Labor Supply and Income Effects of the Earned Income Tax Credit and Welfare Programs

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Abstract

This paper examines the effect of the Earned Income Tax Credit (EITC) and welfare programs on the labor supply and income of single mothers. We characterize the nonlinear budget constraint under these programs using a piecewise linear approximation and estimate nonparametrically a structural labor supply function. Employing a flexible functional form, we show that the EITC effect on hours of work is heterogenous. An EITC expansion increases the hours of poor single mothers whose tax credits increase with earnings and decreases the hours of those not so poor whose tax credits decrease with earnings. These two effects cancel each other, which explains why the EITC is found to have little effects on the average hours of work. Despite its disincentive effect on part of the population, the EITC effectively increases the family income of all affected groups.

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1 Introduction

This study investigates the impacts of recent changes in the U.S. tax and welfare system on the labor supply and income of single mothers. During the 1990s, there have been substantial changes in many aspects of the tax and welfare programs. The Earned Income Tax Credit (EITC), an earning subsidy program, was expanded considerably to become now one of the most expensive federal transfer programs. At the same time, Aid to Families with Dependent Children (AFDC) program was contracted across the country, and most of the states experimented with various forms of welfare waivers.\footnote{Following the enactment of 1996 Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA), the AFDC was eventually replaced by the Temporary Aid to Needy Families (TANF) in 1997.} A lot of studies show that all these events had significant impacts on the labor supply of the low income population, especially single mothers, who constitute the majority of welfare and EITC recipients.

Most of the literature on the effects of recent policy changes focuses on their impacts on participation. The effects on hours worked have not been thoroughly investigated because of two inherent difficulties: i) the nonlinear budget constraint introduced by various programs complicates the identification of the policy effects; ii) different policies changed simultaneously, making it difficult to disentangle individual component effect.

In this study, we examine individual and overall policy effects during the early 1990s. Unlike most of the previous studies that mainly look at policy impacts on participation, we focus on hours of work. We find that these policy changes have significant impacts on single mothers’ hours worked. The EITC expansion and welfare reform together increase the hours of work of single mothers during our sample period. We also investigate its income effect and find that the EITC effectively increases family income for all income groups on its schedule, despite the fact that it is shown to reduce hours of work for part of the affected population.
This study makes three contributions. First, we estimate nonparametrically a flexible structural labor supply function, taking into account the nonlinear constraint under the EITC and welfare programs. Since the nonparametric method is less stringent in distributional and functional assumptions, we are able to obtain more reliable predictions than those from parametric estimates.

Second, instead of focusing on a single program, we model jointly the effects of the EITC and welfare programs. The source of identification is the variation in program parameters in three dimensions: time, state, and family structure. We examine the impact of each policy component and their combined effects, which would help policy makers to understand the usefulness of separate instrument and their interactions.

Third, we relax the standard assumption of constant policy effect and explore the variation of policy impacts across different income groups. We find that an EITC expansion increases the hours of work of single mothers with low income, whose tax credits increase with hours of work (in the so-called phase-in range), while it decreases the hours of work of single mothers who earn relatively high income so that their tax credit decreases with hours of work (in the so-called phase-out range). At the aggregate level, these two effects cancel each other, which helps to explain the finding of previous studies that the EITC significantly increased the participation of single mothers, but had little effects on their average hours of work. This exploration of heterogenous treatment effect would help to improve the targeting efficiency of policies. We also examine the distributional impacts of the mechanical effects and behavioral responses induced by policy changes and find that the EITC benefits all income groups on its schedule.

The rest of the paper is organized as the following. The second section briefly summaries the recent changes in the U.S. tax and welfare system, and reviews the relevant literature. The third section presents the model, estimation strategy and results. The fourth section explores the impact of each policy component and their combined effects. The variations in policy effects on hours worked across different income groups are investigated. The fifth section investigates the income effects. The last section concludes and discusses the policy
implications of our findings.

2 Literature

2.1 Policy background and recent reforms

The EITC, AFDC and Food Stamps are the three most expensive transfer programs in the U.S. tax and welfare system for the low income population during most of the 1990s. All three programs are means-tested programs; their benefits are reduced at certain rates if the recipients’ incomes reach some thresholds. The presence of different marginal credit/tax rates at various income levels makes the budget constraint a complicated nonlinear function of hours of work.

The AFDC is mainly available to single mothers, while the Food Stamps and EITC are open to all low income families. The AFDC provides cash payments to families with children who have been deprived of support due to the absence or unemployment of a parent. The Food Stamps provide low-income households with coupons to purchase food. Both programs determine the eligibility and benefit level of applicants based on their need and family income. A maximum monthly benefit or guarantee that varies with family size is provided to families with zero income. After an initial exemption, the benefit is taxed at a certain rate until it is reduced to zero; then this family is no longer eligible for the program.

The EITC is an earnings subsidy program, which basically equals a specified percentage of earnings up to a maximum dollar amount. The maximum amount applies over a certain income range and then diminishes to zero. The income ranges and percentages have been revised several times since its original enactment, expanding the credit. Figure 1 illustrates the budget constraint under the EITC. Families with earnings below point B receive a tax credit as a fixed percentage of their earnings. We call the earnings range AB the “phase-in range” and the credit rate the “phase-in rate”. Families with earnings in the range BC receive a lump sum maximum tax credit, equal to the earnings level at point B multiplied
by the phase-in rate. We call this range the “plateau range”. Once the family earnings is above point C, the tax credit begins to be taxed until it reaches zero at point D. We call the range CD the “phase-out range” and the tax rate the “phase-out rate”.

For the low income population, the U.S. tax and welfare system has changed substantially during the 1990s. The EITC experienced the most dramatic expansion. There were two major expansions, and the expenditure of the EITC was more than doubled. In 1991, the credit was expanded to provide a larger credit for families with two or more children. For an eligible two children family, the credit rate was increased from 17 percent in 1991 to 40 percent in 1996, and the maximum credit rose from $1,235 to $3,556. Moreover, beginning in 1991, the EITC was not counted as income in most means-tested programs, increasing its value for low-income women. At the same time, the level of AFDC real benefit was lowered, while the eligibility standard became more stringent in most of the states. Under the welfare waiver programs, between January 1993 and August 1996, 43 states experimented with various aspects of the AFDC, such as strengthening work and training requirements, setting time limits for welfare receipt, or extending traditional childcare or Medicaid benefits to those leave the AFDC. All these experiments provided further incentive to work for the low income population, especially single mothers. For a detailed account of the EITC expansion and welfare reform, see Meyer and Rosenbaum (2001).

2.2 Existing studies

There exists a large body of literature on the welfare and tax programs’ effects on labor supply and family income.

Eissa and Liebman (1996) examines the effects of the 1986 EITC expansion on the employment of single women. They find that the 1986 tax reform (including the EITC expansion) increased employment among all single mothers by as much as 2.8 percentage points (from a base of 74.2 percent). Eissa and Hoynes (1998) uses a similar strategy to estimate the effects of the 1993 EITC expansion on married couples, of which the wives are assumed
to be the secondary earners. They find modest negative effects of the EITC on married 
women’s employment, estimating that the EITC expansions between 1984 and 1996 reduced 
the likelihood of labor market participation by around 1.2 percentage points (or 2 percent).

Keane and Moffitt (1998) explicitly parameterizes the preferences and constraints facing 
individuals. They discretize the budget constraints to a number of points and estimate a 
discrete choice model. Their policy simulations show that the EITC expansions between 
1984 and 1996 increased employment of single mothers by 10.7 percentage points, from a 
base of 65.4 percent.

Meyer and Rosenbaum (2001) examines the effects of the EITC and other policy changes 
on the employment of single women. They control for the influence of changes in other 
policies, over time and across states, to isolate the influence of the EITC. They find that 
EITC changes account for 63 percent of the increase in the employment rate of single mothers 
from 1984 to 1996 and 37 percent of the increase from 1992 to 1996.

Hotz et al. (2001) examines the effects of the EITC on welfare recipients. They use 
experimental variation in the California Work Pays Demonstration Project to account for 
the effect of altering the benefit package available to welfare recipients. They base their 
analysis on identifying changes in employment rates for welfare households with two or more 
children relative to households with one child. They find that the EITC has played an 
important role in increasing the employment rates among low-skilled workers, particularly 
those welfare recipients.

Neumark and Wascher (2001) studies the income effects of the EITC using matched CPS 
data. They find that this program increases participation and effectively raises the income 
of some poor families to above poverty level.
3 Estimation of Labor Supply Under Piecewise Linear Budget Constraint

Previous studies on the labor supply effects of the EITC tend to focus on the policy impacts on the extensive margin, or the participation decision, of single mothers.\textsuperscript{2} Employing a reduced-form approach, they find that the EITC expansion has substantial positive effects on single mothers’ labor force participation. At the same time, some of the studies report little effects on the average hours of work. However unlike traditional welfare programs, the benefit of the EITC is not a monotonic function of hours. The EITC unequivocally encourages participation because it shifts out the budget set at all positive hours of work. On the other hand, its effect on the hours of those already working is not unambiguous. For individuals in the phase-in range, the credit subsidizes the wage so that the substitution effect encourages more hours while the income effect reduces hours. For those in the plateau or phase-out range, the EITC has zero or negative effect on the net wage rate while discourages work through income effect. Therefore, the effect of EITC on hours of work is not uniform and warrants a closer investigation of the entire impact distribution. In this section, we relax the assumption of constant policy effect and estimate a flexible structural hours function, taking into account the nonlinear budget constraint.

3.1 Methodology

Two methods are commonly used to deal with the difficulties posed by the endogenous non-linear budget constraint problem: the maximum likelihood estimator (MLE) by Hausman (1981) and the instrumental variable (IV) method.\textsuperscript{3} The MLE explicitly models individual’s utility maximization over the entire budget constraints. The utility function parameters, which are also parameters in the corresponding labor supply function, are estimated by non-

\textsuperscript{2}See Saez (2002) and Meyer (2002) for a discussion on intensive and extensive labor supply responses to income transfer programs.

\textsuperscript{3}A third method is to discretize the budget set into a number of points and fit a discrete choice model. See, for example, Hoynes (1996) and Keane and Moffitt (1998).
linear least squares or maximum likelihood method. This method provides precise estimates when the assumption is correct, but is subject to specification error when the distributional assumption is incorrect.

The IV method linearizes budget constraints around the observed hours and uses instrumental variable technique to account for the endogeneity of the net wage and virtual income. Mroz (1987) and Blomquist (1996) show that this method can be sensitive to the choice of instruments. Another problem with the IV estimator is that the model can be misspecified. The IV approach assigns each individual to her observed segment of the budget set. Given the presence of measurement error and/or optimization error, an exceptionally large positive or negative disturbance may shift the observation to another segment. Thus the desired hours of work of this individual on her observed segment is not generated by the net wage and virtual income of that segment. For the same reason, when the budget constraints are nonlinear, simulations based on the IV estimates can only describe how the hours of work changes along the observed linear segment of the budget constraint even if the predicted hours is shifted to other segments.

Alternatively, Blomquist and Newey (1997) develops a new method to estimate labor supply response to changes in tax system with piecewise linear budget sets. The basic idea is that hours of work is a function of the entire budget set. We can account for a nonlinear budget set by estimating an hours of work function whose arguments summarize the budget set. In the special case of linear budget constraint, this model amounts to a function of the wage and virtual income, which completely characterize the budget set. They show that under the assumptions of utility maximization with globally convex preference and piecewise linear convex budget constraints, we can express the expected hours of work as a sum of functions of slope (the net of tax wage rate), intercept (the virtual income) and kink point for each segment of the budget set. Compared to the MLE, this method imposes fewer

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4 The virtual income is the intercept of the linearized budget constraint with zero hour of work.
5 See Moffitt (1986) and Heim and Meyer (2001) for a discussion of IV estimator under piecewise linear budget constraints.
6 See Blomquist and Newey (2002) for a further generalization of this method.
restriction but only uses the first (conditional) moment information. Since the MLE also
uses other moment information (under the condition of normality of the disturbance), we
would expect to have to use more data to get the same precision as the MLE would give.

We use a two-step procedure to estimate this model. First, the actual budget constraint
is approximated by a budget set consisting of $J$ piecewise linear segments. For the $i^{th}$ linear
budget segment, denote the slope and intercept $w_i$ and $y_i$, the kink point (in hours) between
the $i^{th}$ and $(i+1)^{th}$ segment $l_i = (y_{i+1} - y_i)/(w_i - w_{i+1})$, $i = 1, 2, \ldots, J$. We can then express
the expected hours as an additive function of the form:

$$E(h) = f_1(l_1, w_1, y_1) + f_2(l_1, w_2, y_2) + f_3(l_2, w_2, y_2) + f_4(l_2, w_3, y_3) + \cdots + f_{J+1}(l_{J-1}, w_J, y_J).$$

(1)

In the second step, no assumption about the functional form of $f_i()$ is made, and Equation
(1) is estimated nonparametrically. A cross-validation criterion is used for model selection.
Blomquist and Newey (1997) reports simulations using Swedish data, showing that this
nonparametric estimator performs quite well in terms of predicting the effects of tax reform
on hours of work. Blomquist et al. (2001) provides an in-depth examination of Swedish tax
reform using this method.

### 3.2 The model

We use the standard utility function $U(h, Y + eitc + afdc + fd)$, subject to

$$Y = wh + N,$$

$$eitc = \begin{cases} 
  t_{in}wh, & \text{(if in phase-in range)} \\
  t_{in}K_1, & \text{(if in plateau range)} \\
  t_{in}K_1 - t_{out}(wh - K_2), & \text{(if in phase-out range)}
\end{cases}$$

$$afdc = \max(AFDC_{max} - t_Awh, 0),$$

$$fd = \max(FD_{max} - t_Fwh, 0),$$
where \( h \) is hours of work, \( w \) is gross hourly wage rate, and \( N \) is non-labor income excluding governmental transfers. For the program parameters, \( \text{eitc} \) is the benefit from the EITC, \( K_1 \) and \( K_2 \) is the starting and ending point of the plateau range, and \( t_{\text{in}} \) and \( t_{\text{out}} \) is the phase-in and phase-out rate; \( \text{afdc} \) and \( \text{fd} \) is the benefit from the AFDC and Food Stamps, \( t_A \) and \( t_F \) is the respective tax rate, and \( \text{AFDC}_{\text{max}} \) and \( \text{FD}_{\text{max}} \) is the respective maximum benefit.

The first step of our estimation is to construct the budget constraint for each observation in the sample. The budget constraints of single mothers under the current system are relatively simple. We base the approximation of the budget constraint on the EITC schedule, using both ends of the plateau range as the kink points and adjusting the net wage rate by the corresponding EITC phase-in/phase-out rate.\(^7\) We then calculate the AFDC and Food Stamps benefit for each family according to their income, family structure and welfare rules of their residing state.\(^8\) For each segment, the benefit of the AFDC and Food Stamps are linearized to render the budget sets piecewise linear. The details of constructing the budget constraints are reported in Appendix.

The approximation of the budget constraint is necessary because we want to reduce the number of segments in the budget constraint to avoid the “curse of dimensionality”. Moreover, even if we were able to estimate a labor supply function with a large number of segments, we need a sufficiently large dataset such that we would have enough data to identify the impacts of each segment. Blomquist and Newey (1997) shows that, due to the presence of heterogenous preference, measurement error and optimization error, using approximated budget constraints rather than the exact ones does not impede, sometimes even helps, the applicability of the estimation procedure.

After we construct the approximated piecewise linear budget constraints for each individual, we calculate individual net wage rate on each segment. Because of the piecewise linear

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\(^7\)By construction, people with income below the end of the EITC phase-out range do not need to pay federal income tax. Once the income rises above that point, people need to pay federal income tax, the marginal rate of which is 15% throughout the sample period. The average phase-out rate during our sample period is 15.8%. Therefore, the ending of the phase-out range does not introduce a non-convex section.

\(^8\)The AFDC and Food Stamps tax rates vary with state welfare standards, family structure and individual’s position on the budget constraints.
structure of the budget constraint, the marginal wage rates for the three segments take the form

\[ w_1 = (1 + t_{in} - t_A - t_F) \cdot w, \]
\[ w_2 = (1 - t_A - t_F) \cdot w, \]
\[ w_3 = (1 - t_{out} - t_A - t_F) \cdot w. \]

We can then express the expected hours of work as

\[ E(h) = f_1(l_1, w_1, y_1) + f_2(l_1, w_2, y_2) + f_3(l_2, w_2, y_2) + f_4(l_2, w_3, y_3) + X\gamma, \]

where \( h \) is monthly hours of work, \( f_i() \)s are unspecified smooth functions, and \( X \) is a vector of control variables. Note that \( l_1 \) appears in the first two terms, and \( l_2 \) appears in next two. Included in \( X \) are the usual controls: age, age squared, education, education squared, number of children under age 6, gross state products, and state unemployment rate. We use a set of yearly and state dummies to account for variations over time and across states that are not captured by our characterization of budget constraints and other controls.

Our structural model uses the full variation in policy parameters over time, across states and their interaction with individual gross wage rate and family structure for identification. For example, the identification of the EITC effects is based on the changes in the phase-in/phase-out rate over time and variations in EITC benefits across different gross wage rates and family structures.\(^9\) All these variations enter the model through the budget constraint and are expected to influence individual labor supply in a complicated way due to the nonlinearity of the budget constraint.

### 3.3 Data

The data come from the Current Population Survey (CPS) March Supplements from 1992 to 1997. The March CPS is an annual demographic file of between 50,000 and 62,000

\(^9\)Some states offer state EITC, usually as a small fixed percentage of federal EITC and some of them are not refundable.
households. It includes labor market and income information for the previous year, so the data pertain to tax year 1991-1996. As mentioned above, beginning in 1991, income from the EITC is not counted against means-tested programs, which simplifies the approximation of the budget constraint. Following the enactment of 1996 PRWORA, the AFDC is replaced by the TANF in 1997. Since it is very difficult to characterize various differences between the AFDC and TANF by a few parameters, we end our sample at 1996 to avoid this complication. Nonetheless, our sample period provides ample variations in policies thanks to two major EITC expansions, substantial changes in the AFDC, and state welfare waivers.

We focus on single mothers in our analysis. We note that more than 95% of welfare recipients are single mothers, and over 70% EITC benefits accrue to taxpayers who file as single or heads of households (Greenbook\textsuperscript{10}, 1999). Moreover, the majority of two-parent families are not eligible for the EITC and welfare.

As the participation effect of welfare reform and EITC expansion has been thoroughly studied, we focus on hours of work. We consider single mothers who reported positive hours of work because the wages of those did not work are unobservable and therefore we are unable to construct their budget constraint, which is the key source of identification of our model. Although we can impute their wages from the wages of those working single mothers, we choose not to do so since this would introduce considerable measurement errors into the budget constraints.\textsuperscript{11} Also, as more and more single mothers entered the work force during the 1990s, it is in itself important to understand the policy effects on labor supply conditional on working. Following the usual practice, we exclude those who are younger than 20, older than 50, disable, attending school full time, self-employed, or retired. We further restrict our sample to single mothers with no more than a high school degree, whose hourly wage higher than one dollar, income from capital less than $2,350 (the EITC asset test threshold), and

\textsuperscript{10}The Greenbook refers to the annual Background Material and Data on Major Programs within the Jurisdiction of the Committee on Ways and Means by the U.S. House of Representatives.

\textsuperscript{11}The labor literature suggests that the typical prediction of wage/earnings from cross-sectional data based on personal characteristics and social-economic background can explain only about 30% of the observed variation. Therefore, we treat the gross wage as exogenous in this study.
total family income less than $30,000.\footnote{The end of the EITC phase-out range is below $26,000 in real dollars during the entire sample period. Nonetheless, we set the range up to $30,000 since individuals with earnings initially above the EITC phase-out range might reduce their hours to get into EITC.}

We pool data from 1991 to 1996 for 50 states and D.C.. The AFDC benefit standards of Alaska and Hawaii are substantially higher than those of other states, which makes our method of budget constraint approximation inappropriate for these two states. Therefore, we drop them from our sample. Our final data have 5,373 observations from 48 continental states and D.C. for six year. Table 1 reports the summary statistics of the sample. All the monetary variables are in 1996 U.S. dollar. Our sample of single mothers are relatively young, on the average work long hours and have more than one child. Nearly a third of them did not finish high school.

3.4 Specification and estimation

Equation (2) takes the form of a \textit{generalized additive model} (GAM), as called in the statistics literature. Hastie and Tibshirani (1986) introduces the class of GAM, which replaces the linear form $g(\mu_i) = \sum \beta_i z_i$ of traditional linear models by a sum of smooth functions $\sum f_i(z_i)$, where $E(y_i) = \mu_i$, $y_i$s are independent random variables from the exponential family and $g()$ is the link function. The $f_i()$s are unspecified functions that are estimated using a scatterplot smoother, in an iterative local scoring algorithm. This method provides a flexible method for identifying nonlinear covariate effects.

Without assuming the functional form of $f_i()$s in Equation (2), we can estimate them by some nonparametric estimators, such as the kernel, spline or series estimator. In this study, we use thin plate splines to approximate the multivariate functions $f_i()$s. The penalized likelihood method is employed to estimate our model, which involves multiple smoothing penalties due to the additive $f_i()$ terms.

Wood (2000) discusses the penalized likelihood method for estimating GAM by regression splines. Given model (2), smooth terms are represented using penalized regression splines.

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The penalties measure the wiggliness of each \( f_i() \) as \( \int [f_i''(z)]^2 \, dz \). Wood (2000) shows that it is possible to write the penalty term as \( \int [f_i''(z)]^2 \, dz = \beta' F_i \beta \), where \( \beta \) is the parameter vector, and \( F_i \) is a positive semi-definite matrix depending only on the basis functions of the splines. One can then estimate the model by minimizing

\[
-l(\beta) + \sum_i \lambda_i \beta' F_i \beta,
\]

where \( l() \) is the log-likelihood function for \( \beta \), and \( \lambda_i \)s control the relative weight given to the conflicting goals of good fit and model smoothness.

Wood (2000) suggests using the generalized cross validation (GCV) score to automatically select the \( \lambda_i \)s for each smooth term.\(^{13}\) The GCV governs the balance between goodness-of-fit and parsimony of the model. A small GCV score is preferred. The GCV is defined as

\[
\text{GCV} = \frac{\|W^{\frac{1}{2}} (A - Z\beta)\|^2}{|\text{tr} (I - H)|^2}.
\]

At each stage of iteration, \( W \) is a diagonal weight matrix with \( W_{ii} = [g'(\mu_i)^2 V_i]^{-1} \); \( V_i \) is the variance of \( y_i \); \( A = Z\beta + \Gamma (y - \mu) \), where \( \Gamma \) is a diagonal matrix with \( \Gamma_{ii} = [g'(\mu_i)]^{-1} \); \( H \) is the “influence” or “hat” matrix defined by \( Z(Z'WZ + \sum \lambda_i \beta' F_i \beta)^{-1} Z'W \). The trace of \( H \) gives the estimated equivalent degrees of freedom for the model, which describes the amount of information in the data needed to estimate the residuals. On the other hand, the estimated degrees of freedom reflects the complexity of the partial relationship between the dependent variable and the arguments of the nonlinear terms.

One key advantage of the generalized smoothing spline model is that the selection of degrees of freedom for the components of a fitted GAM is an integral part of model fitting. We use the GCV score to decide which terms to include in the model and the degree of smoothing for each term. Our results suggest dropping \( f_3() \) from the model.\(^{14}\) This is not unexpected. Note that in Equation (2), both \( w_2 \) and \( y_2 \) appear in \( f_2() \) and \( f_3() \). In

\(^{13}\)See Craven and Wahba (1979) for details and properties about GCV, and Gu and Wahba (1991) for its application on generalized smoothing spline model.

\(^{14}\)Removing \( f_3() \) improves the adjusted-R\(^2\) slightly and increases the GCV from 3038.5 to 3040.7.
addition to this, $l_1$ and $l_2$ are highly correlated. Therefore, $f_2()$ and $f_3()$ are highly positively correlated, rendering one of them redundant.

Our preferred model takes the form

$$E(h) = f_1(l_1, w_1, y_1) + f_2(l_1, w_2, y_2) + f_4(l_2, w_3, y_3) + \mathbf{X}\gamma.$$  

Table 2 reports the regression results. The adjusted R-square is nearly twice of that from our preferred parametric estimates.\footnote{The results of parametric estimates are available from the author upon request.}

The coefficients for number of children under six, age, age squared and race all show the expected signs and are statistically significant at the conventional level. The yearly dummies suggest a generally upward time trend for our sample period, which was part of the longest economic growth in the U.S. history. To save space, we do not report the coefficients for state dummies. We also estimate the model without state dummies, in which the state unemployment rate appears to have significant negative effects on hours of work, while the coefficient for state gross products is still not statistically significant. However, the F-test indicates that the state dummies are jointly significant.

The three nonparametric terms are highly significant with virtually zero $p$-values. By construction, the impacts of policy parameters enter the supply function through these nonparametric terms. In next section, we use the regression results to explore the contribution of each policy component and their combined effects.

3.5 Sensitivity analysis

We conduct serval experiments to investigate the sensitivity of our results to alternative specifications. Since most of the single mothers do not pay federal income tax due to their low level of income, standard deduction and personal exemptions, we assume zero income tax liability when calculating their budget constraints. To check how this assumption affects our results, we impose a 15% federal income tax, which is the marginal tax rate for the
lowest income bracket throughout our sample period, on the third segment of their budget sets. Under this alternative budget construction, the regression results are very close to those reported above.

To check if the results are sensitive to our screening of the sample, we conduct a Heckman-type two-step experiment. We first estimate a standard probit model on participation for all the eligible single mothers. The independent variables include family social-economic characteristics, policy parameters, their interactions and a set of yearly and state dummies. We then estimate the nonparametric hour equation (3) with the inverse Mill’s ratio as an additional linear explanatory regressor. The coefficient for the selection term turns out to be insignificant with a $p$-value of 0.58. It is known that the Heckman two-step estimator depends crucially on the bi-normality assumption of the error terms. In a further experiment, we keep the normality assumption of the participation equation but enter the predicted participation probability from the first step probit regression as a nonparametric term. This is a natural extension of our generalized additive model. In either experiment, the results are not sensitive to the correction of potential selection bias.\footnote{In his maximum likelihood estimates of labor supply under piecewise linear budget constraints, Hausman (1981) also finds that correction of selection bias barely affects the results.}

In the third experiment, I estimate the model using only one nonparametric term, whose arguments include the net wage rate and virtual income of the segment on which each individual is observed. The GCV for this model is 3071, compared to 3041 under the three-piece piecewise linear model, demonstrating the benefit of modelling hours as a weighted function of all the segments of the budget constraint.

4 \hspace{1em} \textbf{Effects on Hours of Work}

The U.S. public transfer and tax system for the low income population has undergone substantial reform during the 1990s. It is of value to know the effects of those policy changes. With the long run goal of promoting work and self-sufficiency, it is very important to know
which policy component encourages work, and what changes hours of work in the opposite
direction. If the policy effects are not homogenous, what are their impacts on different in-
come groups? In this section, we attempt to answer these questions using the estimates from
our flexible labor supply function.

4.1 Policy simulation

In our model, all policy factors enter the supply function through their effects on individual
budget constraint. Changes in policy parameters alter individual budget constraint and
subsequently influence their labor supply.

To examine how hours of work respond to changes in various factors, we conduct the
following experiments, taking the distribution of predicted hours as the baseline.

(1) wage: increase the gross wage rate by 20%;

(2) income: increase the nonlabor income (excluding government transfers) by 20%;

(3) afdc: increase the AFDC maximum benefit by 20%;

(4) food stamp: increase the Food Stamps maximum benefit by 20%;

(5) phase-in: increase the EITC phase-in rate by 20%;

(6) phase-out: increase the EITC phase-out rate by 20%.

In an effort to mimic the recent policy changes, we also examine the combined effects of
some policy changes:

(7) in+out: increase the EITC phase-in and phase-out rate by 20%, or (5) plus (6);

(8) combined: reduce the AFDC and Food Stamps maximum benefit by 20% plus (7).

\footnote{If we raise the EITC phase-in rate by 20%, the maximum credit is up by 20%. To keep the phase-out
rate constant, we need to extend the length of phase-out range by 20% so that the EITC credit is phased
out to zero at the end of the phase-out range. Similarly, if we raise the phase-out rate by 20%, we need to
reduce the length of phase-out range by 20%.
To facilitate comparison, in Figure 2, we present box plots of the distribution of predicted hours of work. The vertical axis corresponds to desired monthly hours of work. The ends of the box illustrate the 25th and 75th percentiles and the horizontal bar inside the box marks the sample median. The whiskers correspond respectively to the 10th and 90th percentile. The numbers to the right of the box give the value of corresponding percentiles. The first box describes the distribution of the baseline and the rest eight are the experiment results, as indicated by the labels on the horizontal axis.

The boxplot shows that increasing gross wage rate raises hours of work, while increasing nonlabor income reduces hours. Increase in the AFDC or Food Stamps benefit reduces hours. This is consistent with the literature that welfare programs have undesirable disincentive effects. For example, the studies reviewed in Moffitt (1992) unequivocally show that the AFDC generates a nontrivial work disincentive; Fraker et al. (1985) finds that the Food Stamps program has a modest disincentive effect on labor supply.

Remarkable responses are observed for changes in EITC phase-in or phase-out rate. Higher phase-in rate increases hours while higher phase-out rate lowers hours. The literature reports mixed results on the EITC’s impacts on labor supply. Most of the existing studies focus on participation and do not examine the effects of phase-in rate and phase-out rate separately. Eissa and Liebman (1996), Hotz et al. (2001) and Meyer and Rosenbaum (2001) show that EITC expansion increased the labor supply of single mothers. On the other hand, Eissa and Hoynes (1998), who models the labor supply of married couples jointly, finds that EITC expansion reduced wives’ labor supply.

Our 7th experiment predicts the effects of increasing jointly the EITC phase-in and phase-out rate by 20%, which is exactly the way the EITC was expanded. We find virtually zero net effect on the distribution of hours, which is consistent with previous findings that the EITC expansion had little effects on hours of work. However, as suggested by our 5th and 6th experiments, the responses to change in phase-in or phase-out rate show similar magnitude, but in opposing directions. Consequently, these two effects may offset each other and give us the misleading impression that there are little effects on hours of work. We will
examine this possibility more carefully in next section.

The last experiment, which reduces welfare benefit and expands the EITC, reports the largest increase in hours. This experiment, designed to mimic the recent policy changes, suggests that the overall changes in welfare and tax system during the sample period successfully increase the hours of work of single mothers.

Nextly, we test the hypothesis that the difference in median hours between the baseline distribution and that of those experiment results is zero. The standard errors for the median are obtained using the delta method and are adjusted for prediction errors. The results are reported in Table 3. The median hour from the Food Stamps, phase-in rate, phase-out rate, and the combination of welfare and EITC experiments are significantly different from that of the baseline case at 1% level; the difference in median is significant at 5% level in the wage and AFDC experiment; the virtual income experiment has no significant impact on the median. We note that when we raise the phase-in and phase-out rate jointly, the change in median hour, which is virtually zero, is the smallest (in absolute values) among all the experiments. Since the mean (117) and median (120) of the hour distribution are very close, that expanding the EITC has no effect on the median hour agrees with previous work that reports little EITC effect on the average hours.

Since our model is nonlinear, the size and even the sign of prediction results may vary with the magnitude of changes in policy parameters. Moreover, we are not able to attain a unique elasticity of hours of work to change in wage or policies. To check how sensitive our results are to the proposed magnitude of change in policies, we repeat the experiments by changing the parameters by 10%, 15% and 25% respectively. The outcomes are qualitatively close to our reported results. We calculate the point elasticity of hours of work to various changes in policy parameters, evaluating at the sample average. The results are reported in Table 4. We notice that the elasticities to virtual income and policy parameters are virtually constant across different experiments. The stability of our elasticity estimates suggests

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18 We use the Maritz-Jarrett formula for the standard error of the median.
19 This is consistent with the fact that any change in virtual income and policy parameters shifts or rotates
that our model is robust within a relatively large neighborhood of the observed data and consequently can be used in a broad spectrum of policy simulations.

An interesting feature of the results is that the elasticity of hours of work to gross wage rate decreases in the magnitude of changes. We note that the change in policy parameters leads to a universal change in the budget constraint facing each individual, while the impact of wage change depends on the shape of the budget constraint, the initial position of an individual on the budget constraint and her potential behavioral response. On the average the larger is the increase in gross wage rate, the smaller is the net effect relative to the increase, because larger wage increase is more likely to shift an individual from lower segments of the budget constraint to higher segments, where the tax rate is higher. Consequently, we might expect relatively low elasticity of hours of work when the wage increase is large.

Lastly, we test if the results are consistent with utility maximization. When the budget constraint is linear, the usual linear labor supply function is $E(h) = a + bw + cy$. It is well known that utility maximization with convex preferences requires: $b > 0$ and $b - cH > 0$, where $H$ is the maximum number of hours. Our nonparametric labor supply function relaxes this parametric constraint and therefore substantially increases its flexibility. Nonetheless, we can test the hypothesis of utility consistency using our results. Our experiments show that for a broad range of policy parameters, the wage and income effect is respectively positive and negative, indicating that $b > 0$ and $c < 0$. Therefore, our labor supply function is consistent with utility maximization.

4.2 Heterogenous policy impacts

In the classical linear model and difference-in-difference analysis, we can only identify the average policy effect. However, some policies are believed to have differential effects. The EITC program may belong to this category. Since the position of kink points of the EITC

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the budget constraint in the same way for each individual, regardless her initial position on the budget constraint or potential behavior response. This is a pure “mechanical effect” as described in Ashenfelter (1983).
schedule does not change in real terms over time, the EITC expansion by increasing the phase-in rate is accompanied by a same percentage increase in the phase-out rate to ensure the EITC credit phased down to zero at the end of the phase-out range. The EITC expansion increases the net wage rate of those on the phase-in range, increases the net income of those on the plateau range, and reduces the net wage of those on the phase-out range. Hence theory predicts heterogenous effects on different individuals, depending on their initial positions on the EITC schedule. Fortunately, our flexible nonparametric method relaxes the assumption of constant effect to facilitate the uncovering of potentially heterogenous policy effects.

To check the assumption of constant policy effect, we can project the predicted change in hours of work against some observable characteristics. Although the policy effects can vary in many aspects, one major concern is their impacts on different income groups. We are interested in where and how all these changes take place along the income distribution, a question whose answer may help improve the targeting efficiency of means-tested policies. Our strategy is to predict the change in hours due to exogenous change in policy parameters as a function of observed initial earnings. We fit the predicted changes in hours on earnings as a cubic smoothing spline, using generalized cross-validation to choose the degree of smoothing. In Figure 3, we report the results of experiments (5) to (8) in the previous section. If the policy effects are constant, there would not be any discernible patterns in the smoothed change in hours against the initial earnings. Obviously, none of the plots support the notion of constant effects.

The upper left plot shows that a 20% increase in EITC phase-in rate increases the hours of work. The largest effects are found at the low end of the earning distribution and gradually decrease as earnings rises. This is consistent with the fact that the phase-in rate mainly affects those whose earnings are within the phase-in range. The upper right plot suggests that higher phase-out rate decreases hours. There is a significant dip between $10,000 and $20,000, which spans the majority the phase-out range during our sample period. We note that the decline in hours is smaller for those with earnings near the end of the phase-out range. When we increase the phase-out rate by 20%, we also reduce the length of the phase-
out range by the same percent to ensure that the credit is phased down to zero at the end of the phase-out range. Consequently, some individuals initially on the EITC with earnings close to the end of the phase-out range are no longer eligible for this program and may increase their hours in response to the induced lower income and higher net wage rate. On the other hand, some may reduce their hours to get back onto the EITC. These two effects can offset each other, resulting in a smaller net decrease in hours for those near the end of the phase-out range.

The lower left panel shows the effects of an EITC expansion by increasing the phase-in and phase-out rate by 20% simultaneously. As predicted by theory, individuals initially in the phase-in range respond by increasing hours of work, while those initially in the phase-out range decrease hours. This confirms the prediction made in Moffitt (2002) that EITC expansion draws people to the middle portion of the EITC schedule.

The lower right panel reports the combined effects of EITC expansion and welfare reforms. It shows that this combination of policy changes increases hours of work for all income groups on the EITC schedule, demonstrating that the policy reforms were successful in both promoting work and targeting those most in need. The policy effects are largest for those at the very low end of the income distribution and decrease gradually as income rises. Two factors contribute to the relatively small increase in hours for those in the plateau and phase-out range. First, as we mentioned above, the increased phase-out rate discourages work. Second, the reduction in AFDC benefits would have little effects for those with earnings above the phase-in range because the AFDC benefits have generally been reduced to zero for those with earnings above the phase-in range.

Qualitatively identical patterns are observed for experiments with respectively 10%, 15% and 25% changes in policy variables. Our experiments demonstrate that the EITC has heterogenous effects across income groups. The average change depends on the magnitude of the different responses as well as relative numbers of individuals at different initial positions along the budget constraint. Since the positive effect of the phase-in rate and the negative effect of the phase-out rate offset each other, traditional analysis assuming homogenous
effects might find little EITC effects on the average hours of work.

5 Income Effects

Although one of the major goals of the EITC and welfare reform is to enhance the labor market attachment of low income families, we are also concerned about their economic well-being. In this section, we examine the effects of the EITC expansion on the family income of single mothers from different income groups.

Under the assumption of no behavioral response, a 20% increase of the EITC (in both the phase-in and phase-out rate) would increase the income of those in the phase-in range by 20% of their earnings. For those in the plateau range, the income increases by a lump sum amount $M$, which is equal to the end of the phase-in range multiplied by 20%. For those in the phase-out range, the increase in income equals the difference between $M$ and 20% of their earnings, and this amount decreases toward zero as the earnings approach the end of the phase-out range. These effects are the “mechanical effects”, which are exogenous conditional on individual gross wage, hours of work and family structure, and can be calculated by simply applying the formula of benefit calculation. However, people may change their labor supply behaviors in response to changes in their budget constraints. Therefore, the actual income effect, which consists of the mechanical effect and behavioral response, generally differ from the pure mechanical effects.

We report the predicted change in income from a 20% increase of the EITC (in both the phase-in and phase-out rate) in Figure 4. The mechanical effects are calculated as described above. The actual effect has two components: change in earnings as the predicted change in hours multiplied by observed wage, and the change in the EITC benefit resulting from the interaction of change in the EITC parameters and change in earnings. Both mechanical effect and actual effect are projected as smooth functions of original earnings using the cubic spline. The mechanical effect shows the expected symmetric pattern. The benefits increase in the phase-in range, level off in the plateau range, then decrease in the phase-out range.
However, the behavioral response deviates the actual effect from the mechanical effect. For those in the phase-in range, the increase in income is higher than the mechanical effect since people work more hours in response to a higher phase-in rate/net wage rate. On the other hand, the increase in income is lower than the mechanical effect in the phase-out range since some people reduce their hours due to the disincentive effects of higher phase-out rate/lower net wage rate. Nonetheless, the lump sum increase in benefits dominates the disincentive effect, so the after-tax, after-transfer income also rises for those in the phase-out range.

Our results show that the EITC increases the income of the single mothers, and poorer single mothers benefit more from this program. Since single mother families are at the very low end of the U.S. income strata, the overall income distribution is improved. This result is consistent with the finding that the EITC plays an important role in fighting poverty (Neumark and Wascher (2001)), and also provides micro evidence for the finding of Wu et al. (2002) that the EITC improves the overall U.S. income inequality.

6 Conclusion

There have been dramatic changes in the U.S. tax and welfare system for the low income population during the 1990s, including substantial EITC expansion and welfare reform. In this study, we examine the impacts of these policy changes on the labor supply and income of single mothers. We focus on the hours effect of the EITC, AFDC and Food Stamps, under which single mothers are facing a nonlinear budget constraint. We estimate nonparametrically a flexible structural labor supply function, taking into account the nonlinear budget constraint. We find that the labor supply of single mothers increases in gross wage rate, EITC phase-in rate, and decreases in nonlabor income, welfare benefits and EITC phase-out rate. When the EITC phase-in and phase-out rate increase jointly, we observe little net effects. On the other hand, the combination of EITC expansion and reduction in AFDC and Food Stamps benefits leads to a considerable rise in the hours of work of single mothers.

Previous studies on the EITC find that the EITC substantially increased the participation
of single mothers, but had little effects on the average hours of work. This observation is confirmed in our work. However, unlike traditional welfare programs, the benefit calculation of the EITC is not a monotonic function of hours. The policy effects depend on individual’s initial position on the budget constraint and her potential behavioral response. We relax the assumption of constant policy effect and examine the distributional effects of the EITC. We find that the policy effects of the EITC are heterogenous. The EITC expansion increased the labor supply of those initially on the phase-in range while reduced that of those initially on the phase-out range. These two opposing effects offset each other, which explains the lack of response in average hours of work to the EITC. Finally, although the EITC decreases the hours of work of single mothers on the phase-out range, the income effects dominate the substitution effects so all income groups on the EITC schedule benefit from this program.

The findings of this study provide useful policy implications. The disincentive effect of the phase-out rate of the EITC and people’s behavioral responses suggest that individuals with relatively high earnings potential might choose to work lower hours to take advantage of this program. Policy makers may consider imposing a minimum hours of work requirement and/or a maximum wage rate restriction. By doing so, the EITC, designed to help the working poor, is expected to more effectively exclude the non-targeted group from the program and therefore improve its targeting efficiency.
Appendix: Approximation of Nonlinear Budget Constraints

We approximate the budget constraints of single mothers according to the program information provided in the annual Background Material and Data on Major Programs within the Jurisdiction of the Committee on Ways and Means (the “Greenbook”). For single mothers with less than a college degree, we simplify their budget constraints into three piecewise linear segments, based on the EITC schedule.

Denote the virtual income and net wage for each segment $y_i$ and $w_i$, $i = 1, 2, 3$, the kink points (in hours/month) $l_1 = (y_2 - y_1) / (w_1 - w_2)$ and $l_2 = (y_3 - y_2) / (w_2 - w_3)$. The first segment corresponds to the EITC phase-in range. For AFDC benefit, in addition to a $120$ standard deduction, we assume a 20% deduction in earnings for childcare, up to $160$ multiplied by the number of children:

$$AFDC = AFDC_{\max} - (Earnings - 120 - \min (Earnings \times .2, \ 160 \times \text{Child18})),$$

where $AFDC_{\max}$ is the maximum benefit, and Child18 is the number of dependent children under age 18.

The maximum benefit standard for Food Stamp is $120$ for the first family member and $90$ for each additional one. We assume a 20% earnings deduction, a 20% deduction for childcare up to $160$ multiplied by the number of children, and a $134$ standard deduction. The AFDC benefit is also deducted. To calculate the benefit, we multiply the total deduction by 30% and subtract it from the maximum benefit:

$$FD = FD_{\max} - (Earnings \times .8 - \min (Earnings \times .2, \ 160 \times \text{Child18}) + AFDC - 134) \times .3,$$

where $FD_{\max}$ is the maximum Food Stamps benefit.

The virtual income for the first segment $y_1$ is where earnings (hour) is zero:

$$y_1 = AFDC_{\max} + FD_{\max} - (AFDC_{\max} - 134) \times .3 + \text{Nonearned Income}.$$
We use the end of the phase-in range ($\text{Earn}_1$) of the EITC as the first kink point. The AFDC and Food Stamps benefit at $\text{Earn}_1$ is respectively

$$\text{AFDC}_1 = \max (\text{AFDC}_{\text{max}} - (\text{Earn}_1 - $120 - \min (\text{Earn}_1 \times .2, \$160 \times \text{Child18})), 0),$$

$$\text{FD}_1 = \max (\text{FD}_{\text{max}} - (\text{Earn}_1 \times .8 - \min (\$160 \times \text{Child18}, \text{Earn}_1 \times .2) + \text{AFDC}_1 - $134) \times .3, 0).$$

To render the budget segments piecewise linear, we linearize the AFDC and Food Stamp benefits on each segment. The net wage rate for the first range is therefore constructed as:

$$w_1 = (1 + \text{EITC credit rate} \times (\text{AFDC}_{\text{max}} + \text{FD}_{\text{max}} - \text{AFDC}_1 - \text{FD}_1) / \text{Earn}_1) \times w.$$

The first kink point is then $l_1 = \text{Earn}_1 / w$.

The second segment corresponds to the EITC plateau range, where individuals receive the lump sum maximum EITC benefit. The AFDC and Food Stamp benefits, if any, are phased out linearly. Denoting $\text{Earn}_2$ as the end of the plateau segment of the EITC, we construct the AFDC and Food Stamp benefits as

$$\text{AFDC}_2 = \max (\text{AFDC}_{\text{max}} - (\text{Earn}_2 - $120 - \min (\text{Earn}_2 \times .2, \$160 \times \text{Child18})), 0);$$

$$\text{FD}_2 = \max (\text{FD}_{\text{max}} - (\text{Earn}_2 \times .8 - \min (160 \times \text{Child18}, \text{Earn}_2 \times .2) + \text{AFDC}_2 - 134) \times .3, 0).$$

The net wage rate for the second segment is

$$w_2 = \max ((1 - ((\text{AFDC}_1 - \text{AFDC}_2) + (\text{FD}_1 - \text{FD}_2)) / (\text{Earn}_2 - \text{Earn}_1)) \times w, 0).$$

The kink point $l_2 = l_1 + (\text{Earn}_2 - \text{Earn}_1) / w$, and the virtual income $y_2 = y_1 + w_1 l_1 - w_2 l_1$.

The third segment corresponds to the EITC phase-out range. Denote $\text{Earn}_3$ as the end of the phase-out range. We phase out linearly the EITC benefit and the AFDC and Food Stamp benefits, if any, such than all the benefits are phased down to zero at the end of this segment. The net wage rate the the third segment is

$$w_3 = \max ((1 - \text{EITC phase-out rate} \times (\text{AFDC}_2 + \text{FD}_2) / (\text{Earn}_3 - \text{Earn}_2)) \times w, 0).$$

The virtual income $y_3 = y_2 + w_2 l_2 - w_3 l_2$. 

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References


### Table 1: Summary statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>mean</th>
<th>std. var</th>
<th>min</th>
<th>max</th>
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</thead>
<tbody>
<tr>
<td>Number of dependent children</td>
<td>1.77</td>
<td>0.89</td>
<td>1</td>
<td>9</td>
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<tr>
<td>Number of children under age 6</td>
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<td>0.75</td>
<td>0</td>
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<tr>
<td>Age</td>
<td>32.09</td>
<td>7.10</td>
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<td>49</td>
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<tr>
<td>Hours/month</td>
<td>114.63</td>
<td>63.79</td>
<td>0.42</td>
<td>429</td>
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<tr>
<td>Wage/hour</td>
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<td>3.90</td>
<td>1.02</td>
<td>44.50</td>
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<tr>
<td>Other income ($1,000)</td>
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<td>3.83</td>
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<td>27.38</td>
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<tr>
<td>State gross products ($1e+6)</td>
<td>0.26</td>
<td>0.25</td>
<td>0.01</td>
<td>0.97</td>
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<tr>
<td>State unemployment rate</td>
<td>6.38</td>
<td>1.49</td>
<td>2.6</td>
<td>11.4</td>
</tr>
</tbody>
</table>

**percent**

| Less than high school                | 5.9   |
| High school dropout                  | 22.5  |
| High school diploma                  | 71.6  |
| White                                 | 71.8  |
| Black                                 | 24.7  |
| Other                                 | 3.5   |

Number of observations: 5,373

<table>
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<tr>
<th>Variable</th>
<th>coefficient</th>
<th>standard error</th>
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<tr>
<td>Education</td>
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<tr>
<td>Education^2</td>
<td>1.63</td>
<td>0.25</td>
</tr>
<tr>
<td># of Children&lt; age 6</td>
<td>-3.80</td>
<td>1.30</td>
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<tr>
<td>Age</td>
<td>7.70</td>
<td>1.03</td>
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<tr>
<td>Age^2</td>
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<td>0.02</td>
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<tr>
<td>White</td>
<td>8.80</td>
<td>1.89</td>
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<tr>
<td>Gross State Products</td>
<td>14.69</td>
<td>77.78</td>
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<tr>
<td>State Unemployment Rate</td>
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<td>1.41</td>
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<tr>
<td>Year=1992</td>
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</tr>
<tr>
<td>Year=1993</td>
<td>-6.39</td>
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</tr>
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<td>Year=1994</td>
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</tr>
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<td>Year=1995</td>
<td>6.87</td>
<td>6.77</td>
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<td>Year=1996</td>
<td>5.08</td>
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<table>
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<tr>
<th>Nonparametric terms</th>
<th>equivalent d.f.</th>
<th>p-value</th>
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<tbody>
<tr>
<td>$f_1 ()$</td>
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<td>$p_1 &lt; 0.01$</td>
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<tr>
<td>$f_2 ()$</td>
<td>11.26</td>
<td>$p_2 &lt; 0.01$</td>
</tr>
<tr>
<td>$f_4 ()$</td>
<td>17.99</td>
<td>$p_3 &lt; 0.01$</td>
</tr>
</tbody>
</table>

Adjust R-square 0.231  
GCV score 3040.7  
number of observations 5,373

Note:
(1) Dependent variable: monthly hours of work.
(2) Coefficients for state dummies are not reported.
Table 3: Test for difference in the median

<table>
<thead>
<tr>
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<th>median</th>
<th>std. error</th>
<th>diff</th>
<th>p-value</th>
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<td>baseline</td>
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<td>—</td>
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<tr>
<td>wage</td>
<td>122.41</td>
<td>0.59</td>
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<tr>
<td>income</td>
<td>119.04</td>
<td>0.75</td>
<td>-1.32</td>
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<tr>
<td>afdc</td>
<td>118.03</td>
<td>0.77</td>
<td>-2.32</td>
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<tr>
<td>food stamp</td>
<td>116.99</td>
<td>0.78</td>
<td>-3.37</td>
<td>0.01</td>
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<td>phase-in</td>
<td>124.85</td>
<td>0.77</td>
<td>4.50</td>
<td>0.00</td>
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<tr>
<td>phase-out</td>
<td>116.26</td>
<td>0.79</td>
<td>-4.09</td>
<td>0.00</td>
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<tr>
<td>in+out</td>
<td>121.26</td>
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<td>126.23</td>
<td>0.85</td>
<td>5.87</td>
<td>0.00</td>
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Note:
(1) The standard errors are adjusted for prediction errors.
(2) The third column reports the difference between the median of predicted hours and that of the baseline case.
(3) The last column reports the p-value for the t-test that the difference in median is zero.
<table>
<thead>
<tr>
<th>Elasticity</th>
<th>wage</th>
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<th>food stamp</th>
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<th>phase-out</th>
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<tbody>
<tr>
<td>△/10%</td>
<td>0.107</td>
<td>-0.056</td>
<td>-0.074</td>
<td>-0.126</td>
<td>0.192</td>
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<tr>
<td></td>
<td>(0.052)</td>
<td>(0.052)</td>
<td>(0.052)</td>
<td>(0.051)</td>
<td>(0.052)</td>
<td>(0.051)</td>
</tr>
<tr>
<td>△/15%</td>
<td>0.086</td>
<td>-0.057</td>
<td>-0.073</td>
<td>-0.127</td>
<td>0.190</td>
<td>-0.154</td>
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<tr>
<td></td>
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<tr>
<td>△/20%</td>
<td>0.067</td>
<td>-0.058</td>
<td>-0.072</td>
<td>-0.128</td>
<td>0.188</td>
<td>-0.155</td>
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<tr>
<td></td>
<td>(0.026)</td>
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<td>△/25%</td>
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<td>-0.157</td>
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<tr>
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Note:
(1) △: percentage change in average hours.
(2) The standard errors, which are adjusted for the predicted errors, are reported in parentheses.
Figure 1: EITC budget constraint
Figure 2: Estimated desired hours of work
Figure 3: Smoothed predicted changes of hours

Note: Dotted lines indicate the 95% confidence band. The standard errors are generally larger at the end of the distribution because of the relatively small number of observations there.
Figure 4: Predicted changes in family income (from 20% increase in the EITC phase-in and phase-out rate) as a smoothed function of initial earnings