about 0.15. The estimates confirm the conjecture made by Meyer (2002, p.378) that "it appears that incentives affecting the labor supply of single mothers work almost exclusively through the participation margin." Indeed, the structural employment elasticities here are nearly double the estimates inferred by Meyer and Rosenbaum (2001). 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 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 (2005) 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 (2005) 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.[10] 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.

[10] 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.

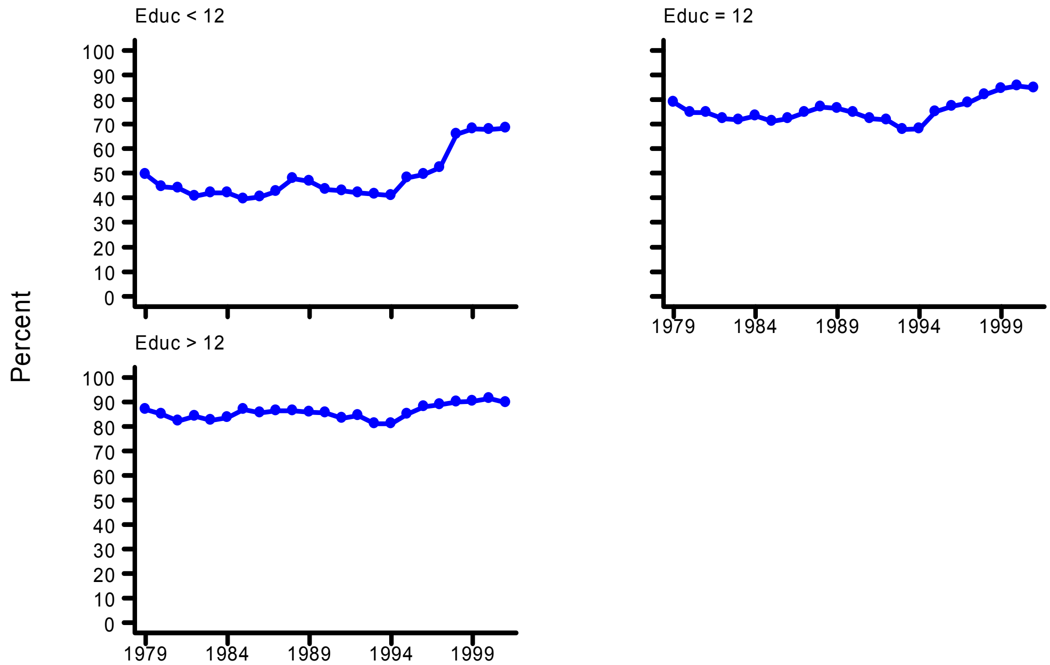

Figure 1: Employment Rate by Education, 1979-2001

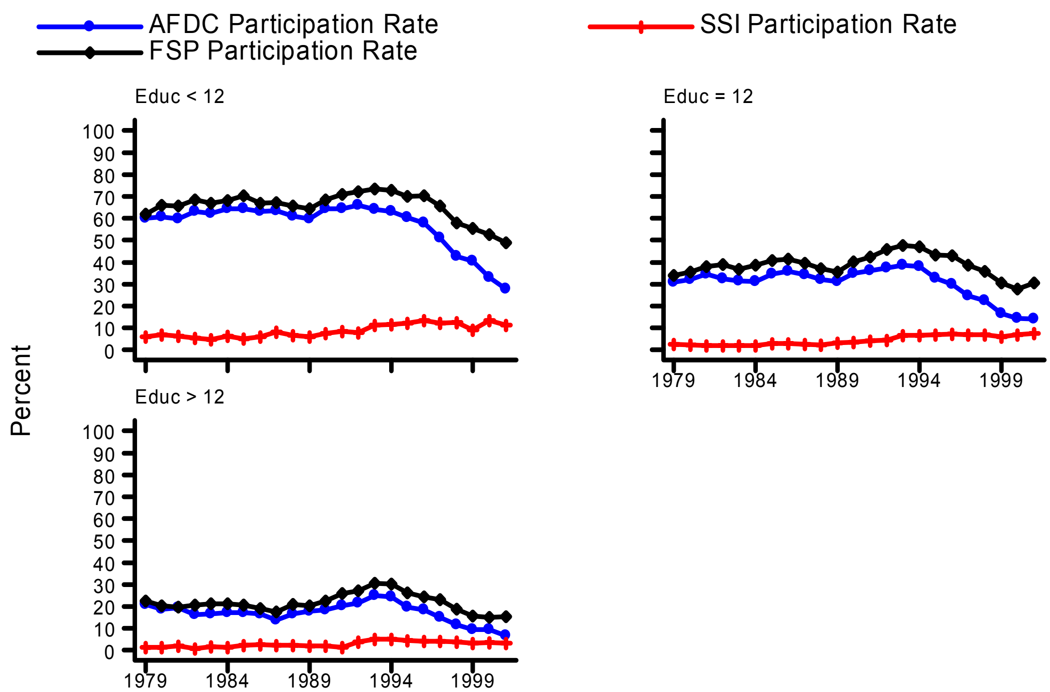

Figure 2: AFDC, SSI, & FSP Participation by Education, 1979-2001

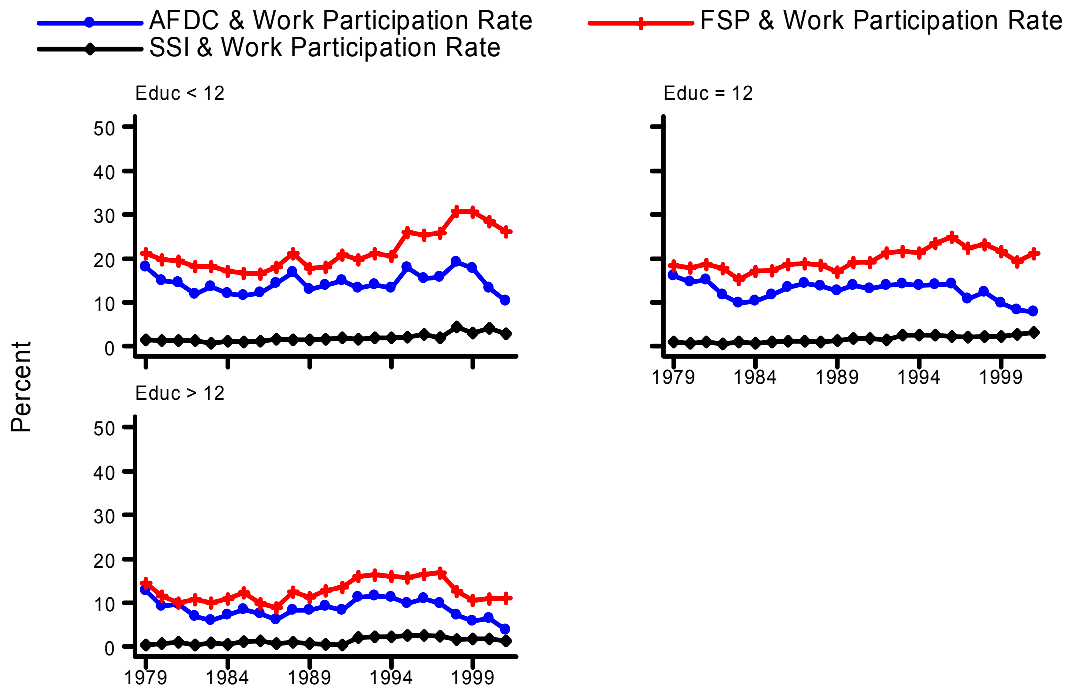

Figure 3: Work and Transfer Participation by Education, 1979-2001

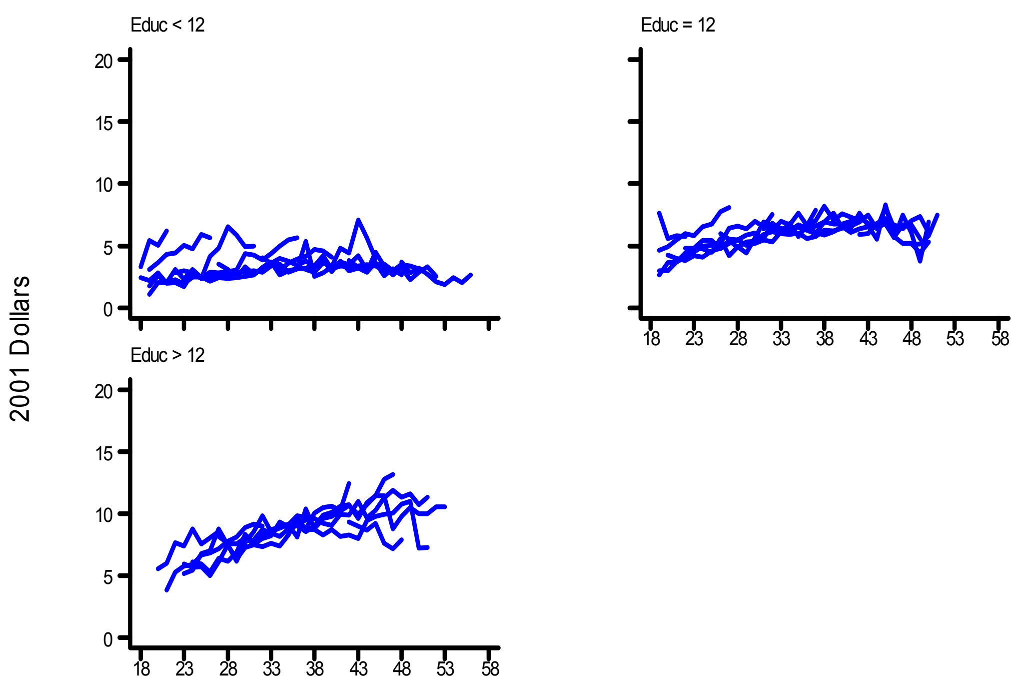

Figure 4: Life-Cycle Net Wage Rate by Education

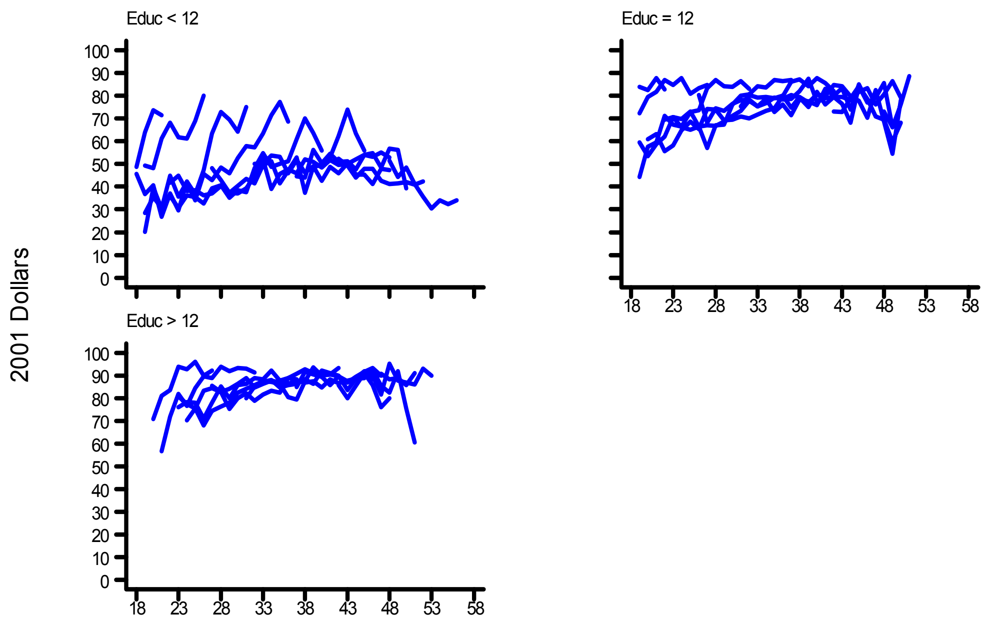

Figure 5: Life-Cycle Employment Rate by Education

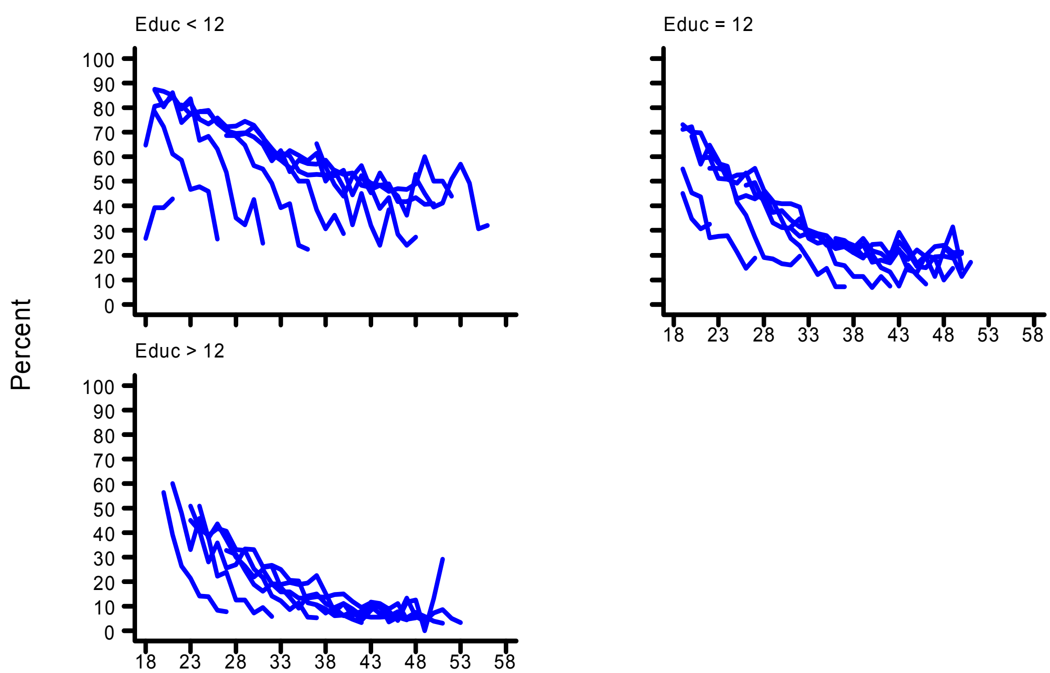

Figure 6: Life-Cycle AFDC Participation by Education

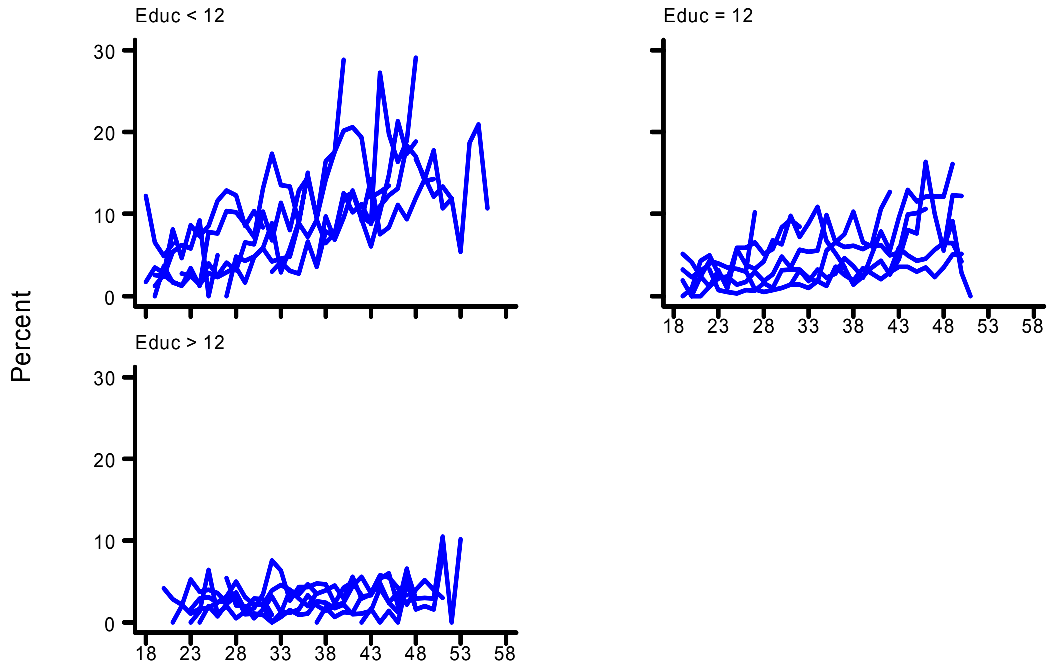

Figure 7: Life-Cycle SSI Participation by Education

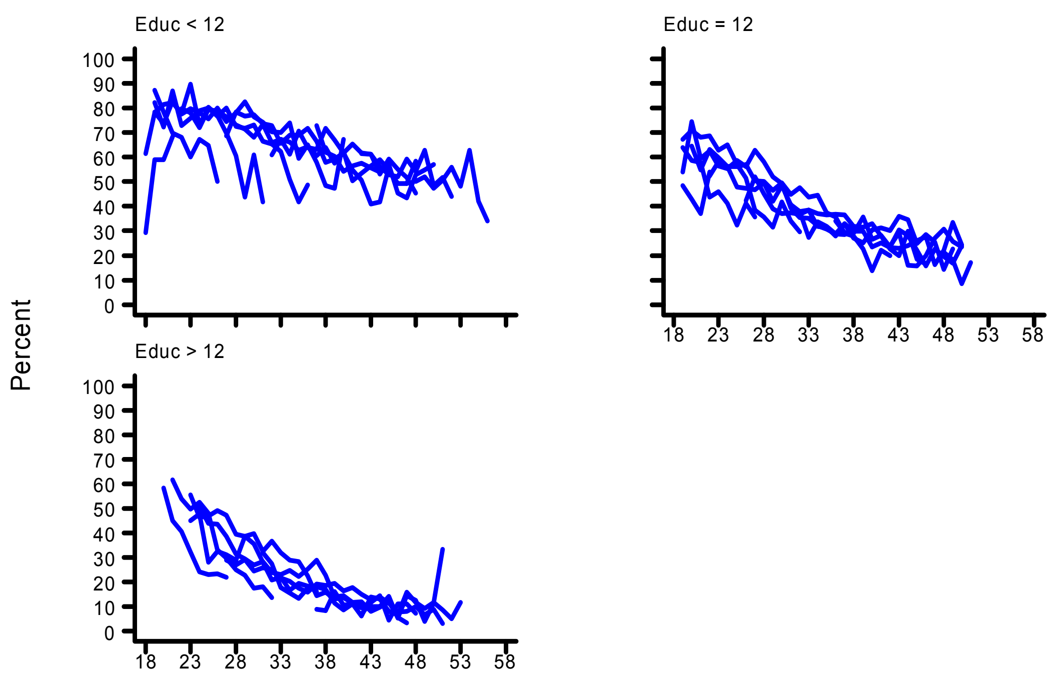

Figure 8: Life-Cycle Food Stamp Participation by Education

Table 1: Distribution of Marginal Tax Rates and Gross and Net Wages and Benefits 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
25th Percentile Effective Monthly AFDC Benefit	0.00	0.00	0.00
50th Percentile Effective Monthly AFDC Benefit	134.09	22.14	110.11
75th Percentile Effective Monthly AFDC Benefit	501.09	375.61	274.26
25th Percentile Effective Monthly SSI Benefit	0.00	0.00	0.00
50th Percentile Effective Monthly SSI Benefit	151.26	116.63	0.00
75th Percentile Effective Monthly SSI Benefit	506.24	525.56	339.99
25th Percentile Effective Monthly FSP Benefit	0.00	0.00	0.00
50th Percentile Effective Monthly FSP Benefit	71.89	0.00	97.98
75th Percentile Effective Monthly FSP Benefit	357.19	260.28	297.47

NOTE: 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. The summary statistics are weighted by the family weight provided in the CPS and include non-workers and transfer-program nonparticipants.

Table 2 Structural Labor Supply Estimates Ignoring Transfers

	Lee Correction		Deaton Correction		Heckman Correction	
	Hours of Work	Participation	Hours of Work	Participation	Hours of Work	Participation
After-Tax Wage	172.72 (73.71)	5.75 (0.36)	195.95 (77.36)	1.66 (0.08)	258.57 (95.22)	11.45 (0.40)
Virtual Non-labor Income	–4.17 (2.19)	–0.006 (0.004)	–4.22 (2.23)	–0.002 (0.001)	–5.25 (1.69)	0.000 (0.004)
Number of Kids < Age 6	–26.75 (14.98)	–0.46 (0.02)	–34.04 (16.17)	–0.13 (0.004)	–70.98 (14.82)	–0.49 (0.01)
Number of Kids Age 6-18	–19.74 (8.22)	–0.11 (0.006)	–19.16 (8.11)	–0.04 (0.002)	–33.46 (7.84)	–0.02 (0.007)
Race (1=white)	13.18 (16.92)	–0.02 (0.02)	17.85 (17.87)	–0.007 (0.006)	37.51 (11.70)	
Wage Residual	–292.49 (74.08)		–315.75 (78.41)		–378.29 (97.10)	
Virtual Income Residual	10.30 (2.73)		10.37 (2.83)		11.36 (2.23)	
Selection	–849.88 (132.04)		844.99 (173.21)		–435.54 (71.92)	
Selection^2	286.23 (54.77)		–753.71 (381.09)			
Selection^3	–32.72 (39.56)		–918.95 (374.85)			

Table 2 Continued

	Lee Correction		Deaton Correction		Heckman Correction	
	Hours of Work	Participation	Hours of Work	Participation	Hours of Work	Participation
Uncompensated Wage Elasticity						
Average	0.30		0.34		0.45	
25th Percentile	0.08		0.09		0.12	
Median	0.08		0.09		0.12	
75th Percentile	0.14		0.16		0.21	
Compensated Wage Elasticity						
Average	0.34		0.38		0.50	
25th Percentile	0.11		0.12		0.16	
Median	0.13		0.14		0.18	
75th Percentile	0.18		0.20		0.25	
Participation Wage Elasticity						
Average		2.76		2.57		5.51
25th Percentile		1.28		1.91		2.61
Median		2.27		2.22		4.08
75th Percentile		3.73		2.80		7.07

NOTE: There are 56,732 observations used in the hours worked equation and 78,853 observations in the participation equation. 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: Structural Labor Supply Estimates Conditional on Transfer Program Income

	Lee Correction		Deaton Correction		Heckman Correction	
	Hours of Work	Participation	Hours of Work	Participation	Hours of Work	Participation
After-Tax Wage	195.33 (67.63)	6.67 (0.37)	220.59 (68.61)	2.09 (0.09)	265.07 (97.79)	13.14 (0.45)
Virtual Non-labor Income	–13.93 (2.50)	–0.02 (0.004)	–14.22 (2.62)	–0.006 (0.001)	–16.79 (3.07)	–0.004 (0.004)
Number of Kids < Age 6	–46.71 (14.23)	–0.48 (0.01)	–55.85 (14.10)	–0.14 (0.004)	–85.27 (13.96)	–0.52 (0.01)
Number of Kids Age 6-18	–8.78 (5.99)	–0.08 (0.01)	–9.64 (5.77)	–0.02 (0.002)	–17.51 (7.24)	0.003 (0.009)
Race (1=white)	30.66 (14.27)	–0.05 (0.02)	36.23 (14.98)	–0.02 (0.006)	53.56 (15.37)	–0.40 (0.03)
Wage Residual	–311.92 (65.10)		–337.19 (67.23)		–381.60 (90.28)	
Virtual Income Residual	12.86 (2.59)		13.14 (2.76)		15.73 (3.13)	
Selection	–722.51 (99.18)		685.57 (139.46)		–388.67 (58.41)	
Selection^2	241.95 (52.74)		–796.80 (364.71)			
Selection^3	–13.42 (33.66)		–941.57 (319.11)			

Table 3 Continued

	Lee Correction		Deaton Correction		Heckman Correction	
	Hours of Work	Participation	Hours of Work	Participation	Hours of Work	Participation
Uncompensated Wage Elasticity						
Average	0.34		0.38		0.46	
25th Percentile	0.09		0.11		0.13	
Median	0.09		0.11		0.13	
75th Percentile	0.16		0.18		0.21	
Compensated Wage Elasticity						
Average	0.46		0.51		0.61	
25th Percentile	0.18		0.20		0.24	
Median	0.23		0.25		0.29	
75th Percentile	0.31		0.33		0.39	
Participation Wage Elasticity						
Average		3.19		3.09		6.33
25th Percentile		1.28		2.41		2.99
Median		2.64		2.80		4.66
75th Percentile		4.33		3.55		8.09

NOTE: There are 56,732 observations used in the hours worked equation and 78,853 observations in the participation equation. 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 4: Structural Labor Supply Estimates Conditional on Transfer Program Income and Fixed Costs of AFDC/TANF Participation

	Lee Correction		Deaton Correction		Heckman Correction	
	Hours of Work	Participation	Hours of Work	Participation	Hours of Work	Participation
After-Tax Wage	115.05 (60.21)	4.18 (0.36)	116.79 (59.27)	0.40 (0.13)	174.33 (67.32)	9.77 (0.61)
Virtual Non-labor Income	–4.96 (1.97)	0.004 (0.004)	–3.65 (2.08)	0.000 (0.001)	–6.73 (2.06)	0.002 (0.004)
Number of Kids < Age 6	–38.37 (13.62)	–0.26 (0.02)	–41.33 (9.51)	–0.05 (0.01)	–75.04 (12.76)	–0.39 (0.02)
Number of Kids Age 6-18	–9.16 (6.45)	–0.03 (0.01)	–9.62 (6.56)	–0.01 (0.002)	–18.12 (6.46)	0.005 (0.009)
Race (1=white)	–24.71 (13.55)	–0.18 (0.02)	–32.29 (17.71)	–0.03 (0.006)	–8.39 (13.08)	–0.36 (0.01)
AFDC/TANF Participation	–827.99 (59.97)	–1.61 (0.09)	–978.76 (104.80)	–0.63 (0.04)	–919.04 (67.09)	–0.85 (0.11)
Wage Residual	–277.93 (54.27)		–288.32 (58.37)		–342.20 (65.69)	
Virtual Income Residual	4.42 (1.71)		3.22 (2.06)		6.28 (1.75)	
Selection	–483.65 (91.73)		582.37 (96.48)		–77.87 (61.63)	
$Selection^2$	253.21 (38.56)		299.93 (321.95)			
$Selection^3$	–47.92 (32.92)		–209.56 (292.13)			

Table 4 Continued

	Lee Correction		Deaton Correction		Heckman Correction	
	Hours of Work	Participation	Hours of Work	Participation	Hours of Work	Participation
Uncompensated Wage Elasticity						
Average	0.20		0.20		0.30	
25th Percentile	0.06		0.06		0.08	
Median	0.06		0.06		0.08	
75th Percentile	0.09		0.09		0.14	
Compensated Wage Elasticity						
Average	0.24		0.23		0.36	
25th Percentile	0.09		0.08		0.13	
Median	0.11		0.10		0.15	
75th Percentile	0.14		0.13		0.21	
Participation Wage Elasticity						
Average		2.00		0.65		4.69
25th Percentile		0.91		0.45		2.18
Median		1.54		0.53		3.42
75th Percentile		2.72		0.68		6.11

NOTE: There are 56,732 observations used in the hours worked equation and 78,853 observations in the participation equation. 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 5: Structural Labor Supply Estimates Conditional on Transfer Program Income and Fixed Costs of AFDC/TANF, SSI, and FSP Participation

	Lee Correction		Deaton Correction		Heckman Correction	
	Hours of Work	Participation	Hours of Work	Participation	Hours of Work	Participation
After-Tax Wage	57.40 (44.73)	4.07 (0.37)	54.52 (62.41)	0.39 (0.13)	92.50 (49.99)	10.27 (0.62)
Virtual Non-labor Income	–5.84 (2.51)	0.003 (0.005)	–4.71 (2.37)	0.000 (0.001)	–7.35 (2.69)	0.001 (0.005)
Number of Kids < Age 6	–29.36 (12.78)	–0.25 (0.02)	–25.00 (13.95)	–0.05 (0.007)	–54.73 (10.44)	–0.38 (0.02)
Number of Kids Age 6-18	18.99 (8.55)	–0.01 (0.01)	41.88 (11.55)	–0.02 (0.004)	22.98 (10.17)	0.05 (0.01)
Race (1=white)	–40.67 (19.63)	–0.19 (0.02)	–66.76 (21.70)	–0.03 (0.007)	–35.66 (16.92)	–0.43 (0.03)
AFDC/TANF Participation	–463.94 (67.60)	–1.38 (0.12)	–376.68 (93.06)	–0.70 (0.05)	–414.58 (84.69)	–0.25 (0.15)
SSI Participation	282.44 (258.46)	–0.06 (0.23)	203.14 (332.06)	–0.08 (0.08)	347.58 (236.25)	0.004 (0.23)
FSP Participation	–483.18 (74.49)	–0.40 (0.15)	–820.96 (114.32)	0.10 (0.06)	–662.53 (75.57)	–0.89 (0.15)
Wage Residual	–243.22 (45.83)		–267.77 (58.53)		–291.81 (47.12)	
Virtual Income Residual	4.30 (2.23)		2.76 (2.29)		5.52 (2.58)	
Selection	–477.41 (104.06)		537.38 (123.04)		–159.12 (56.09)	
Selection^2	209.40 (55.03)		98.84 (352.39)			
Selection^3	–37.75 (35.73)		–155.33 (289.82)			

Table 5 Continued

	Lee Correction		Deaton Correction		Heckman Correction	
	Hours of Work	Participation	Hours of Work	Participation	Hours of Work	Participation
Uncompensated Wage Elasticity						
Average	0.10		0.10		0.16	
25th Percentile	0.03		0.03		0.04	
Median	0.03		0.03		0.04	
75th Percentile	0.05		0.04		0.07	
Compensated Wage Elasticity						
Average	0.15		0.14		0.23	
25th Percentile	0.06		0.06		0.09	
Median	0.08		0.07		0.11	
75th Percentile	0.11		0.10		0.15	
Participation Wage Elasticity						
Average		1.95		0.45		4.95
25th Percentile		0.88		0.44		2.28
Median		1.51		0.51		3.63
75th Percentile		2.68		0.66		6.52

NOTE: There are 56,732 observations used in the hours worked equation and 78,853 observations in the participation equation. 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 6: 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	0.05	1.67	1.11	7.40	2.30	9.50
25th Percentile	0.03	0.38	0.31	1.00	0.33	0.95
Median	0.03	0.55	0.39	1.86	0.47	2.27
75th Percentile	0.03	1.22	0.66	4.46	1.07	5.33
Compensated Wage Elasticity						
Average	0.11	1.75	1.16	7.49	2.35	9.59
25th Percentile	0.06	0.44	0.35	1.07	0.37	1.00
Median	0.08	0.63	0.43	1.94	0.53	2.29
75th Percentile	0.10	1.29	0.72	4.56	1.12	5.39
Participation Wage Elasticity						
Average	1.68	3.41	2.48	4.12	2.80	3.64
25th Percentile	0.75	1.54	1.11	2.24	1.26	1.75
Median	1.19	3.06	1.98	4.03	2.28	3.38
75th Percentile	2.09	4.96	3.40	5.83	3.88	5.21

NOTE: Estimates based on Lee selection correction results in columns (1) and (2) of Table 5.

Appendix Table 1: Weighted Sample Means ad Standard Deviations

	Single Female-Headed Families			
	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: First-Stage Log Wage and Virtual Income Estimates

	No Transfers		Conditional on Transfer Income		Conditional on Transfer Income and Fixed Costs	
	Log Wage	Virtual Income	Log Wage	Virtual Income	Log Wage	Virtual Income
Number of Kids < 6	0.030	–0.948	0.030	–0.978	0.030	–0.978
	(0.006)	(0.117)	(0.006)	(0.115)	(0.006)	(0.115)
Number of Kids 6-18	–0.026	0.058	–0.031	0.873	–0.026	0.872
	(0.003)	(0.061)	(0.007)	(0.144)	(0.003)	(0.144)
Race (1=white)	0.043	2.272	0.043	1.428	0.043	1.428
	(0.005)	(0.107)	(0.005)	(0.105)	(0.005)	(0.105)
State Unemployment Rate	0.003	–0.207	0.003	–0.138	0.003	–0.136
	(0.002)	(0.045)	(0.002)	(0.045)	(0.002)	(0.045)
Log State Minimum Wage	0.019	1.474	0.038	0.486	0.037	0.320
	(0.062)	(1.259)	(0.062)	(1.255)	(0.063)	(1.267)
EITC Subsidy Rate	0.663	21.962	0.631	9.255	0.631	9.298
	(0.142)	(2.906)	(0.154)	(3.096)	(0.153)	(3.097)
Welfare Waiver			0.003	–0.335	0.003	–0.328
			(0.014)	(0.274)	(0.014)	(0.274)
State AFDC Benefit ($100s)			8.6e-6	0.135	8.6e-6	0.138
			(4.2e-5)	(0.085)	(4.2e-5)	(0.085)
Federal FSP Benefit ($100s)			4.9e-5	0.403	4.9e-5	0.401
			(9.7e-5)	(0.196)	(9.7e-5)	(0.196)
Federal/State SSI Benefit ($100s)			–3.9e-5	0.038	–3.9e-5	0.036
			(7.8e-5)	(0.158)	(7.8e-5)	(0.158)
AFDC Earned Income Tax			6.2e-5	0.583	6.2e-5	0.559
			(2.4e-4)	(0.476)	(2.4e-4)	(0.477)
AFDC Unearned Income Tax			8.6e-5	–0.022	8.6e-5	–0.022
			(1.6e-4)	(0.329)	(1.6e-4)	(0.329)
FSP Earned Income Tax			–0.002	1.538	–0.002	1.504
			(9.1e-4)	(1.834)	(9.1e-4)	(1.834)
FSP Unearned Income Tax			2.2e-4	0.821	2.2e-4	0.915
			(5.9e-4)	(1.180)	(5.9e-4)	(1.185)
Party of Governor (1=Democrat)					1.1e-4	0.097
					(0.005)	(0.104)
F-Statistic	18.56	19.61	18.26	15.88	18.22	15.85
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Adjusted R^2	0.13	0.14	0.13	0.12	0.13	0.12

NOTE: 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: First-Stage Probit Employment Participation Estimates

	No Transfers	Conditional on Transfer Income	Conditional on Transfer Income and Fixed Costs
Number of Kids < Age 6	–0.308	–0.307	–0.307
	(0.014)	(0.013)	(0.013)
Number of Kids Age 6-18	–0.223	–0.173	–0.173
	(0.006)	(0.012)	(0.012)
Race (1=white)	0.220	0.223	0.223
	(0.012)	(0.012)	(0.012)
State Unemployment Rate	–3.963	–3.742	–3.776
	(0.501)	(0.509)	(0.510)
Log State Minimum Wage	–0.187	–0.251	–0.229
	(0.145)	(0.146)	(0.148)
EITC Subsidy Rate	2.363	2.387	2.381
	(0.372)	(0.401)	(0.401)
Welfare Waiver		0.089	0.089
		(0.032)	(0.032)
State AFDC Benefit ($100s)		–0.077	–0.078
		(0.010)	(0.010)
Federal FSP Benefit ($100s)		0.000	0.000
		(0.020)	(0.020)
Federal/State SSI Benefit ($100s)		0.029	0.030
		(0.018)	(0.018)
AFDC Earned Income Tax		–0.079	–0.079
		(0.059)	(0.058)
AFDC Unearned Income Tax		0.019	0.018
		(0.040)	(0.040)
FSP Earned Income Tax		0.128	0.131
		(0.214)	(0.214)
FSP Unearned Income Tax		0.098	0.083
		(0.138)	(0.138)
Party of Governor (1=Democrat)			–0.014
			(0.012)
LR Statistic	17,084.03	17,194.09	17,195.33
	[0.000]	[0.000]	[0.000]
Pseudo R^2	0.18	0.18	0.18

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.

Appendix Table 4: First-Stage Probit AFDC/TANF, SSI, and FSP Participation Estimates

	AFDC/TANF	SSI	FSP
Number of Kids < Age 6	0.264	–0.025	0.212
	(0.013)	(0.021)	(0.013)
Number of Kids Age 6-18	0.201	0.046	0.255
	(0.013)	(0.017)	(0.014)
Race (1=white)	–0.422	–0.256	–0.421
	(0.012)	(0.018)	(0.012)
State Unemployment Rate	3.459	–0.907	4.699
	(0.515)	(0.842)	(0.499)
Log State Minimum Wage	–0.117	0.302	–0.352
	(0.151)	(0.235)	(0.146)
EITC Subsidy Rate	–1.087	–0.713	–0.918
	(0.406)	(0.571)	(0.375)
Welfare Waiver	–0.094	–0.032	–0.078
	(0.032)	(0.046)	(0.031)
State AFDC Benefit	0.073	–0.081	0.004
($100s)	(0.010)	(0.016)	(0.009)
Federal FSP Benefit	0.008	0.081	0.081
($100s)	(0.020)	(0.030)	(0.021)
Federal/State SSI Benefit	–0.042	0.062	0.003
($100s)	(0.018)	(0.033)	(0.018)
AFDC Earned Income Tax	0.011	0.112	0.079
	(0.059)	(0.091)	(0.055)
AFDC Unearned Income	–0.049	0.057	–0.033
Tax	(0.040)	(0.064)	(0.038)
FSP Earned Income Tax	0.413	–0.124	0.168
	(0.214)	(0.369)	(0.207)
FSP Unearned Income Tax	–0.419	0.087	–0.234
	(0.139)	(0.222)	(0.134)
Party of Governor	0.035	–0.037	0.038
(1=Democrat)	(0.013)	(0.020)	(0.012)
LR Statistic	24,232.48	2,738.06	22,525.56
	[0.000]	[0.000]	[0.000]
Pseudo R^2	0.24	0.09	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.

Appendix Table 5: Structural Log Wage Equation Estimates
(Workers Only with Correction for Sample Selection)

	No Transfers		Conditional on Transfer Income		Conditional on Transfer Income and Fixed Costs	
	Lee Correction	Heckman Correction	Lee Correction	Heckman Correction	Lee Correction	Heckman Correction
Number of Kids < 6	0.055	0.035	0.050	0.033	0.050	0.033
	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Number of Kids 6-18	0.007	–0.000	0.005	–0.002	0.005	–0.002
	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)
Race (1=white)	0.022	0.034	0.025	0.036	0.025	0.036
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Selection	–0.469	–0.133	–0.424	–0.117	–0.422	–0.117
	(0.066)	(0.026)	(0.064)	(0.025)	(0.064)	(0.025)
Selection^2	0.191		0.178		0.177	
	(0.031)		(0.031)		(0.031)	
Selection^3	–0.119		–0.111		–0.110	
	(0.032)		(0.031)		(0.031)	
F-Statistic	71.65	72.16	71.54	72.10	71.55	72.10
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Adjusted R^2	0.13	0.13	0.13	0.13	0.13	0.13

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 6: Structural AFDC/TANF, SSI, and FSP Participation Equation Estimates

	AFDC/TANF	SSI	Food Stamps
After-Tax Wage	–4.729	0.354	–3.387
	(0.396)	(0.366)	(0.356)
Virtual Non-labor Income	0.025	–0.010	0.007
	(0.006)	(0.007)	(0.004)
Number of Kids < Age 6	0.416	–0.046	0.313
	(0.015)	(0.022)	(0.014)
Number of Kids Age 6-18	0.130	0.064	0.239
	(0.008)	(0.012)	(0.008)
Race (1=white)	–0.245	–0.261	–0.279
	(0.024)	(0.028)	(0.022)
Participation Wage Elasticity			
Average	–5.93	0.77	–3.61
25th Percentile	–7.92	0.69	–4.87
Median	–5.76	0.77	–3.52
75th Percentile	–3.78	0.89	–2.28
LR Statistic	16,083.17	2,110.41	16,236.70
	[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.