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UKCPR Discussion Paper Series
#2004-03
http://www.ukcpr.org/Publications/DP2004-03.pdf

September 2004

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James P. Ziliak
Department of Economics
and
UK Center for Poverty Research
University of Kentucky

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James P. Ziliak
Department of Economics
and
UK Center for Poverty Research
University of Kentucky

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* Please address correspondence to James P. Ziliak, Department of Economics, 335 Gatton B&E Building, University of Kentucky, Lexington, KY 40506-0034; E-mail: jziliak@uky.edu. I thank Kathryn Kirkland and Gerron McKnight for excellent research assistance. In addition I am grateful to Peter Gottschalk, Steven Haider, Robert Moffitt, Jeff Smith, Ken Troske, and seminar participants at the 2004 Institute for Research on Poverty Summer Workshop, and the Universities of Florida and Oregon for helpful comments on an earlier draft. All errors are my own.

Relative Prices and Substitution Across Wage, Welfare, and Disability Income

Abstract: In this paper I exploit the fact that the social and economic reforms over the past two decades differentially affected the opportunity costs of non-participation in work, welfare, and disability programs for single mothers across different birth-year and education cohorts. This cohort variation in after-tax wages and transfer benefits is used to identify own- and cross-price elasticities of demand for and substitution across wage, welfare, and disability income over 1979 to 2001 in the Current Population Survey. To estimate these key parameters I model household preferences with a conditional Almost Ideal Demand System that admits corner solutions, nonseparability, endogenous wages and incomes, and latent heterogeneity via cohort and state fixed effects. I match individual and family-level data in the CPS both with family-specific federal, state, and payroll tax rates, and with state-specific and time-varying benefit levels and effective tax rates in the AFDC and SSI programs. Using a two-limit Tobit instrumental variables estimator I find strong evidence of sizable own and cross-programmatic substitution effects. For example, the estimated elasticities imply that between 1979 and 1999 the increase in the generosity of SSI relative to AFDC accounts for about 40 percent of the average growth in SSI, while the increase in real wages accounts for about one-half of the average decline in AFDC shares over the past two decades. Simulations suggest that changes in relative after-tax wages and transfer-program benefits over the past two decades lead to a substantial "pull" out of cash welfare and into expanded reliance on employment and disability as a means of financial support among single mothers.

Key Words: Labor Supply, Aid to Families with Dependent Children, Supplemental Security Income, Conditional Demand, Instrumental Variables
JEL Codes: D1, I3, J2

Epochal changes in the U.S. economic and social policy landscapes over the past two decades have altered significantly the economic rewards to work, to welfare participation, and to participation in disability programs. These changes affected all segments of the low-income population, but were especially pronounced among single female-headed families with children. A result of this changing landscape was a massive shift in the composition of the safety net of single mothers away from cash welfare (Aid to Families with Dependent Children, AFDC) and toward labor-market based income and credits (the Earned Income Tax Credit, EITC) and disability income (Supplemental Security Income, SSI). In 1979 expenditure levels on AFDC totaled $25 billion in real 1999 dollars, $16 billion for SSI, and $4.7 billion for the EITC; by 1999 $13.5 billion was spent on AFDC, $29 billion on SSI, and $32 billion on the EITC. At the peak of the 1970s expansion, around 40 percent of the poverty gap—that is, the aggregate distance between pre-tax and pre-transfer family income and the family-size adjusted poverty threshold—was filled by AFDC, but only 3 percent was filled by SSI and 0.30 percent by the EITC (Ziliak 2003). By the peak of the 1990s expansion, AFDC filled only 10 percent of the gap, whereas SSI and the EITC filled nearly 9 and 7 percent, respectively. While much attention has been placed on factors that "pushed" women off of welfare such as the 1996 welfare reform, there were also significant "pull" factors onto disability and into the labor force both from increased relative generosity of SSI benefits and from before- and after-tax real wage growth. The purpose of this paper is to estimate the role of relative price changes in explaining substitution across wage, welfare, and disability income over the past two decades.[1]

Several explanations have been proffered in recent years to help understand the fundamental economic developments affecting low-income American's decisions to work and/or

[1] Throughout the paper the term "prices" will be used to refer to the opportunity costs of leisure (wage), of non-participation in AFDC (AFDC benefit), and of non-participation in SSI (SSI benefit). Moffitt (1981) uses a similar terminology.

participate in income maintenance programs. 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 (Gundersen and Ziliak 2004; Katz and Krueger 1999; Krueger and Solow 2001). 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 and Michalopoulos 2003; Meyer and Rosenbaum 2001; Schmidt and Sevak 2004). While still yet a third area emphasizes judicial and legislative changes that relaxed disability program eligibility criteria (Bound and Burkhauser 1999; Garrett and Glied 2000; Kubik 1999; Stapleton, et al. 2001). Collectively this research has shed important light on various dimensions of economic behavior among low-income Americans. However, the research has at times been conducted on a program-by-program basis without regard to interaction effects with other programs, and/or without a formal labor market. In addition, the research is frequently executed using aggregate county or state-level data, rather than individual-level data, and models are typically reduced-form specifications. In short, research emphasizing the role of relative wage and transfer-program benefit movements in inducing substitution across various work and transfer-program states over time in the context of a behavioral model is lacking.[2,3]

Understanding the role of relative price changes in accounting for the shifting composition of household budgets is important both for models of the family and for public-

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[2] As part of the 1996 welfare reform the AFDC program was abolished and replaced by a new program, Temporary Assistance for Needy Families (TANF). For convenience I refer to cash welfare as AFDC throughout this paper. In addition, disability income refers to the SSI program for the purposes of this paper.

[3] This paper is similar in spirit to Meyer and Rosenbaum (2001), who used a 'difference-in-differences' estimator to estimate the effects of changes in after-tax wages and AFDC benefits (along with some other policy variables) on the probability of single-mother's employment from 1984 to 1996. The analysis here differs in many aspects from Meyer and Rosenbaum including the focus on both extensive and intensive margins of not just work but also welfare and disability, the use of a more structural framework, a different identification and estimation scheme, and the use of a longer time series.

policy analysis. For example, to understand the effect of a cut in AFDC benefits, or an increase in the EITC, it is critical to know whether labor-force and transfer-program participation and quantity decisions are sensitive to changes in wages and program benefits, and if sensitive, to quantify the own and cross-price elasticities. While there is considerable evidence on the effect of own wages on female labor supply choices (Mroz 1987), we know much less about how the earnings of women changes in response to outside options such as the generosity of welfare or disability benefits (especially in the context of a structural model), and about how welfare or disability program usage of women changes over time in response to other transfer-program parameters and labor-market opportunities.[4] Research on the latter is crucial to a more complete understanding of the recent changes in welfare and work, and ultimately can shed light on issues of optimal program design.

In this paper I exploit the fact that the social and economic reforms over the past two decades differentially affected the opportunity costs of non-participation in work, welfare, and disability programs for single mothers across different birth-year and education cohorts. This cohort variation in after-tax wages and transfer benefits is used to identify own- and cross-price elasticities of demand for and substitution across wage, welfare, and disability income over 1979 to 2001 in the Current Population Survey.

I begin by developing a static model akin to Moffitt (1983) and Keane and Moffitt (1998) where the family head derives utility from work and from participation in two transfer programs: cash welfare (AFDC) and disability (SSI), subject to a budget constraint that is nonlinear due to the tax treatment of wages and transfers. Preferences for work, welfare, and disability are

[4] Moffitt (1983), Hoynes (1996), and Keane and Moffitt (1998) are important exceptions in the literature on the joint choice of work and welfare participation, but each focuses on a single cross-section of data and do not address the more recent changes. See Moffitt (1992) for a review of the literature. There has also been important contributions in the literature on the effect of labor-market opportunities on welfare-spell durations, e.g. Blank and Ruggles (1996) and Hoynes (2000).

conditioned on other income sources (e.g. other transfers and private nonlabor income), demographics, macroeconomic and policy factors, and the fact that participation in transfer programs may impose a utility "cost" in the form of stigma and/or hassle effects. I use the flexible functional form for indirect preferences that generates a conditional Almost Ideal Demand System (AIDS) of income shares. This functional form is the standard bearer in much of the consumption literature both because of the flexibility in price and income responses, and the fact that it provides a ready means to conduct welfare analysis. Wages are subject to direct taxation from federal, state, and payroll taxes, as well as implicit taxation from the EITC, AFDC, and SSI programs. To maintain tractability across twenty-three years of data and fifty-one separate state tax and welfare programs, I construct effective marginal tax rates using the *TAXSIM* program from NBER as well as quality control data from the AFDC and SSI programs (Fraker, Moffitt, and Wolf 1985; McKinnish, Sanders, and Smith 1999).

Because many families do not receive income from disability, welfare, and/or work, or may be solely dependent on one of these sources, the well-known econometric problem of corner solutions must be confronted. In addition, income derived from work, AFDC, and SSI may not be separable from other income sources, such as food stamps, the EITC, and other non-labor income. Furthermore, the after-tax wage, after-tax transfer benefits, and income variables are likely endogenous in the share equations. To simultaneously address nonparticipation (i.e. share = 0), dependence (i.e. share = 1), nonseparability, and endogeneity I adopt an instrumental variables two-limit Tobit-type estimator for the unrestricted system of conditional income-share equations (Browning and Meghir 1991; Smith and Blundell 1986). Identification is achieved by assuming that after-tax real wages and transfer benefits, conditional on the cohort group and time effects, grow differentially across groups over and above any changes in sample composition in the labor force, welfare programs, or disability programs (Blundell, Duncan, and Meghir 1998). This framework provides consistent estimates of preference parameters and readily permits calculation of own and cross-price elasticities at both the extensive and the intensive margins, calculation of elasticities of substitution, tests of cross-equation restrictions with an auxiliary minimum-distance estimator, and welfare costs of alternative transfer-program policies.

I find strong evidence of sizable own and cross-programmatic substitution effects, both at the extensive and intensive margins. Among single female heads of families the elasticity of ever participating in AFDC with respect to the after-tax AFDC benefit is +0.6, it is –0.7 with respect to the after-tax SSI benefit, and –1.0 with respect to the after-tax real wage. These elasticities provide insight into the role of relative prices in accounting for changes in work, welfare, and disability. For example, between 1979 and 1999 the increase in the generosity of SSI relative to AFDC accounts for about 40 percent of the average growth in SSI, while the increase in real wages accounts for about one-half of the average decline in AFDC shares over the past two decades. Welfare simulations imply that relative price changes across work, welfare, and disability over the past two decades lead to a substantial "pull" off of dependence on cash welfare and into expanded reliance on employment and disability as a means of financial support for single mothers.

II. Trends in Work, Welfare, and Disability

Over the past two decades the U.S. economy experienced both the deepest recession and the most protracted expansion in post-war history. Except for a modest tapering off in the mid-1990s, wage inequality rose unabated during this period (Katz and Autor 1999), but so too did labor productivity, especially during the 1990s, that drove down core inflation and unemployment rates and led to significant real wage gains across the wage distribution (Katz and

Krueger 1999). Concomitant with these economic developments were major social policy reforms and legal rulings that affected cash welfare (AFDC), disability (SSI), and employment.[5] I briefly describe the key programs and reforms in the context of time-series trends in participation rates.

AFDC, which was established by the Fair Labor Standards Act in the 1930s, was the primary cash welfare program for low-income families with dependent children under age 18. For most of its history over 90 percent of the AFDC caseload was comprised of single mothers with children, with the remaining fraction consisting of two-parent cases and so-called child-only cases whereby only the child in the family receives the benefit. To qualify the family had to pass a sequence of income and liquid asset tests, and the benefit, which was reduced by the presence of most forms of earned and unearned income, varied widely both across states and family size. Beginning in 1981 the statutory benefit reduction rate was set at 100 percent, though the effective tax rates were significantly lower because of state variation in the level and types of exemptions (Fraker, Moffitt, and Wolf 1985; McKinnish, Sanders, and Smith 1999). Funding for the program was via the federal government with a matching grant supplied by the states, with the state match rate set at the same level as required for the state's Medicaid insurance program.

States began experimenting with their welfare programs in the early-1990s via waivers from federal regulations granted by the U.S. Department of Health and Human Services. These waivers included time limits on benefit receipt, work requirements, and work incentives such as higher earnings disregards and liquid-asset limits. The waivers were codified into federal legislation with the passage of the Personal Responsibility and Work Opportunity Reconciliation

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[5] Meyer and Rosenbaum (2001) offer a nice timeline of the passage of major social and tax policy legislation in the 1980s and 1990s.

Act (PRWORA) in 1996. This eliminated the AFDC program and replaced it with a state block grant program known as Temporary Assistance for Needy Families (TANF). Under PRWORA, cash assistance is no longer an entitlement and aid is subject to a federal lifetime limit of 60 months (or shorter based on state discretion).

Figure 1 depicts the time series of AFDC participation rates over the period 1979 to 2001 among single mothers who are between the ages of 18 and 60 and who have related children under age 18 present in the family.[6] The figure depicts the trends separately for three education groups, less than high school, high school graduates, and those with some post-secondary education. Through most of the 1980s the fraction of the population on AFDC in each group held relatively constant, though the levels clearly varied greatly across education groups. This was followed by an upsurge in participation the early 1990s, especially among single mothers with high school or more, only to plummet downward for all education groups in the mid and late 1990s. Research to date on the changes in the AFDC program have tended to focus primarily on macroeconomic factors, such as state unemployment rates and employment growth rates, and policy reforms such as welfare reform and the EITC expansions. The consensus in the literature is that the macroeconomy was the most important factor behind the changes, but there is swift debate about the aggregate importance of welfare reform (Blank 2002; Ziliak et al. 2000). Comparatively little attention has been paid, however, to the role of relative price changes, i.e. AFDC benefits relative to the market wage and relative to SSI benefits, as a source of the caseload changes.

[Figure 1 here]

[6] The data, which is described in detail below, come from the Current Population Survey. In Figure 1 AFDC and SSI refer to family-level participation rates, implying that the head may or may not be part of the grant. It is not possible to separate parent from child welfare receipt in the CPS. The employment rate is based on the family head.

The SSI program, which was established in 1972, provides cash assistance to the needy aged, the blind, and the disabled. While identifying potential recipients based on age and vision is readily assessed, verifying disabilities is difficult and fraught with controversy. As described in Daly and Burkhauser (2003) there is a three-step process in identifying disabilities: (i) a physical or mental malfunction that (ii) leads to an impairment which in turn (iii) generates an inability to perform socially expected functions, notably work for adults and schooling for children. Challenges notwithstanding the bulk of the SSI caseload are disabled recipients. On top of the programmatic criteria of being aged, blind, or disabled, to qualify for SSI the family must meet both income and liquid asset tests. In contrast to AFDC and its successor TANF, the SSI program has substantially more federal oversight. The grant and eligibility criteria are set at the federal level, as are the statutory benefit reduction rates on earned and unearned incomes. Importantly for the analysis in this paper, about half of the states supplement the federal grant for individuals living independently, which provides much needed cross-state variation in gross benefits for use in identification.

Figure 1 shows the time series SSI participation rates for the same sample of single mothers as used in the AFDC series. Across all education groups SSI participation was stable in the 1980s; however, enrollment increased substantially after 1990, especially among low-educated single mothers. Previous research by Kubik (1999) and Garrett and Glied (2000) points to a 1990 Supreme Court decision, known as the *Zebley* decision, for much of the post-1990 growth in SSI. As noted previously, an individual is deemed disabled for purposes of SSI eligibility if the disability limits or prohibits participation in gainful activity. For adults the gainful activity is generally market work. Prior to 1990 the Social Security Administration maintained a formal list of disabilities recognized as limiting work, but also considered “off-list” disabilities. However, there was no such "off-list" for children, whose gainful activity was schooling. This had the effect of making SSI eligibility for children more stringent than for adults. The Court ruled in the *Zebley* decision that the differential treatment of children was unconstitutional, and as a consequence Congress redesigned the SSI program to make child eligibility no more stringent than adult eligibility. In the first four years after *Zebley* the number of children receiving SSI increased three-fold (Kubik 1999), but given the continued growth into the late 1990s there seems to be other factors at work beyond the *Zebley* decision.

Compared to the AFDC program research on the SSI program is scare, and research on own and cross-price effects on SSI participation is even less common. Kubik (1999) is a notable exception in his analysis of children on SSI.[7] In his child participation model he examined the economic incentives facing families on AFDC of moving a child onto SSI by specifying a variable he called the net SSI benefit, defined as the gain in family income by moving a child from AFDC onto SSI. When removing a child from the AFDC program the AFDC grant amount falls, but the loss in AFDC income is more than offset by the gain in total family income from the SSI grant. He used this cross-differential to help identify the growth in the child SSI caseload after the *Zebley* decision. An alternative approach suggested by Kubik, and the one followed here, is to use state-specific supplements to the federal SSI grant along with the state-specific AFDC grant as separate variables. As described in the data section the relative variation in these series over two decades is substantial, and this cross-section and time-series variation is significantly enhanced by the inclusion of effective tax rates that are used in constructing after-tax AFDC and SSI benefits.

[7] Schmidt and Sevak (2004) examine the effect of welfare reform on SSI participation. Their model differs from the current paper in that they rely on a reduced-form specification and do not model a formal labor market.

Coincident with the changes in the AFDC and SSI program in the 1990s were substantial increases in labor force participation among single mothers. Figure 1 highlights that the time series of employment rates is nearly a mirror image of the trends in AFDC and parallel with the growth in SSI. The research to date attempting to explain the growth in labor-force participation among single women with children has emphasized welfare reform and/or EITC expansions (Blank 2002; Meyer and Rosenbaum 2001). However, additional structural economic models of own wages and of cross-program effects on labor-market outcomes are needed for a more complete understanding of the changing economic conditions of single mothers.[8]

III. An Economic Model of Income Shares

In this section I develop a standard economic model of labor supply and transfer-program participation akin to that proposed by Moffitt (1983) and Keane and Moffitt (1998). Important for the ensuing model are the programmatic interactions among AFDC, SSI, and work. First, it is not possible for a given individual to receive both AFDC and SSI income, but families may receive both. Second, aside from the automatic family-size induced reduction in the AFDC grant, the AFDC benefit is not reduced by the presence of SSI in the family, and likewise, the SSI benefit is not reduced by the presence of AFDC income in the family (U.S. House of Representatives 2004; Social Security Administration 2004). Third, benefits from both AFDC and SSI are taxed by the presence of labor-market earnings. The implication for modeling purposes then is that the before-tax state-specific maximum AFDC and SSI benefits can be treated as exogenous in models of AFDC, SSI, and work, but before and after-tax wages must be treated as endogenous, as must after-tax AFDC and SSI benefits.

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[8] Kubik (1999) provides a limited analysis of the effects of the AFDC and SSI benefit generosity on labor supply of women. However, his analysis stops in 1994, prior to the big shift in employment, and does not include the women's own wage rate. The distinctions between his model and that of this paper will be highlighted in the next section.

Specifically, the family head is assumed in each period t to have direct preferences over hours of market work, h_t, income, M_t, and participation in the cash welfare program AFDC (I_{ct} =1 if participate in AFDC; 0 otherwise) and participation in the disability program SSI (I_{dt} = 1 if participate in SSI; 0 otherwise). For the moment consider a preference structure where income is an implicit function of AFDC and SSI participation, and where transfer program participation generates a utility cost, possibly due to stigma or hassle effects. The utility function is

(1) $$U_t(h_t, M_t(I_{ct}, I_{dt}); z_t) - \xi_c I_{ct} - \xi_d I_{dt},$$

where $\xi_{jt}, j = c, d$, are the marginal disutilities of participating in AFDC and SSI, and the z_t are a set of conditioning goods such as demographics.

The current-period budget constraint facing the single mother is

(2) $$M_t = W_t h_t + N_t + I_{ct} G_{ct} + I_{dt} G_{dt} - T_t(Y_t),$$

where W_t is the before-tax hourly wage rate, N_t is nonlabor income aside from AFDC or SSI, G_{ct} is the maximum AFDC benefit guarantee, G_{dt} is the maximum SSI benefit guarantee, Y_t is taxable income, and $T_t(Y_t)$ is tax payments. The tax payment function emanates both from direct taxation of wages and nonlabor income from federal (FED), state, and Social Security payroll (SS) tax systems, as well as implicit taxation from participation in the EITC, AFDC, and SSI programs. The tax function is

(3) $$\begin{aligned} T_t(Y_t) = T_t^{FED}(W_t h_t, N_t, E_t^{FED}) + T_t^{SS}(W_t h_t, E_t^{SS}) + T_t^{STATE}(W_t h_t, N_t, E_t^{STATE}) + \\ T_t^{EITC}(W_t h_t, N_t, E_t^{EITC}) + T_t^{c}(W_t h_t, N_t, E_t^{c}) + T_t^{d}(W_t h_t, N_t, E_t^{d}), \end{aligned}$$

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). Defining $\tau_t \equiv T_t'(Y_t)$ as the marginal tax rate, the resulting after-tax "prices" of work, welfare, and disability are, respectively

$$p_{wt} = W_t(1-\tau_t^{FED} - \tau_t^{SS} - \tau_t^{STATE} - \tau_t^{EITC} - \tau_t^{c,1} I_{ct} - \tau_t^{d,1} I_{dt}),$$
$$(4) \qquad p_{ct} = G_{ct} - \tau_t^{c,1} W_t h_t - \tau_t^{c,2} N_t,$$
$$p_{dt} = G_{dt} - \tau_t^{d,1} W_t h_t - \tau_t^{d,2} N_t,$$

where $\tau_t^{c,1}, \tau_t^{c,2}, \tau_t^{d,1}, \tau_t^{d,2}$ reflect the fact that the AFDC and SSI programs assess different tax rates to labor and nonlabor income. Note that the worker only faces these additional marginal rates on their wages if they participate in the program(s), and that the prices of welfare and disability are zero if $G_{jt} - \tau_t^{j,1} W_t h_t - \tau_t^{j,2} N_t \leq 0, j = c, d$.[9] The net prices in equation (4) represent the opportunity cost of leisure and non-participation in AFDC and SSI.

Because the choice of I_{ct} and I_{dt} depends on whether utility is higher when participating in one or both programs versus not participating, and since the ensuing focus is on estimating own and cross-price effects on budget shares, it is common to turn to the indirect utility function, $V_t = V_t(-p_{wt}, -p_{ct}, -p_{dt}, M_t(I_{ct}, I_{dt}); z_t) - \xi_{ct} I_{ct} - \xi_{dt} I_{dt}$, where the negative sign in front of the prices is needed for indirect utility to have the typical property of non-increasing in prices, i.e., higher wages and transfer benefits make consumers better off, contrary to typical goods prices that make the consumer worse off.

Before proceeding it is important to note that aside from work, welfare, and disability the single mother has access to a variety of other transfer programs such as the Food Stamp Program, housing assistance, the Social Security Disability Income Program, among others. Decisions to participate in these programs may not be strongly separable from the focal choice variables of work, AFDC, and SSI in equations (1)–(4). Browning and Meghir (1991), in a model of consumption demand, offer a transparent solution to the problem that consumption

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[9] For simplicity it is assumed that take-up rates in the EITC program are 100 percent. Using data from 1990, Scholz (1994) estimated that EITC participation rates approached 85 percent. Given the significantly increased generosity in the EITC in the 1990s, coupled with major outreach efforts on the part of the IRS, the assumption of complete take up does not seem unreasonable.

decisions may be nonseparable from labor supply choices by conditioning the demand system on labor supply and treating the latter as endogenous in estimation. This results in a conditional demand system that yields most of the parameters relevant for within-period consumer preferences. I follow a similar strategy here by breaking up income, M_t, into the "income from programs of interest," i.e. work, welfare, and disability, denoted throughout as "WWD income" and defined as $\tilde{M}_t = W_t h_t + I_{ct} G_{ct} + I_{dt} G_{dt} - T_t(Y_t)$, and "other income" N_t that becomes part of the conditioning set, z_t.[10] As described below, other income will be treated as endogenous in estimation.[11]

Solving the model in its present form is very complicated because of the highly nonlinear budget set and multiplicity of choices across possible hours of work and participation decisions in either or both AFDC and SSI. Keane and Moffitt (1998) tackle their problem in a fully structural framework, but to maintain tractability they limit the hours choice to one of three outcomes: no work, part-time work, and full-time work, and then utilize a simulated method of moments estimator. A similar approach could be followed here. However, because my objective is to identify the effects of price changes over time the method of Keane and Moffitt is not tractable in the face of twenty-three years of data across fifty-one separate state tax and welfare programs. Instead, I adopt a more transparent approach through a number of simplifying assumptions, which results in a quasi-structural framework.

First, instead of solving simultaneously the budget segment location along with the hours and transfer-program participation decisions, I construct effective marginal tax rates (described

[10] The income from work, welfare, and disability (WWD income) comprises 70 percent of total income for single mothers over 1979 to 2001.

[11] Part of the incentive to include SSDI and food stamps in the conditioning set, rather than the choice set, stems from the fact that benefits are federally set and thus there is inadequate variation to identify price effects. Autor and Duggan (2003) get around this problem to some extent in their paper on SSDI by constructing time-varying and state-specific SSDI benefit replacement rates. While this is a creative solution, it functions less like a "price" variable compared to state set AFDC and SSI benefit levels, and certainly compared to person-specific wage rates.

in the data section), linearize the constraint by taking the net prices in equation (4) as given and add a lump-sum transfer to nonlabor income to yield "virtual" other income equal to $\tilde{N}_t = N_t + \tau_t W_t h_t - T(Y_t)$. I then treat the net prices and virtual income as endogenous in estimation. This is a common approach in the taxation and labor supply literature (MaCurdy, Green, and Paarsch 1990). While the presence of transfer programs creates nonconvexities in the budget set and thus confounds the use of linearized budget constraints, the multiplicity of segments across different programs and tax systems, coupled with the fact that the single mother may cycle on and off programs and work within a year, implies that the budget set may be effectively convex (Moffitt 2002). Second, the difficulties associated with the dichotomous participation decisions in the utility function are mitigated somewhat by converting the discrete outcomes to continuous income shares. This focus on budget shares is common in the consumption literature and also has been used to examine the tradeoff between the receipt of wage income versus fringe benefits (Woodbury 1983). A number of identification and estimation challenges still arise from the existence of corner solutions, and these are discussed more fully in the next section.

To operationalize the model a functional form is needed for indirect preferences. Because of its widespread use in the applied consumption literature, in part owing to its flexibility and desirable aggregation properties to conduct welfare analysis, I adopt the PIGLOG specification of indirect utility as (suppressing the conditioning variables z_t and the stigma indicators):

(5) $$V_t = \frac{\ln \tilde{M}_t + \ln a(p_t)}{b(p_t)}.$$ [12]

The usual approach in the consumption literature is to adopt the following two price indices:

[12] Note that a negative sign would typically replace the '+' in equation (5) in the standard goods model.

(6a) $$\ln a(p) = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2}\sum_k \sum_j \gamma_{kj} \ln p_k \ln p_j ,$$

and

(6b) $$\ln b(p) = \sum_k \beta_k \ln p_k ,$$

which permit straightforward tests of behavioral restrictions such as adding-up ($\sum_k \alpha_k = 1$, $\sum_k \beta_k = 0$, and $\sum_k \gamma_{kj} = 0$), homogeneity ($\sum_j \gamma_{kj} = 0$), and symmetry ($\gamma_{jk} = \gamma_{kj}$). The price indices are homogeneous degree zero ($b(p)$) and degree one ($a(p)$), respectively.

Applying Roy's Identity to equation (5) and using equations (6a) and (6b) yields the system of income shares:

(7) $$s_{it} = \alpha_i + \sum_j \gamma_{ij} \ln p_{jt} + \beta_i \ln\left(\frac{\tilde{M}_t}{a(p_t)}\right),$$

where $s_{it} \equiv \frac{p_{it}q_{it}}{\tilde{M}_t}$, $q_i = h, I_c, I_d$, is the income share of source *i* in the family's total budget, and $\frac{\tilde{M}_t}{a(p_t)}$ is real WWD income. This is the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980). Following Browning and Meghir (1991), one can add the set of conditioning goods, including the potentially endogenous virtual other income term, transparently through the intercepts in equation (7), i.e. $\alpha_{it} = \alpha_{i0} + \sum_p \alpha_{ip} z_{ipt}$.

IV. Identification and Estimation

The income shares in equation (7) tell us how changes in prices and income affect the relative shares of each WWD income source in the family's total budget. In order to identify these effects we need to specify the source of variation in prices and income, as well as the sources of variation from other measured and unmeasured factors. Given time series data on prices and income it is possible to estimate the parameters in equation (7); however, time series data mask important heterogeneity in labor-market, welfare, and disability program participation, including possible stigma effects, and the attendant heterogeneity in price responses. To capture this heterogeneity I use pseudo panel data in which clusters of like individuals are grouped together, in this case by five-year birth cohort and three education levels, and the groups are followed over time (Blundell, Duncan, and Meghir 1998).

Specifically let *n* (= 1,…,*N*) denote the groups, *t* (=1,…,*T*) denote time, and rewrite equation (7) as:

(8) $$s_{it} = \alpha_{it} + \sum_{j} \gamma_{ij} \ln p_{jt} + \beta_i \ln\left(\frac{\tilde{M}_t}{a(p_t)}\right) + \delta_{in} + \lambda_{it} + \varepsilon_{it},$$

where δ_{in} is the group effect, λ_{it} is the time effect, and ε_{it} is an error term which will be elaborated on below. The specification in equation (8) yields exclusion restrictions needed for identification of price and income effects in that unobserved differences in average WWD income shares are captured by a permanent group effect and an additive time effect. In many applications this assumption is sufficient; however, it is too strong for the model at hand because it implies that self-selection into work, welfare, or disability is captured by the group and time effects. Given high rates of nonparticipation in the labor force among female heads of families with young children, especially those mothers with low education, and even higher rates of nonparticipation in AFDC and SSI among mothers with high school education or more, the model needs to account explicitly for corner solutions where the share equals zero. Likewise, families may be wholly dependent on a single income source among the $\tilde{M}_t$; indeed, the notion of eliminating "dependence" on welfare (AFDC share = 1) weighed heavily in the debates surrounding the 1996 welfare reform.

I accommodate nonparticipation and dependence by adopting a two-limit Tobit-type model specification for the WWD income shares:

(9) $$s_{it} = \max(0, x_{it}\pi + \delta_n + \lambda_t, 1),$$

where x_{it} is a vector containing demographics, prices, and the income terms.[13] Under the assumption of normality the specification in (9) yields a fixed effects two-limit Tobit model. It is widely believed that the so-called incidental parameters problem (i.e. the fact that the number of group effects grows with the number of groups) renders fixed-effect Tobit slope estimates inconsistent with a fixed number of time periods because estimation of the group effect is not separable from estimation of slope parameters in nonlinear models. However a recent simulation by Greene (2003) shows that in the case of the standard Tobit model the bias manifests itself in the variance parameter σ_ε^2 and not the slopes, and further that this bias gets small in modest-sized T samples, i.e. $T > 6$. While similar evidence is not available for the two-limit Tobit model, the underlying structure is the same and given that I have 23 years in my sample this bias should be minimal.

Importantly, for identification one also needs the assumption that conditional on the group and time effect, prices grow differentially across groups over and above any changes in sample composition in the labor force, welfare programs, or disability programs. If the only source of price variation is time then identification of (9) would not be possible. However, I exploit the fact that the maximum benefit guarantees of AFDC and SSI vary both over time and

[13] Papke and Wooldridge (1996) propose a flexible framework for estimating proportions data. In their approach the outcome of interest lies within the unit interval, but the estimator can accommodate "nuisance" outcomes such a 0 and 1. In the model here, nonparticpation and dependence have important economic and policy implications, which makes the two-limit Tobit framework attractive.

across U.S. states, and with individual-level data on labor income, other income, and effective marginal tax rates I can exploit cohort-group and time-series variation in net AFDC benefits, net SSI benefits, and net wages as defined in equation (4) for estimation.

Because the after-tax prices in equation (4) are functions of choice variables, either explicitly in the case of the size of the after-tax AFDC and SSI benefits as a function of earnings, or implicitly in the case of after-tax wages because the marginal tax rate is a function of earnings, the net prices must be treated as endogenous in estimation. Furthermore, families may not derive any income from $\tilde{M}_t$, leading to the possibility of non-random selection arising through the choice of positive $\tilde{M}_t$.[14] The combination of selection into WWD income, coupled with endogenous net prices and virtual other income in the income share equations, can be addressed straightforwardly in the Tobit framework of equation (9).

Consider the problem of identifying the effects of net prices and virtual other income. Blundell et al. (1998), in a model of labor supply and taxation among married women in the U.K., argue that interactions of the group and time effects capture macro "shocks" to wages and taxes due to exogenous changes in tax policies and the wage structure (e.g. skill-biased technological change), and that these interactions serve as valid exclusion restrictions for identification of after-tax wages in their model. I follow a similar identification strategy here by exploiting the fact that reforms to the U.S. tax and welfare systems, coupled with the widely noted changes in the wage structure, differentially affected birth-year by education cohorts of single mothers over the past two decades. The ensuing reduced-form linear prediction equations of the after-tax prices (p_j , j=w,c,d) and virtual other income ($\tilde{N}_t$) for those observations with positive values of the respective net prices and other income are specified as a function of

[14] As noted in the data section only around 5 percent on single mother families over 1979–2001 report $\tilde{M}_t = 0$.

demographics (l_t), group effects, time effects, and complete interactions of group and time effects:

(10) $$g_{jt} = \varsigma_j l_{jt} + \delta_{jn} + \lambda_{jt} + \psi_j(\delta_{jn} \times \lambda_{jt}) + \nu_{jt} \;\; , g,j = p_w, p_c, p_d, \tilde{N}_t .$$

Smith and Blundell (1986) show that the fitted residuals from the regressions in (10), $\hat{\nu}_{jt}$, can be included as extra regressors in a Tobit model like equation (9) to yield consistent estimates of the parameters π. At the same time, this variable addition procedure allows one to test whether net prices and virtual other income are exogenous by testing the statistical significance of the fitted residuals.

The additional econometric issue here is that the shares in equation (9) are undefined for families with $\tilde{M}_t = 0$. This possible non-random selection is handled in two ways; one, by permitting non-separabilities in preferences for income by conditioning the system on virtual other income, $\tilde{N}_t$, and two, by estimating the reduced-form prediction equation (10) for $\tilde{M}_t$ by Tobit rather than OLS (i.e. including the observations with $\tilde{M}_t = 0$), constructing Tobit residuals for families with $\tilde{M}_t > 0$, and estimating equation (9) with the fitted residuals for families with $\tilde{M}_t > 0$. This accounts explicitly for composition changes in wage, welfare, and disability income, and is an extension to the Tobit Type III method (Amemiya 1985). The complete specification of the income share equations used in the two-limit Tobit model estimation is thus

(11) $$s_{it} = \alpha_{it} + \sum_j \gamma_{ij} \ln p_{jt} + \beta_i \ln\left(\frac{\tilde{M}_t}{a(p_t)}\right) + \delta_{in} + \lambda_{it} + \hat{\upsilon}_{p_w t} + \hat{\upsilon}_{p_c t} + \hat{\upsilon}_{p_d t} + \hat{\upsilon}_{Nt} + \hat{\upsilon}_{\tilde{M}t} + \varepsilon_{it} .$$ [15]

[15] Asymptotic t-statistics are a valid method of testing the statistical significance of the coefficients on the residual variables. However, strictly, one should adjust all standard errors for the presence of the generated regressors if the residual variables are found statistically significant (Wooldridge 2002). I do not make this ex post adjustment in the results reported below.

Finally, because I estimate an unrestricted system of WWD income share equations it is possible to test cross-equation restrictions such as symmetry of price effects in an auxiliary analysis with a minimum-distance estimator (Blundell, Pashardes, and Weber 1993; Browning and Meghir 1991). Specifically, let the vector of unrestricted parameters be Γ with dimension L and the symmetry restricted parameters be Θ with dimension Q. Under the null hypothesis of symmetry, $\Gamma = H\Theta$, where *H* is a matrix of rank L – Q(Q–1)/2. Given the unrestricted estimates, $\hat{\Gamma}$, and the attendant variance-covariance matrix $\hat{\Omega}$, the null hypothesis of symmetry can be tested by minimizing the criterion function

(12) $$\Psi = (\hat{\Gamma} - H\Theta)'\hat{\Omega}^{-1}(\hat{\Gamma} - H\Theta) \sim \chi^2_{Q(Q-1)/2}$$

with respect to Θ. The restrictions can be tested by plugging the estimates $\hat{\Theta}$ back into the criterion function, $\hat{\Psi}$, which is asymptotically distributed as chi-square with degrees of freedom equal to Q(Q–1)/2.

V. Data

The data come from the 1980–2002 waves (1979–2001 calendar years) of the March Annual Demographic File 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. In the CPS a family is defined as two or more persons related by birth, marriage or adoption. The focus is on single female-headed families with children because they have historically been the primary recipients of cash welfare.[16] The total number of observations is 88,802 single female-headed families.

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[16] In results not tabulated I conducted a separate analysis of male-headed families. Such families have always been eligible for SSI, whether single or married, and two-parent male-headed families were eligible for AFDC in half of the states prior to 1990, and in all states since 1990 (subject to some additional criteria on work effort of the primary breadwinner). However, average participation rates among male heads were only 1.5 and 0.1 percent in each of

The families are then allocated to thirteen different five-year date of birth cohorts, 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. In Table 1 I depict the distribution of families into the thirteen birth cohorts for each year of the sample. From Table 1 it is clear that the five birth cohorts from 1939 to 1963 provide complete information over the sample period, but the contributions of the earlier and later cohorts also contain critical information for identification much like one would find in a standard unbalanced panel of families. Recall that each cell in Table 1 is split into three education groups, so that a complete table has 897 cells. 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 from estimation. In addition there were 121 women with hourly wages exceeding $500 per hour but with inconsistent data; thus, those observations were deleted. Finally, there were 4,421 women with no reported wage, AFDC, or SSI income. These observations are included in the first-stage Tobit prediction equation (10) for $\tilde{M}_t$, but not the second stage, leaving the final sample with $\tilde{M}_t > 0$ used in estimation of the instrumental variables two-limit Tobit model in equation (11) at 80,495.

[Table 1 here]

An important advantage of cohort-based data is that it is possible to characterize life-cycle profiles by combining cohort averages by age. In Figures 2–4 I present the life-cycle profiles of AFDC participation, SSI participation, and employment rates of single mothers for the thirteen birth cohorts by the three education groups. Across all three education groups, Figure 2 reveals that AFDC participation declines with age, which is to be expected because

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AFDC and SSI, and annual employment rates averaged 98 percent. Hence, identification of the model with extreme forms of nonparticipation in transfer programs, coupled with high participation in work, was tenuous.

children under 18 years old "age" out of the household over time and thus program eligibility declines. Another advantage of combining cohorts by age as in Figure 2 is that holding age fixed one can examine "cohort-specific" effects. For example, more recent cohorts are less likely to participate in AFDC at a given age than older cohorts, which may explain some of the time-series variation in Figure 1 via reduced entry onto the rolls (Grogger, Haider, and Klerman 2003). Figure 3 shows that SSI participation, especially for mothers with high-school or less, has a strong upward life-cycle trajectory, likely indicating that work-limiting disabilities are more common among older heads than younger ones. Unlike AFDC, at each age younger cohorts are more likely to take up SSI than older cohorts. Lastly, Figure 4 shows that single mothers' life-cycle employment rates follow an inverted U shape, as predicted by standard life-cycle models, but the more striking aspect of the figure is the strong cohort effect, i.e. that young cohorts of mothers are working at much greater rates than older cohorts. These cohort-specific differences in participation rates form the basis for identification of this model.

[Figures 2–4 here]

A. Gross Prices

The variables used in the analysis draw from the CPS, coupled with state survey and administrative data, and income tax rates from the NBER *TAXSIM* program. Variables from the CPS include annual real WWD income, $\tilde{M}_t$, which is the sum of labor-market earnings of the family head, the family-level amount of annual AFDC income, and the family-level amount of annual SSI income. The head's gross hourly wage, W_t, also comes from the CPS, defined as the ratio of annual earnings to annual hours of work (annual weeks worked times usual hours per week). For single mother families it is assumed that there is only one decision-maker present, making the head's earnings and wages the appropriate metric of labor-market effort. However, the child (children) in the family may be the recipient of AFDC or SSI income and it is not possible to separate out child-only receipt from adult receipt, forcing analysts to resort to the family-level for AFDC and SSI income. In addition, children in the family may receive labor-market income. This income is combined with other non-labor/non-AFDC/non-SSI income, including social security, private pension, SSDI, child support, alimony, rent/interest/dividends, and the dollar value of in-kind transfers such as food stamps, school lunch and breakfast, and housing assistance to form the "other" income variable, N_t. (Note that the EITC payment is included as part of the adjustment to make virtual income) In a bid to simplify estimation, the price deflator used to construct real prices and incomes in equation (7), *a(p)*, is proxied by the Consumer Price Index with 2001 base year.[17]

I link several state-level variables to the CPS data using unique state identifiers for each family in the CPS. Based on the literature review in Section II the model should control for general changes in the macroeconomy as well as changes in welfare policy. To this end I obtain data from the U.S. Bureau of Labor Statistics on state unemployment rates and data from the U.S. Department of Health and Human Services to construct an indicator variable that equals 1 as of the date when a state implemented either a pre-welfare reform waiver or their state TANF plan.[18] Both variables vary across states and over time, variation which is needed to identify state-specific economic and policy effects from aggregate macro effects. In addition, because the maximum AFDC and SSI benefit guarantees, G_c and G_d, found in equation (4) are set at the state level I obtain data from selected issues of the Committee on Ways and Means *Green Book* on the

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[17] In the consumption literature this price index is sometimes proxied with the so-called Stone price index, which is a weighted sum of the prices, and in other cases the parameters of *a(p)* are estimated through an iterative-moment procedure. Given the focus in this paper is on income shares, not goods consumption, deflating by the CPI is not likely to impart much bias.

[18] Unemployment rates are obtained from the URL: http://www.bls.gov/lau/home.htm; and data on welfare policies from the URL: http://www.aspe.hhs.gov/hsp/Waiver-Policies99/policy_CEA.htm.

maximum monthly AFDC benefit for a two-, three, and four-person family, and the SSI benefit for an individual living independently. The AFDC benefit for a four-person family is used to proxy the gross price of welfare for families with four or more persons. The SSI benefit is provided as either an individual benefit or a couple benefit, and for each group it varies whether or not the person or couple lives independently (i.e. not in care). In light of the fact that my sample is drawn from the non-institutionalized population, and focus is on single parent families, I use the independent individual-level SSI benefit as the gross price of disability.

[Figures 5–7 here]

Figures 5–7 depict the type of gross price variation needed to help identify relative price effects on work, welfare, and disability. In Figure 5 I plot the time series of average cross-state real weekly wages, real AFDC maximum benefit guarantees (for three-person families), and real SSI maximum benefit guarantees. Weekly wages are used in Figure 5 so the scale is comparable to AFDC and SSI benefits. As SSI benefits are indexed to inflation, average SSI benefits are constant over the two decade period in Figure 5. Likewise, average real weekly wages are relatively flat in the 1980s, though there is a sharp increase beginning in the mid 1990s, reflecting the rising reward to work for single mothers. However, AFDC is not indexed and because states kept nominal benefits fixed for much of the period, inflation has eroded the real return to welfare participation. Indeed, even in the mid 1980s both SSI and employment were becoming more attractive on average relative to welfare, and by the mid 1990s there was a strong gross price incentive to substitute away from AFDC and toward SSI and work.

As described in Section IV, time series variation is not sufficient to permit identification of price effects in the model in equations (5) and (6). Figures 6 and 7 reveal that there is ample cross-section variation as well as time variation. Figure 6 presents life-cycle real hourly wages by education group, akin to Figures 2–4. It is clear that life-cycle wages follow the usual hump shape, but it is also clear that at any given age more recent cohorts have realized higher wages compared to older cohorts. In Figure 7 I present the cross-state standard deviation in the AFDC and SSI maximum guarantees for each year (i.e. the "between-group" variation). While it is not surprising that cross-state variation is higher with AFDC than SSI because only half the states supplement the federal SSI benefit for individuals living independently, whereas the AFDC benefit is strictly set at the state level, there is still considerable variation in gross SSI benefits across states to be optimistic that identification will be achieved.

B. Net Prices

The tax function in equation (3) and the attendant net prices in equation (4) are very complicated nonlinear functions of labor income, nonlabor income, and assorted deductions and exemptions. Modeling all the various kinks, corners, and holes across the budget frontier over twenty-three years is impractical. Instead, I construct effective marginal tax rates for use in constructing net prices by combining data from three sources. First, I construct estimates of direct income tax rates across the federal, state, payroll, and EITC tax schedules from 1979 to 2001 for each of the 80,450 female heads using the NBER *TAXSIM* program. Specifically, the *TAXSIM* module calls for basic information on labor income, nonlabor income, 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.[19] 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

[19] 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.

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 as part of the system, and not simply assumed, I only assess the employee share.

Along with the direct tax rates on wages I construct implicit marginal tax rates for the AFDC and SSI 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). To estimate effective guarantees and rates these authors use quality control data by state from the AFDC program to run (truncated) regressions of the following form:

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

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, and $K3_t$ is the number of children greater than two. Estimates of effective guarantees (i.e. benefits for those with no additional income) 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 rate on labor income and nonlabor income are $\hat{\tau}_t^{c,1}$ and $\hat{\tau}_t^{c,2}$. I obtained AFDC quality control data from the Urban Institute (http://afdc.urban.org/) over the period 1983–1997 to run similar regressions. Because McKinnish et al. (1999) report little difference between the statutory maximum AFDC benefit and the effective benefit, a result that I verify here, I use the statutory benefit guarantee but the estimated effective tax rates from equation (13) in construction of the net AFDC price as defined in equation (4).[20]

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 marginal rates, $\hat{\tau}_t^{d,1}$ and $\hat{\tau}_t^{d,2}$, 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.[21] Hence, I use the estimated effective 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.[22]

[Tables 2 and 3 here]

I conclude the data section with a brief examination of summary statistics in Tables 2 and 3. In Table 2 we see that for female-headed families there are sharp distinctions across education

[20] Data from the AFDC quality control before 1983 are limited. Fraker et al (1985) present results on effective tax rates for the 1979–1982 period, and I use those estimates in my analysis. In cases where rates are missing due to insufficient sample size in the AFDC-QC data I use the average rate in the surrounding years to impute the missing value. The U.S. Department of Health and Human Services has not made QC data on the TANF program publicly available after 1997. Hence I make a simplifying assumption and assume that the effective rate is constant in each year after 1997. I address this assumption in sensitivity analyses later in the paper.

[21] 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.

[22] In results not tabulated I constructed the net SSI price using statutory rates and deductions. There was no change in the qualitative results reported below, and little change in the quantitative values.

groups with respect to participation in AFDC, SSI, and employment. Among female heads with less than high school the income shares of AFDC and work are nearly identical, 49 and 45 percent respectively, with the remaining 6 percent going to SSI. However, as education increases, reliance on wage income relative to welfare or disability income grows considerably. This is made clear toward the bottom of Table 2 where I report the fraction of non-participation and the fraction reporting dependence on a single income source. With the possible exception of the SSI program, these average fractions suggest that the two-limit Tobit rather than the single-limit Tobit model is justified. While average gross AFDC and SSI maximum benefits do vary somewhat across education groups, variation across education levels in average gross wages, average marginal tax rates, average WWD income, and average other income sources is pronounced.

Table 3 examines the distribution of marginal tax rates and net prices in more detail during the peaks of the last three business cycles. At the 25th percentile the federal marginal tax rate has become considerably more negative over the past two decades, reflecting the subsidy offered by the EITC program; however, federal marginal tax rates have actually risen at the median and 75th percentiles even in light of the major tax cuts of 1981, 1986, and 2001. Estimated state marginal tax rates are zero at the 25th and 50th percentiles, but have increased from 3 percent in 1979 to 4.4 percent in 1999. On the contrary the payroll tax rate affects the first three quartiles the same and the burden has risen considerably over the last decades. Summing up across the latter three tax rates shows that the cumulative marginal tax rate for a mother at the 25th percentile has fallen from –0.039 to –0.263, but the cumulative rate for the mother at the 75th percentile has risen 30 percent from 0.331 to 0.431. A simple 'difference-in-difference' calculation suggests that the inter-quartile range (i.e. the difference between the 75th

and 25th percentiles) in direct marginal tax rates rose 32 percentage points between 1979 and 2001. These trends reflect changes both in tax policy (higher subsidies for the poor) as well as in the higher incomes of single mothers in the top end of the income distribution that placed them in relatively higher marginal tax brackets.

The next four panels in Table 3 reveal several patterns about effective tax rates on earnings and nonlabor income in the AFDC and SSI programs. First, the effective rates are considerably lower than the statutory rates of 100 percent in the case of AFDC and 50 percent/100 percent in the case of SSI. Second, the rates assessed on earnings and nonlabor income diverge, as found in Fraker et al. (1985) and McKinnish et al. (1999). Lastly, in the case of AFDC there is a secular decline in the effective rates assessed on both earned and unearned income. This is consistent with the goal of "making work pay" that was a prominent part of the welfare waivers and TANF program in the 1990s. As a consequence, while the sum of federal, state, payroll, AFDC, and SSI tax rates took a sizable bite out of the gross wage rate as seen by the net wages in 1979 and 1989, just when gross wages took off in the 1990s, cumulative tax rates (direct and implicit) fell, making the net reward to work significantly more attractive. Importantly, the secular decline in gross AFDC prices outweighed the concomitant decline in effective tax rates on AFDC so that the net price of AFDC fell relative to the net price of SSI.

VI. Results

In this section I present results from estimating the two-limit Tobit instrumental variables income share models in equation (11). In addition to prices and income and the attendant first-stage residuals to account for non-random selection into WWD income and possible endogeneity of net prices and virtual other income, each specification controls for basic demographics such as the race of the family head and the number of children under age 18 present, for state unemployment rates and indicators for implementation of state-specific welfare reforms, and for date-of-birth by education cohort fixed effects as well as fixed time effects.[23] Because there might be a residual source of latent heterogeneity over and above the birth-year by education cohort effects at the state level that could confound the effects of welfare and disability prices on the WWD income shares, I present a parallel set of estimates that include state fixed effects.

In Table 4 I record the results from the instrumental variables two-limit Tobit model for female-headed families. The results in the first column indicate that the share of WWD income going to AFDC is increasing in the generosity of the AFDC maximum benefit guarantee, in the number of children, and in the state unemployment rate. The latter implies that welfare utilization is countercyclical, which is consistent with the aggregate AFDC caseload literature (Ziliak et al. 2000), while the positive signs on the welfare benefit and on number of children align with priors based on demand theory in the case of the former and in the latter case with ample evidence that poverty and welfare reliance is increasing in family size. There is strong evidence in the first column of Table 4 that higher wages, SSI benefit generosity, WWD income, and virtual other income are associated with lower shares of welfare income. This implies that work and SSI are substitutes for welfare. The first-stage residuals indicate that non-random selection is present, i.e. the WWD income residual is statistically significant, and that it is necessary to instrument each of the net price and other income variables.

[Table 4 here]

The results for the SSI share in column (2) largely parallel those in the AFDC share equation in terms of qualitative signs; namely the SSI share is increasing in its own price and in the number of children, but decreasing in the prices of AFDC and work. That SSI shares

[23] The number of parameters in the first-stage regressions is unwieldy and are not presented for brevity. They are available from the author upon request. The exclusion restrictions are jointly different from zero (p-value < 0.00) in each of the first-stage regressions.

increase with the number of children is broadly consistent with the model of Kubik (1999) in that as the family size grows there is a strong incentive to apply for SSI benefits for one or more children given the higher marginal benefits. There are some differences in the SSI model compared to the AFDC model. First, the SSI share is statistically independent of both WWD income and other income, rather than declining as in the AFDC share model. Second, there is no evidence of non-random selection into WWD income. Third, SSI shares are statistically independent of welfare waivers, whereas the AFDC share is lower after welfare reform.

In the third column the earnings share is strongly positively related to the net wage rate, indicative of an upward-sloping uncompensated labor supply schedule for women, and significantly negatively related to the prices of welfare and disability. The earnings share is increasing in both income terms, and while the positive sign on the virtual other income term implies that leisure is inferior, this is not an uncommon finding in either the male or female labor supply literature (Pencavel 1986; Mroz 1987). The results in column (3) also suggest that the earnings share moves procyclically with the state business cycle, is higher for white single mothers than for non-white mothers, and is positively affected by welfare reform. The latter could arise from both "carrot" and "stick"—carrots that made work with welfare more attractive such as higher earnings disregards, and sticks that made welfare less attractive than work because of new rules time limiting welfare.

In columns (4)-(6) of Table 4 I record the estimates of the same unrestricted share equations but with the addition of state fixed effects. The parameter estimates are remarkably robust with the inclusion of the 50 state dummy variables, suggesting that the identification scheme is not spuriously linked to state fixed heterogeneity. There are only a couple of differences worth note with the inclusion of state fixed effects. One is that the SSI share is no longer responsive to the state unemployment rate, and the earnings share is less responsive to the state economy. In addition, with state fixed effects the negative influence of welfare waivers on the AFDC share is eliminated, and the positive influence on earnings shares is muted, suggesting that the waivers largely reflected state-specific time-invariant welfare policy differences.

The cross-price effects in each equation indicate the each share is a substitute for the other income sources. I test whether or not these effects are symmetric with the chi-square test of symmetry from the minimum distance estimator in equation (12), and record the values at the bottom of Table 4. The estimated test statistic values of 186 for columns (1)-(3) and 217 for columns (4)-(6), each with three degrees of freedom, soundly reject the null hypothesis that the cross-price effects are symmetric.

A. Elasticities at the Extensive and Intensive Margins

The coefficients in Table 4 provide information on the qualitative relationships between the income shares and explanatory variables, but do not offer much guidance on economic magnitudes of the relationships. The reason for this is because unlike a true censoring application the estimated coefficients from the (two-limit) Tobit model with corner solutions do not carry much meaning (Wooldridge 2002); that is, to examine economic magnitudes with corner solution applications we need to examine the response at both the extensive (participation and dependence) and the intensive (unconditional mean) margins.

The unconditional mean for any given share equation in the two-limit Tobit model is (Maddala 1983):

$$E(s_i) = \Phi_{1i}L_{1i} + \Psi' R_i(\Phi_{2i} - \Phi_{1i}) + \sigma(\phi_{1i} - \phi_{2i}) + (1 - \Phi_{2i})L_{2i}, \tag{14}$$

where L_{1i} and L_{2i} are the lower (0) and upper (1) limits of the share, Ψ is the full vector of unknown parameters from equation (11), R is the full vector of regressors from equation (11),

$\Phi_{1i} = \Phi\left(\frac{L_{1i} - \Psi' R_i}{\sigma}\right), \Phi_{2i} = \Phi\left(\frac{L_{2i} - \Psi' R_i}{\sigma}\right)$ are the cumulative normal distributions at the lower and upper limits, σ is the standard deviation, and $\phi_{1i} = \phi\left(\frac{L_{1i} - \Psi' R_i}{\sigma}\right), \phi_{2i} = \phi\left(\frac{L_{2i} - \Psi' R_i}{\sigma}\right)$ are the normal density functions at the lower and upper limits. For a change in any continuous variable R_j the change in the unconditional mean of the income share is

$$\frac{\partial E(s_i)}{\partial R_j} = \Psi_j(\Phi_{2i} - \Phi_{1i}). \quad (15)$$

Point elasticities are calculated by multiplying both sides of equation (15) by the ratio of $\frac{R_j}{E[s_i]}$.

Noting that the probability of *ever* being on welfare (or on SSI or working), i.e. the participation margin, is $1-\Phi_{1i}$, the effect of a change in any continuous variable on the decision to participate is $\frac{\partial(1-\Phi_{1i})}{\partial R_j} = \frac{\Psi_j}{\sigma}\phi_{1i}$. Likewise, the probability of dependence on welfare (or SSI or work) is $1-\Phi_{2i}$ such that the marginal effect of a continuous variable on dependence is $\frac{\partial(1-\Phi_{2i})}{\partial R_j} = \frac{\Psi_j}{\sigma}\phi_{2i}$. Elasticities are straightforward to calculate by multiplying the partial effect by the ratio of the regressor to one minus the cdf. As discussed in Wooldridge (2002) consistent estimates of the average partial effect (elasticity) in the context of a Tobit model with endogenous regressors can be found by computing the means of the nonlinear functions, rather than evaluating the function at mean values of variables. This is the approach followed here, and after some tedious calculations standard errors are computed using the so-called delta method.

[Table 5 here]

Table 5 contains the average own and cross-price elasticities of demand for wage, welfare, and disability income at the extensive (ever participate and dependence) and intensive margins (unconditional mean). I present estimates both for the base case without state fixed effects and for the case with state effects, but focus discussion on the state-effects models. First with respect to the AFDC share equation, the own price elasticities of demand for AFDC income are a sizable 0.63, 0.71, and 1.05 at the participation, unconditional mean, and dependence margins. That is, a 10 percent increase in the net AFDC price raises the likelihood of ever participating by 6.3 percent, raises the share of AFDC by 7.1 percent, and raises the likelihood of dependence by 10.5 percent. The cross price elasticities of the AFDC share with respect to the net price of SSI at the three margins are –0.74, –0.84, and –1.23, and with respect to the net wage are –1.0, –1.1, and –1.7. These large responses suggest that the "pull" out of welfare and into SSI or work is quite strong. Indeed, between 1979 and 1999 the income share of AFDC fell nearly two-thirds on average, and average real after-tax hourly wages rose by just over one-third, indicating that net wage gains among single mothers, all else equal, can account for just over one-half of the average decline in AFDC income shares over the past two decades (based on the unconditional mean elasticity of –1.1).

The estimates in Table 5 also reveal that the SSI share is quite responsive to its own price, as well as to the net AFDC price and the net wage. In particular there is a large participation response into and out of SSI when AFDC benefits change. For example, the estimated SSI participation elasticity with respect to AFDC of about –0.6 suggests that the 50 percent decline between 1979 and 1999 in the average net AFDC benefit would lead to a 30 percent increase in ever participating in SSI. Given that SSI participation rose about 70 percent between 1979 and 1999 for single-mother families, all else equal, the relative price variation can account for upwards of 40 percent of that growth.

Interestingly, the elasticities in Table 5 indicate that net price changes in either AFDC or SSI have a comparatively dampened impact on earnings—a 10 percent increase in AFDC or SSI benefits lowers the earnings share by about 1.5 percent. However, earnings shares of single mothers are quite responsive to their own wage possibilities, with the participation elasticity being about 0.3, the mean elasticity about 0.4, and the dependence elasticity about 0.8[24] All else equal, with the mean share elasticity of 0.4, the mean increase in the net wage of one-third can account for upwards of one-half of the 27 percent increase in the earnings share between 1979 and 1999.

B. Morishima Elasticities of Substitution

In addition to own- and cross-price elasticities the parameter estimates in Table 4 can be used to construct elasticities of substitution, which indicate the ease of substitution between the income shares as well as changes in relative income shares when relative prices change. The usual metric for this purpose is the so-called Allen partial elasticity of substitution. However, Blackorby and Russell (1989) demonstrate that the Allen elasticity contains no new information over the cross-price elasticities when there are more than two goods in the system. Instead, they propose a new measure called the Morishima elasticity of substitution (in honor of Morishima, who independently derived a similar measure but was never translated from the original Japanese). The *MES* between any two goods *i* and *j* is

(16) $$MES_{ij} = \eta_{ji}^{H} - \eta_{ii}^{H} ,$$

[24] Kimmel and Kniesner (1998) find similar sized or larger elasticities of female labor supply using data from the Survey of Income Programs and Participation. They did not consider welfare programs in their analysis.

where $\eta_{ji}^{H}, \eta_{ii}^{H}$ are the cross and own compensated (Hicksian) elasticities of demand. Blackorby and Russell (1989) discuss at length how and why the *MES* is inherently asymmetric across price changes. In the context of the income share model estimated in Table 4 we expect $MES < 0$ because we find that the income sources are substitutes, $\eta_{ji}^{H} < 0$, and that shares are increasing in their own price, $\eta_{ii}^{H} > 0$.

[Table 6 here]

In Table 6 I record the estimated Morishima elasticities of substitution at the mean values of the elasticities. To read the table, note, for example, that the second row containing the SSI benefit reveals the elasticity of substitution between AFDC and SSI, and earnings and SSI, respectively. The ease of substitution increases as the elasticity increases in absolute value. From Table 6 it appears that there is relative ease in substituting into and out of all forms of income. The relative ease of substitution into and out of SSI is consistent with the sizable elasticities reported in Table 5 and indicates that there may be less difficulties in moving across programs than prior beliefs might suggest.[25]

C. Sensitivity Analyses

Before proceeding with policy simulations and welfare analysis I examine the sensitivity of the results to several model assumptions. For convenience I report the implications of the assumptions in terms of the extensive and intensive margin elastiticites. The first test addresses two issues simultaneously—whether the 1996 welfare reform is the driving force for the substitution patterns identified, and the potential bias of assuming constant effective AFDC tax

[25] I am not aware of any previous estimates on the elasticity of substitution across work, welfare, and disability. As discussed below I re-estimated the models with the gross prices in place of the net prices. In this case it was less easy to substitute into and out of SSI, which aligns with priors because of the disability determination process. The use of net prices of SSI here, which, to my knowledge, is the first such application, suggests that it is no more difficult to substitute income from SSI than other programs. More research on this issue is needed.

rates after 1997 due to the lack of quality control data. The large swings in the time series of AFDC and work depicted in Figure 1 began in the mid 1990s just as federal welfare legislation was taking shape. Hence, it is plausible that the economic magnitudes of the elasticities reported in Table 5 are driven by the welfare-reform data. In Table 7 I report the attendant elasticities evaluated at the means based on parameter estimates from equation (11), but with a restricted sample period of 1979 to 1996. Comparing columns (1)–(3) in Table 7 to columns (4)–(6) of Table 5 shows that the elasticity estimates are little changed with the restricted sample period. Indeed the SSI share elasticities are larger in absolute value in Table 7 than in Table 5, possibly due to new restrictions placed on eligibility for child SSI benefits after 1996. That the elasticities are robust overall to the shorter time series coincides with evidence presented earlier that the relative returns to SSI and work began to increase as early as the mid 1980s as inflation eroded the real value of AFDC benefits.

[Table 7 here]

The model in equation (11) is based on the assumption that selection occurs via the *combined* sum of wage, welfare, and disability income ($\tilde{M}_t$) and that the first-stage Tobit for WWD income adequately controls for selection. Hence, least-squares predictors for net wages and benefits and virtual income are valid methods of controlling for their endogeneity in estimation. I test this assumption by estimating first-stage Tobit models of equation (10) for all income and price terms, and then including Tobit residuals in the second-stage two-limit Tobit model of equation (11). I record the results of this test in columns (4)–(6) of Table 7. There are no qualitative changes in the estimated elasticities under the first-stage Tobit assumption; however, the absolute values of the elasticites exceed the base-case estimates in Table 5 in most cases, and indeed, in some cases seem implausibly large, notably the elasticities of AFDC and

SSI with respect to the net wage. These results do not cast doubt on the base case reported in Table 5, and one might interpret those estimates as conservative.

As a final check I examine the importance of controlling for direct and implicit taxation by setting the marginal tax rates equal to zero in equation (4) and instead use real gross wages and benefits, as well as other income without the lump-sum virtual-income transfer. I still account for possible non-random selection in WWD income, i.e. $\tilde{M}_t > 0$, by estimating the first stage Tobit model in equation (10) for $\tilde{M}_t$ and including the fitted residual as an additional regressor. I addition I allow for the possibility that the gross hourly wage and "other" nonlabor income (N_t) are endogenous by including fitted residuals from first-stage least-squares predictions of wages and other income based on the specification in equation (10). However, AFDC and SSI prices are treated as exogenous, and are allowed to be non-zero for all mothers and not just actual AFDC and SSI recipients. While this exercise is "fictional" in the sense that taxes are not zero, it is not without policy interest because the gross AFDC and SSI prices reflect the *potential* payoff from participation in each program in the absence of income from other sources.

I record the results of using gross prices in panel B of Table 7. While many of the results are robust to using the simpler gross prices rather than net prices, there are two important differences, both related to the SSI program. First, under the gross price assumption I find that the SSI share is declining in the SSI gross price, which is contrary to demand theory, though the unconditional mean elasticity is not statistically significant. Second, the results in column (3) of panel B indicate that SSI and work are complements and not substitutes. This is theoretically possible, but in light of the strong results in Table 5 that indicate the earnings share is declining in the net SSI price, the gross-price model in Table 7 is likely to be misspecified.

D. Policy Simulations and Welfare Analysis

A key feature of deriving the system of equations from an indirect preference function is that the estimated parameters can be used in counterfactual policy experiments to determine possible welfare losses or gains from alternative policy prescriptions. In this section I use the estimated parameters reported in Table 4 to simulate how the expected shares of AFDC, SSI, and earnings (based on the unconditional mean formula in equation (14)) respond to changes in relative prices. In addition I use those same parameters to simulate out the fraction of families that have welfare improvements after the various policy reforms. For the latter, I construct the baseline indirect utility function in equations (5) and (6), denoted as $\hat{V}_0$. The attendant baseline cost function is

(17) $$\hat{C}_0 \equiv C(\hat{V}_0, \hat{p}_0) = \hat{V}_0 b(\hat{p}_0) - \ln a(\hat{p}_0),$$

where $\ln a(\hat{p}_0), b(\hat{p}_0) \equiv \exp(\ln(b(\hat{p}))$ are the fitted price indices from estimation. In conducting welfare changes after policy reforms to prices I hold well being constant at the initial level and examine changes in the "cost" of reaching the reference utility level by altering the price, i.e. $\Delta\hat{C} = C(\hat{V}_0, \hat{p}_1) - C(\hat{V}_0, \hat{p}_0)$ for a change in prices from p_0 to p_1 (King 1983). Beneficial reforms raise welfare by lowering the cost of living; that is, $\Delta\hat{C} < 0$.

It is important to note that because the price index $b(\hat{p})$ is equal to zero if any one of the three net prices is equal to zero, the indirect utility function in equation (5) is undefined in those situations, which is the case for most families in the sample. Instead, I replace the actual net prices with their predicted values from the first-stage prediction equations (10). That is, for each family I assign the net price that they would receive *in expectation* if they were to actually participate. Then for each policy reform I consider I first estimate the least-squares prediction equations (10) using the new price variable as the dependent variable on those families with positive net prices and then use the fitted values as proxies as if they did participate in each of the programs and the labor force. These predictions are also used construct the post-reform expected shares using the formulas in equation (14).

I consider five separate price reforms, three to the AFDC program and two to the wage structure. In the first reform to AFDC I fix the prices at their 1979 real levels. This is intended to simulate what would have happened to the shares of AFDC, SSI, and earnings had the AFDC benefit been indexed to inflation and kept constant in real terms over the past two decades. For the next reform I assume that each state only offers a single benefit regardless of family size, in this case the benefit for a family with one adult and two dependent children. This exercise is akin to imposing a "family cap," which is a policy adopted in about half the states after the 1996 welfare reform whereby the benefit is fixed at the previous level after a new child enters the family unit. In the third reform to AFDC I assume that the gross benefit varies across family size but that the benefit is uniform across all states and held constant in real terms, which is similar to the current rules governing the Food Stamp Program. To implement this reform I set the family-size specific benefit equal to the median state benefit in 1979. For the first reform to wages I assume that the wage structure is fixed at its level in 1979, prior to the two-decade climb in wage inequality and also the productivity induced wage growth of the late 1990s. To implement this reform I estimate net wages using the sample of mothers in 1979, and then use the coefficients to predict wages for each ensuing person year. Finally, I turn to a long-standing exercise in the tax literature of simulating how behavior changes in response to the elimination of direct taxation. In this case, I assume that implicit taxation via the AFDC and SSI systems still exists, but federal, state, and payroll taxes are eliminated, including the EITC.

[Table 8 here]

In Table 8 I record the results of the five simulations. For each reform I report the percentage changes in the AFDC, SSI, and earnings shares, each relative to the predicted baseline, as well as the percentage of families that experience welfare gains after the reform. I record the results at the 25th, 50th, and 75th percentiles for each peak year of the past three business cycles. Fixing the AFDC benefit at its 1979 level has little effect on behavior in the baseline year of 1979, as expected, but there are very large responses in both 1989 and 1999. Specifically, because inflation substantially eroded the real value of AFDC during the 1980s and 1990s, fixing the gross benefit at its 1979 level suggests more than a doubling of the AFDC share at the median by 1999. However, the higher relative price of nonparticipation in AFDC results in sizable predicted declines in both SSI and earnings such that by 1999 there are no families better off in expectation under this reform.[26] This result highlights the importance of wage growth to single mothers well being in the late 1990s.

In the next panel of Table 8 we see that imposing a family cap raises the AFDC share by about 8–15 percent at the median because families who previously received a lower two-person benefit now qualify for the higher three-person benefit. However, because the SSI and earnings shares fall by only 7 and 2 percent at the median, respectively, well being improves for about 24 percent of families in each year. The third panel shows what happens to simulated shares and well being if the AFDC program had instead offered an inflation-adjusted uniform benefit across states. In the baseline year the AFDC, SSI, and earnings shares are little changed at the median, but about 50 percent of families have higher welfare. The reason for this is in part an artifact of setting the benefit at the median state in 1979, which means higher AFDC benefits for those with

[26] Clearly actual AFDC families with no other income source are better off under this reform because the higher benefit places them on a higher indifference curve (see Moffitt 2003 for a graphical exposition of similar reforms). What the simulation shows is the opportunity cost of welfare use compared to taking up SSI or work.

actual prices less than the median, but lower benefits for those above the median and thus higher SSI and earnings shares. Two decades later, however, the simulated effects of the uniform benefit are much like the previous reform where benefits were fixed at the 1979 levels. That is, predicted shares of AFDC are more than double the actual predicted baseline level, while predicted shares of SSI are 35 percent lower and shares of earnings are 12 percent lower. As a consequence there are no winners from this reform in expectation given the wage and SSI benefit structures in 1999.

The last two panels in Table 8 contain the reforms to the wage structure. In the first case of imposing the wage structure from 1979 onto the rest of the sample years we see that in 1989 at the median the predicted shares of AFDC and SSI each rise about 10 percent, and earnings shares fall about 3 percent. On average about 48 percent of the single mother families in 1989 would have benefited from this reform. The reason for this is that the lower predicted wages increased the reward to participation in both AFDC and SSI, which benefited about half the families. By 1999, the median predicted share of AFDC is about 40 percent higher and the share of SSI is just under 30 percent higher, while the earnings share is 7 percent lower. However, even though two of the three income shares are higher, only about one-fourth of single mothers in 1999 would have been better off under the 1979 wage structure both because actual real wages were much higher in 1999 than in 1979 and because of the higher weight given to earnings in the utility function. Finally, removal of federal, state, and payroll taxation results in welfare improvements for 85 to 90 percent of single mothers across the business cycle peaks. Interestingly, the simulated earnings response in 1999 is much lower than the distribution of responses in 1979. This reflects the large expansions in both the standard deduction and the EITC during the 1980s and 1990s, which substantially lowered effective tax burdens on single mothers by 1999 such that the positive earnings response of removal of state and payroll taxes is offset by the negative earnings response of removal of the EITC subsidy in this reform.

VII. Conclusion

I examined the role that changes in relative prices across work, welfare, and disability played in explaining the epochal economic developments among single female-headed families over the past two decades. I modeled labor supply and transfer-program participation decisions in the context of an Almost Ideal Demand System that admits corner solutions, nonseparability of preferences over income sources, endogenous wages and incomes, and latent heterogeneity across birth-cohort and education levels and across U.S. states. Using the Current Population Survey I constructed date of birth-by-education cohorts for single female-headed families spanning the calendar years 1979 to 2001, and matched individual and family-level data in the CPS with family-specific direct income tax rates from the NBER *TAXSIM* program as well as state-specific and time-varying benefit levels and effective tax rates in the Aid to Families with Dependent Children program and the Supplemental Security Income program.

I found strong evidence of sizable own and cross-programmatic substitution effects in income shares. Among single female heads of families the elasticity of ever participating in AFDC with respect to the after-tax AFDC benefit is +0.6, it is –0.7 with respect to the after-tax SSI benefit, and –1.0 with respect to the after-tax real wage, and the corresponding intensive margin elasticities at the means were +0.7, –0.8, and –1.1, respectively. These elasticities provide insight into the role of relative prices in accounting for changes in work, welfare, and disability. For example, between 1979 and 1999 the increase in the generosity of SSI relative to AFDC accounts for about 40 percent of the average growth in SSI, while the increase in real wages accounts for about one-half of the average decline in AFDC shares over the past two decades.

The estimated elasticities of substitution provided corroborative evidence that families not only substituted across income sources, but that they did so with some ease.

I conducted a number of counterfactual policy experiments on the AFDC program such as indexing the AFDC benefit at its real 1979 level and introducing a uniform inflation-adjusted federal AFDC benefit much like the current Food Stamp Program. Each of these reforms predicted a sizable increase in the share of income accruing to AFDC. However, the higher relative price of nonparticipation in AFDC resulted in sizable predicted declines in both SSI and earnings such that by 1999 there are no families better off in expectation under these reforms. These simulations highlight the importance of before- and after-tax wage growth to well being of single mothers in the late 1990s. Collectively the estimates presented here imply that relative price changes across work, welfare, and disability over the past two decades lead to a substantial “pull” out of cash welfare and into expanded reliance on employment and disability as a means of financial support.

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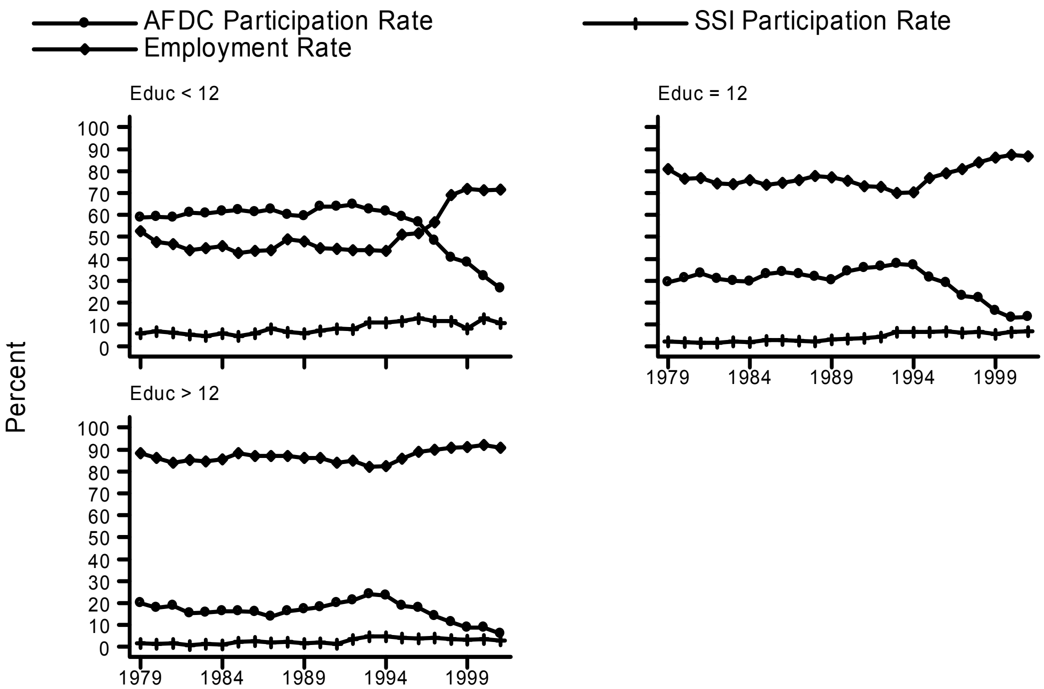

Figure 1: AFDC, SSI, & Work Participation by Education, 1979-2001

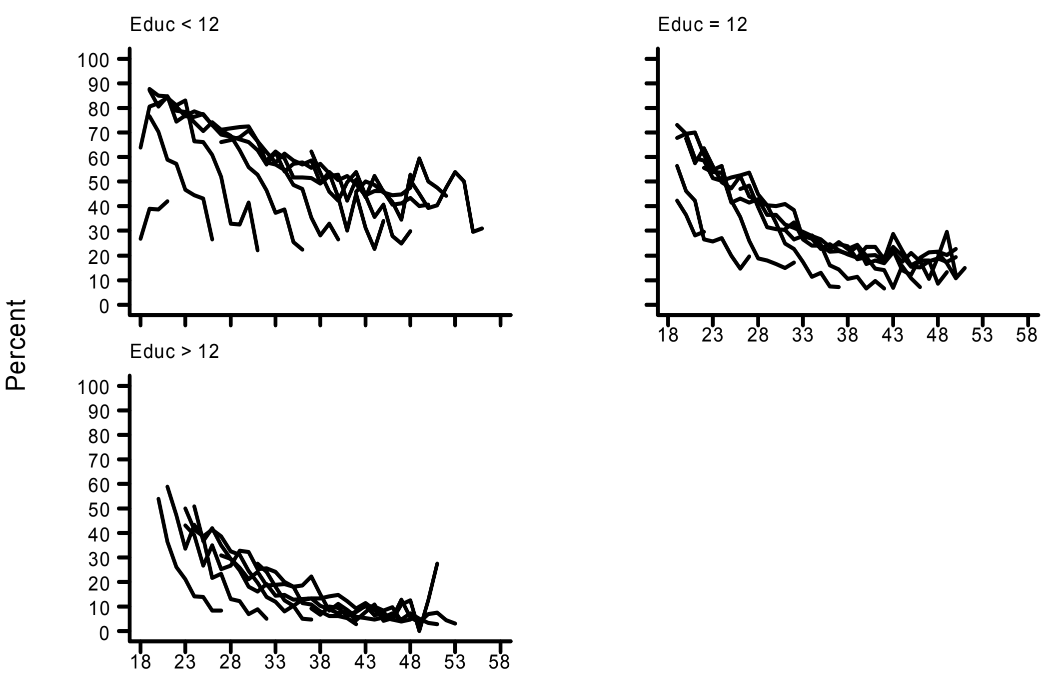

Figure 2: Life-Cycle AFDC Participation by Education

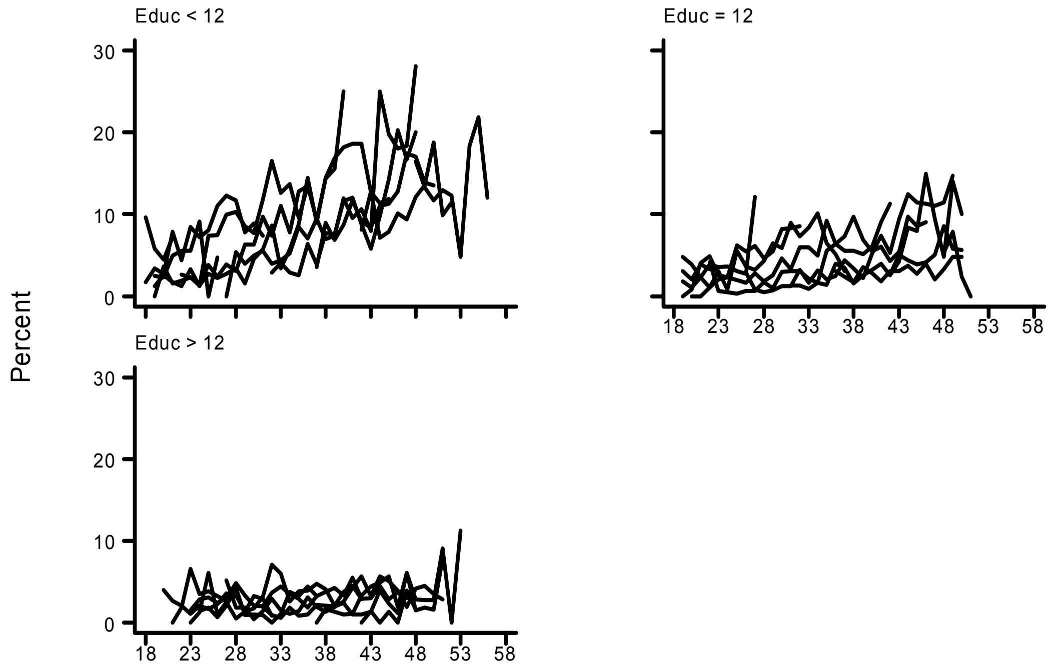

Figure 3: Life-Cycle SSI Participation by Education

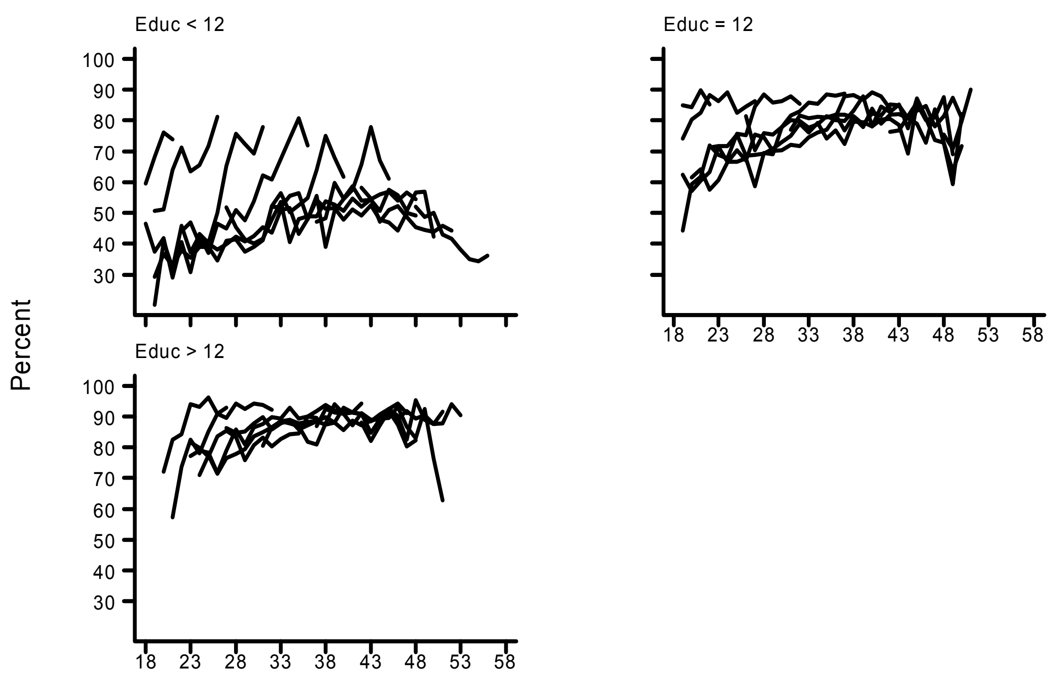

Figure 4: Life-Cycle Employment Rate by Education

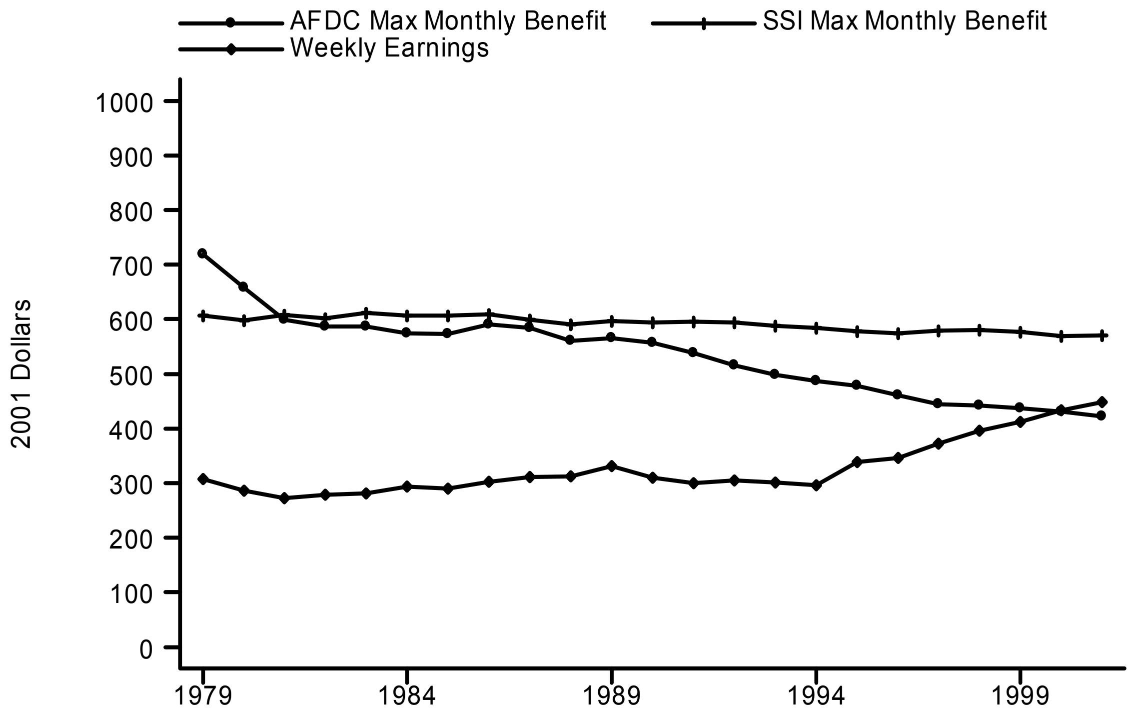

Figure 5: Real Average State Benefits and Earnings, 1979-2001

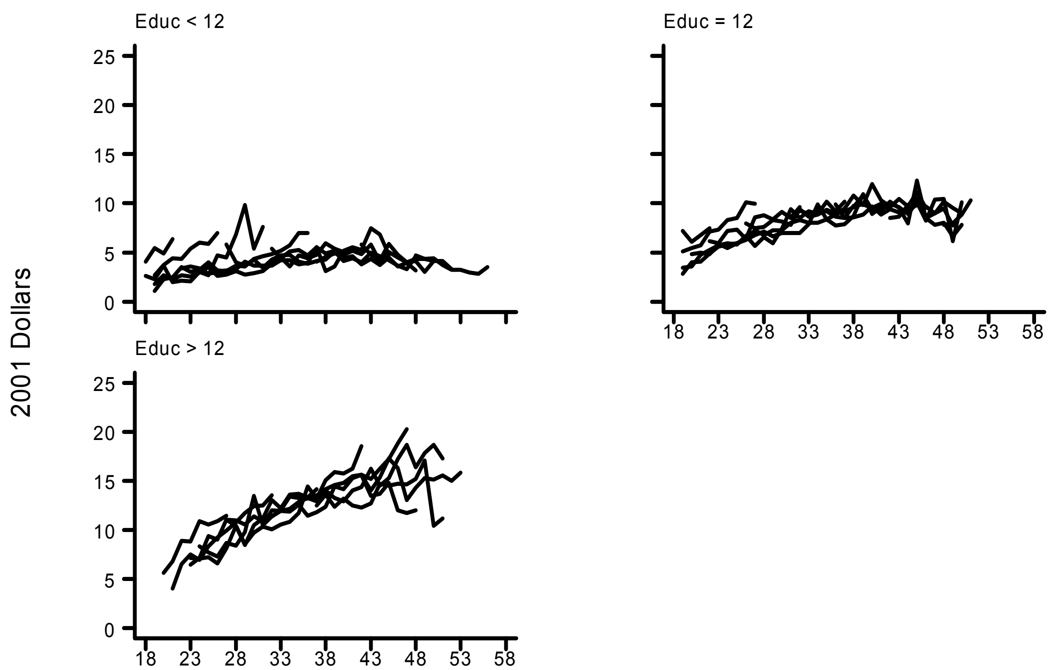

Figure 6: Life-Cycle Real Wages by Education

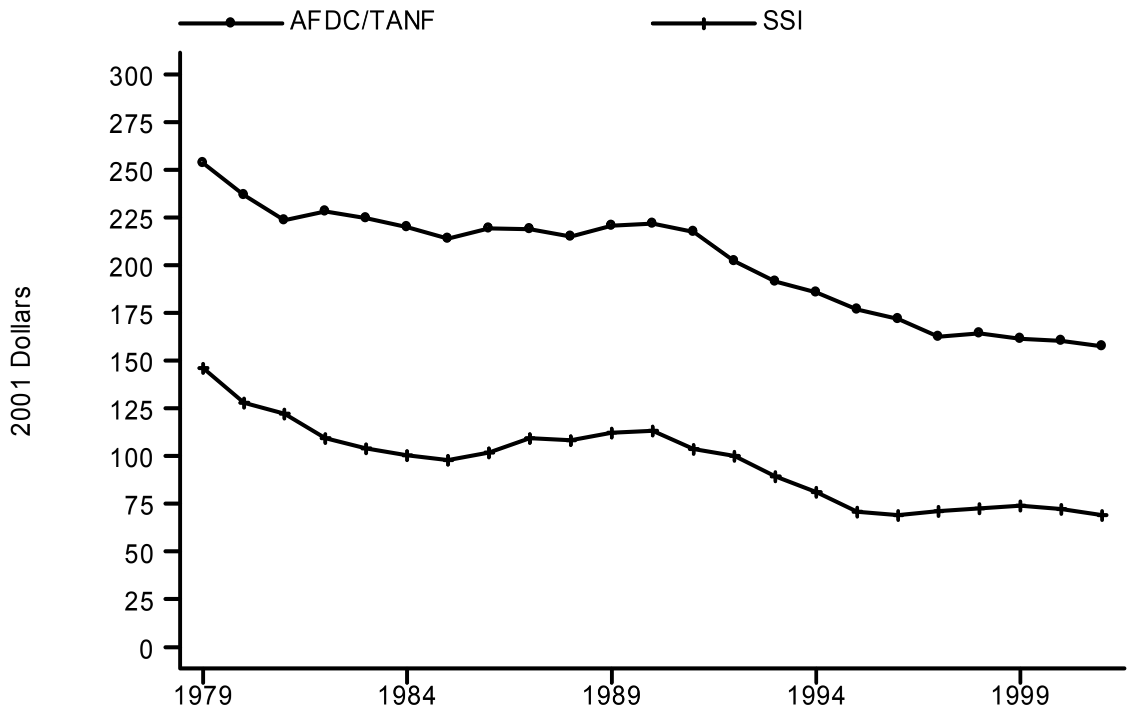

Figure 7: Cross-State Standard Deviation of AFDC/TANF and SSI

Table 1: Number of Observations by Year in Each 5-Year Birth Cohort from 1919–1983

Year	1979-1983	1974-1978	1969-1973	1964-1968	1959-1963	1954-1958	1949-1953	1944-1948	1939-1943	1934-1938	1929-1933	1924-1928	1919-1923
1979					104	509	765	801	669	449	304	199	48
1980					165	578	787	841	664	476	265	174	38
1981					237	620	698	794	618	353	244	112	21
1982				15	304	644	713	805	529	313	194	75	15
1983				34	375	685	725	740	525	298	137	69	11
1984				77	464	736	848	726	501	234	113	45	
1985				143	513	776	817	698	410	186	78	32	
1986				242	615	759	872	655	372	172	72	21	
1987			17	302	632	769	850	619	320	111	58	12	
1988			43	360	624	764	718	499	248	72	45	6	
1989			112	452	684	875	774	478	227	99	37		
1990			157	539	742	859	782	435	192	75	28		
1991			232	555	847	874	741	402	153	54	13		
1992		25	329	624	847	827	722	369	139	47	3		
1993		50	403	657	853	882	595	312	104	27			
1994		100	472	698	880	841	543	252	79	18			
1995		144	471	565	738	741	508	171	59	14			
1996		237	456	565	770	719	437	156	50	12			
1997	9	268	497	610	758	592	374	122	62	8			
1998	39	369	512	628	729	623	286	116	51	1			
1999	101	405	518	614	706	576	240	89	27				
2000	254	747	1000	1097	1209	988	414	139	37				
2001	372	755	1072	1163	1236	935	391	140	20				

Note: Data are from the 1980-2002 March Annual Demographic Files of the Current Population Survey. The unit of analysis is the family, and to be included in the sample the head is required to be a single woman between the ages of 18 and 60, not self-employed, not a farmer, and to have children under the age of 18 present. The total number of observations is 88,802 single female-headed families.

Table 2: Selected Weighted Summary Statistics

	Single Female-Headed Families			
	Total	Education < 12	Education = 12	Education > 12
AFDC Income Share	0.246	0.495	0.222	0.105
	(0.403)	(0.462)	(0.386)	(0.282)
SSI Income Share	0.031	0.058	0.027	0.017
	(0.149)	(0.203)	(0.140)	(0.120)
Wage Income Share	0.723	0.447	0.752	0.879
	(0.423)	(0.467)	(0.405)	(0.303)
AFDC Participation Rate	0.329	0.607	0.309	0.162
	(0.470)	(0.488)	(0.462)	(0.369)
SSI Participation Rate	0.052	0.091	0.046	0.032
	(0.222)	(0.287)	(0.209)	(0.177)
Employment Rate	0.784	0.535	0.815	0.917
	(0.412)	(0.499)	(0.388)	(0.276)
Gross 3-Person AFDC Monthly	512.727	529.579	511.534	502.633
Benefit	(216.734)	(224.415)	(216.298)	(211.167)
Gross SSI Monthly Benefit	588.850	593.476	585.255	589.837
	(95.131)	(98.278)	(93.047)	(95.167)
Gross Hourly Wage	9.317	4.406	8.626	13.454
	(10.551)	(7.802)	(9.258)	(11.876)
Income, $\tilde{M}_t$ ($1000)	18.450	10.262	16.704	26.030
	(17.543)	(8.334)	(14.256)	(21.990)
Other Income, N_t ($1000)	7.201	6.407	6.574	8.463
	(10.535)	(8.727)	(8.878)	(13.007)
Race (=1 if white)	0.630	0.578	0.623	0.674
	(0.483)	(0.494)	(0.485)	(0.469)
Number of Children < 18 years old	1.833	2.200	1.787	1.636
	(1.006)	(1.220)	(0.952)	(0.823)
Fraction No AFDC Income	0.671	0.393	0.691	0.838
	(0.470)	(0.488)	(0.462)	(0.369)
Fraction All AFDC Income	0.183	0.395	0.158	0.068
	(0.387)	(0.489)	(0.365)	(0.252)
Fraction No SSI Income	0.948	0.909	0.954	0.968
	(0.222)	(0.287)	(0.209)	(0.177)
Fraction All SSI Income	0.012	0.023	0.010	0.007
	(0.110)	(0.151)	(0.101)	(0.082)
Fraction No Wage Income	0.216	0.465	0.185	0.083
	(0.412)	(0.499)	(0.388)	(0.276)
Fraction All Wage Income	0.646	0.357	0.667	0.818
	(0.478)	(0.479)	(0.471)	(0.386)
Federal Marginal Tax Rate	3.875	–8.885	4.402	11.953
	(23.034)	(20.259)	(22.664)	(21.340)
Effective AFDC Tax on Earnings	–0.321	–0.323	–0.327	–0.314
	(0.132)	(0.132)	(0.132)	(0.133)
Effective AFDC Tax on Nonlabor	–0.245	–0.258	–0.251	–0.229
	(0.163)	(0.166)	(0.168)	(0.154)

Note: All income and price data are deflated by the CPI with 2001 base year. Real income is the sum of income from earnings, AFDC, and SSI. Observations in birth-education cohorts with fewer than 50 observations are dropped. In addition, there are 4,421 female heads who do not have income from either earnings, AFDC, or SSI. The total number of observations in estimation is 80,495. The summary statistics are weighted by the family weight provided in the CPS.

Table 3: Distribution of Marginal Tax Rates and Gross and Net Prices in Peak Business Cycle Years

	1979	1989	1999
25th Percentile Federal MTR	–0.100	–0.140	–0.340
50th Percentile Federal MTR	0.040	0.010	0.150
75th Percentile Federal MTR	0.240	0.250	0.310
25th Percentile State MTR	0.000	0.000	0.000
50th Percentile State MTR	0.000	0.000	0.000
75th Percentile State MTR	0.030	0.040	0.044
25th Percentile FICA MTR	0.061	0.075	0.077
50th Percentile FICA MTR	0.061	0.075	0.077
75th Percentile FICA MTR	0.061	0.075	0.077
25th Percentile AFDC Effective Earnings MTR	0.260	0.246	0.180
50th Percentile AFDC Effective Earnings MTR	0.300	0.406	0.278
75th Percentile AFDC Effective Earnings MTR	0.370	0.496	0.367
25th Percentile AFDC Effective Nonlabor MTR	0.227	0.115	0.101
50th Percentile AFDC Effective Nonlabor MTR	0.368	0.184	0.143
75th Percentile AFDC Effective Nonlabor MTR	0.546	0.362	0.233
25th Percentile SSI Effective Earnings MTR	0.144	0.144	0.144
50th Percentile SSI Effective Earnings MTR	0.180	0.180	0.180
75th Percentile SSI Effective Earnings MTR	0.209	0.198	0.204
25th Percentile SSI Effective Nonlabor MTR	0.639	0.639	0.639
50th Percentile SSI Effective Nonlabor MTR	0.702	0.705	0.702
75th Percentile SSI Effective Nonlabor MTR	0.731	0.731	0.731
25th Percentile Gross Hourly Wage	2.440	2.018	5.982
50th Percentile Gross Hourly Wage	8.266	8.028	9.199
75th Percentile Gross Hourly Wage	12.488	12.939	13.953
25th Percentile Net Hourly Wage	1.462	1.050	4.593
50th Percentile Net Hourly Wage	5.791	5.708	6.273
75th Percentile Net Hourly Wage	8.885	8.918	10.089
25th Percentile Gross Monthly AFDC Benefit	475.726	357.041	295.525
50th Percentile Gross Monthly AFDC Benefit	683.093	488.432	386.946
75th Percentile Gross Monthly AFDC Benefit	839.229	696.944	524.078
25th Percentile Net Monthly AFDC Benefit	0.000	0.000	0.000
50th Percentile Net Monthly AFDC Benefit	171.993	54.287	7.667
75th Percentile Net Monthly AFDC Benefit	563.238	409.883	276.566
25th Percentile Gross Monthly SSI Benefit	507.441	525.564	531.519
50th Percentile Gross Monthly SSI Benefit	544.035	539.846	531.519
75th Percentile Gross Monthly SSI Benefit	661.137	629.820	599.554
25th Percentile Net Monthly SSI Benefit	0.000	0.000	0.000
50th Percentile Net Monthly SSI Benefit	217.775	252.243	153.039
75th Percentile Net Monthly SSI Benefit	507.441	509.074	389.197

See notes to Tables 1 and 2 for sample description, and text for variable descriptions. Gross and net wages include non-workers, and net AFDC and SSI benefits are set to zero for those with calculated benefits less than zero.

Table 4: Instrumental Variable Tobit Estimates of Income Share Models, After-Tax Prices

	No State Fixed Effects			State Fixed Effects		
	AFDC Share	SSI Share	Earnings Share	AFDC Share	SSI Share	Earnings Share
Log AFDC Benefit	0.115 (0.011)	–0.106 (0.022)	–0.132 (0.012)	0.120 (0.011)	–0.104 (0.022)	–0.135 (0.012)
Log SSI Benefit	–0.140 (0.003)	0.215 (0.007)	–0.105 (0.004)	–0.141 (0.003)	0.216 (0.007)	–0.105 (0.004)
Log Wage	–0.185 (0.037)	–0.211 (0.095)	0.306 (0.043)	–0.194 (0.037)	–0.217 (0.095)	0.315 (0.043)
Log WWD Income	–0.036 (0.013)	–0.040 (0.032)	0.086 (0.015)	–0.029 (0.013)	–0.044 (0.032)	0.086 (0.015)
Log Virtual Other Income	–0.092 (0.026)	–0.025 (0.068)	0.157 (0.030)	–0.095 (0.026)	–0.022 (0.067)	0.161 (0.030)
Race (=1 if White)	–0.050 (0.007)	–0.054 (0.017)	0.058 (0.008)	–0.034 (0.007)	–0.054 (0.018)	0.047 (0.008)
Number of Children Under 18 Years old	0.042 (0.005)	0.031 (0.013)	–0.049 (0.006)	0.038 (0.005)	0.031 (0.013)	–0.047 (0.006)
Unemployment Rate	0.009 (0.002)	0.013 (0.005)	–0.013 (0.002)	0.006 (0.003)	–0.003 (0.007)	–0.006 (0.003)
Welfare Waiver (=1 when implemented)	–0.026 (0.014)	–0.016 (0.032)	0.045 (0.016)	0.003 (0.015)	–0.013 (0.035)	0.023 (0.017)
1st Stage Wage Residual	–0.240 (0.037)	–0.226 (0.095)	0.213 (0.043)	–0.230 (0.037)	–0.217 (0.095)	0.201 (0.043)
1st Stage Income Residual	0.022 (0.013)	–0.010 (0.031)	–0.036 (0.015)	0.024 (0.013)	–0.005 (0.031)	–0.039 (0.015)
1st Stage Other Income Residual	0.111 (0.026)	0.115 (0.068)	–0.180 (0.030)	0.116 (0.026)	0.112 (0.068)	–0.186 (0.030)
1st Stage AFDC Residual	0.106 (0.011)	–0.003 (0.022)	–0.082 (0.012)	0.104 (0.011)	–0.004 (0.022)	–0.080 (0.012)
1st Stage SSI Residual	–0.004 (0.003)	0.082 (0.007)	–0.010 (0.003)	–0.004 (0.002)	0.081 (0.007)	–0.010 (0.003)
χ^2 test of symmetry [p-value]		186.323 [0.000]			217.115 [0.000]	

Note: Asymptotic standard errors are in parentheses. All specifications control for birth-year by education cohort effects and year effects. See notes to Tables 1 and 2 for sample description.

Table 5: Extensive and Intensive Margin Price Elasticities

	No State Fixed Effects			State Fixed Effects		
	AFDC Share	SSI Share	Earnings Share	AFDC Share	SSI Share	Earnings Share
AFDC Benefit—Ever Participate	0.599	–0.589	–0.130	0.633	–0.587	–0.134
	(0.481)	(0.810)	(0.058)	(0.503)	(0.817)	(0.059)
AFDC Benefit—Unconditional Mean	0.667	–0.648	–0.170	0.713	–0.637	–0.176
	(0.065)	(0.147)	(0.016)	(0.066)	(0.146)	(0.016)
AFDC Benefit—Dependence	1.011	–0.902	–0.326	1.049	–0.894	–0.336
	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)
SSI Benefit— Ever Participate	–0.727	1.196	–0.104	–0.743	1.215	–0.105
	(0.129)	(0.341)	(0.017)	(0.136)	(0.342)	(0.018)
SSI Benefit—Unconditional Mean	–0.809	1.316	–0.136	–0.838	1.320	–0.137
	(0.021)	(0.117)	(0.005)	(0.022)	(0.117)	(0.005)
SSI Benefit—Dependence	–1.227	1.832	–0.260	–1.232	1.852	–0.262
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Hourly Wage—Ever Participate	–0.960	–1.169	0.302	–1.020	–1.223	0.314
	(1.603)	(3.459)	(0.207)	(1.680)	(3.492)	(0.211)
Hourly Wage—Unconditional Mean	–1.069	–1.286	0.396	–1.149	–1.328	0.411
	(0.216)	(0.589)	(0.056)	(0.221)	(0.590)	(0.056)
Hourly Wage—Dependence	–1.621	–1.790	0.759	–1.690	–1.864	0.787
	(0.009)	(0.008)	(0.009)	(0.009)	(0.007)	(0.009)

Note: Elasticities are evaluated at the means of the nonlinear functions. Standard errors calculated via the ‘delta method’ are in parentheses.

Table 6: Morishima Elasticities of Substitution

	No State Fixed Effects			State Fixed Effects		
	AFDC Share	SSI Share	Earnings Share	AFDC Share	SSI Share	Earnings Share
AFDC Benefit		–2.126	–1.235		–2.160	–1.356
SSI Benefit	–1.306		–1.426	–1.326		–1.464
Hourly Wage	–0.917	–1.462		–0.960	–1.468	

Note: Elasticities are evaluated at the means of the nonlinear functions.

Table 7: Sensitivity of Extensive and Intensive Margin Elasticities To Alternative Specifications

	After-Tax Prices with State Fixed Effects					
	Pre-Welfare Reform (1979-1996)			Tobit First Stage		
	AFDC Share	SSI Share	Earnings Share	AFDC Share	SSI Share	Earnings Share
AFDC Benefit—Ever Participate	0.514	–0.868	–0.126	1.186	–0.601	–0.216
	(0.549)	(1.245)	(0.091)	(0.178)	(0.238)	(0.021)
AFDC Benefit—Unconditional Mean	0.580	–0.940	–0.163	1.330	–0.639	–0.283
	(0.075)	(0.213)	(0.024)	(0.035)	(0.066)	(0.005)
AFDC Benefit—Always Participate	0.868	–1.332	–0.314	1.979	–0.924	–0.541
	(0.004)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)
SSI Benefit—Ever Participate	–0.712	1.405	–0.107	–0.890	1.115	–0.086
	(0.117)	(0.401)	(0.022)	(1.113)	(1.873)	(0.140)
SSI Benefit—Unconditional Mean	–0.803	1.521	–0.138	–0.998	1.185	–0.112
	(0.020)	(0.152)	(0.006)	(0.147)	(0.330)	(0.037)
SSI Benefit—Always Participate	–1.202	2.155	–0.266	–1.485	1.716	–0.215
	(0.001)	(0.001)	(0.001)	(0.006)	(0.004)	(0.006)
Hourly Wage—Ever Participate	–1.012	–1.501	0.380	–2.479	–2.764	0.623
	(1.678)	(4.738)	(0.295)	(1.014)	(1.733)	(0.123)
Hourly Wage—Unconditional Mean	–1.142	–1.626	0.491	–2.779	–2.938	0.815
	(0.230)	(0.742)	(0.076)	(0.141)	(0.389)	(0.033)
Hourly Wage—Always Participate	–1.709	–2.302	0.945	–4.139	–4.253	1.558
	(0.011)	(0.007)	(0.010)	(0.005)	(0.004)	(0.005)

Note: Elasticities are evaluated at the means of the nonlinear functions. Standard errors calculated via the ‘delta method’ are in parentheses.

Table 7 Continued

Before-Tax Prices with State Fixed Effects			
	AFDC Share	SSI Share	Earnings Share
AFDC Benefit—Ever Participate	0.456 (0.252)	–0.460 (0.504)	–0.084 (0.066)
AFDC Benefit—Unconditional Mean	0.537 (0.097)	–0.509 (0.229)	–0.112 (0.033)
AFDC Benefit—Always Participate	0.725 (0.024)	–0.592 (0.072)	–0.170 (0.016)
SSI Benefit—Ever Participate	–0.603 (0.613)	–1.047 (1.385)	0.100 (0.160)
SSI Benefit—Unconditional Mean	–0.710 (0.234)	–1.157 (0.631)	0.133 (0.080)
SSI Benefit—Always Participate	–0.958 (0.059)	–1.347 (0.198)	0.203 (0.039)
Hourly Wage—Ever Participate	–1.395 (0.364)	–1.338 (0.824)	0.611 (0.097)
Hourly Wage—Unconditional Mean	–1.641 (0.143)	–1.479 (0.372)	0.814 (0.048)
Hourly Wage—Always Participate	–2.215 (0.035)	–1.723 (0.114)	1.239 (0.023)

Note: Elasticities are evaluated at the means of the nonlinear functions. Standard errors calculated via the ‘delta method’ are in parentheses.

Table 8: Distribution of Simulated Responses to Various Policy Reforms Across Peak Business Cycle Years (Percent)

	1979	1989	1999
AFDC Benefit Fixed at Real 1979 Level			
25th Percentile of AFDC Share Response	–0.590%	12.570%	68.372%
50th Percentile of AFDC Share Response	0.758	27.633	120.399
75th Percentile of AFDC Share Response	2.848	46.417	180.247
25th Percentile of SSI Share Response	–1.777	–22.692	–41.211
50th Percentile of SSI Share Response	–0.591	–17.112	–34.409
75th Percentile of SSI Share Response	0.542	–12.489	–27.542
25th Percentile of Earnings Share Response	–0.629	–13.765	–17.124
50th Percentile of Earnings Share Response	–0.205	–6.689	–11.135
75th Percentile of Earnings Share Response	0.287	–4.029	–7.171
Percent with Welfare Gain	36.3	5.1	0.0
"Family Cap" AFDC Benefit for 3 Persons			
25th Percentile of AFDC Share Response	0.939	1.884	0.152
50th Percentile of AFDC Share Response	9.508	8.529	14.247
75th Percentile of AFDC Share Response	27.831	23.990	26.500
25th Percentile of SSI Share Response	–13.794	–13.301	–12.908
50th Percentile of SSI Share Response	–6.799	–7.089	–7.550
75th Percentile of SSI Share Response	–0.896	–1.852	–0.071
25th Percentile of Earnings Share Response	–5.599	–4.402	–3.381
50th Percentile of Earnings Share Response	–2.632	–1.840	–1.353
75th Percentile of Earnings Share Response	–0.199	–0.257	–0.025
Percent with Welfare Gain	24.1	22.4	24.1
Uniform Federal AFDC Benefit			
25th Percentile of AFDC Share Response	–16.137	11.866	62.420
50th Percentile of AFDC Share Response	–0.784	26.505	121.806
75th Percentile of AFDC Share Response	8.117	54.263	176.719
25th Percentile of SSI Share Response	–7.612	–26.243	–40.416
50th Percentile of SSI Share Response	0.790	–17.499	–35.089
75th Percentile of SSI Share Response	9.801	–11.124	–26.892
25th Percentile of Earnings Share Response	–3.759	–14.153	–18.345
50th Percentile of Earnings Share Response	0.445	–7.421	–11.727
75th Percentile of Earnings Share Response	2.973	–3.925	–7.099
Percent with Welfare Gain	52.3	4.9	0.0

Table 8 Continued

	1979	1989	1999
1979 Net Wage Structure			
25th Percentile of AFDC Share Response	–3.561%	–0.153%	16.753%
50th Percentile of AFDC Share Response	–0.995	9.576	41.885
75th Percentile of AFDC Share Response	1.177	23.031	88.673
25th Percentile of SSI Share Response	–3.348	–1.242	12.729
50th Percentile of SSI Share Response	–1.156	9.854	28.243
75th Percentile of SSI Share Response	1.226	25.439	56.014
25th Percentile of Earnings Share Response	–0.571	–7.043	–11.402
50th Percentile of Earnings Share Response	0.447	–3.056	–7.129
75th Percentile of Earnings Share Response	1.581	0.032	–3.190
Percent with Welfare Gain	63.2	47.7	26.4
Elimination of Income Taxes			
25th Percentile of AFDC Share Response	–41.664	–37.674	–48.115
50th Percentile of AFDC Share Response	–29.953	–27.094	–38.665
75th Percentile of AFDC Share Response	–13.425	–12.232	–22.347
25th Percentile of SSI Share Response	–32.615	–34.195	–35.342
50th Percentile of SSI Share Response	–25.442	–26.229	–28.037
75th Percentile of SSI Share Response	–16.625	–16.398	–16.331
25th Percentile of Earnings Share Response	7.823	5.079	4.504
50th Percentile of Earnings Share Response	11.265	8.892	7.171
75th Percentile of Earnings Share Response	20.627	16.102	10.178
Percent with Welfare Gain	90.2	83.0	88.8