Working Paper Series
Congressional Budget Office
Washington, D.C.

Discrete Choice Models for Estimating Labor Supply

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Working Paper 2021-04

April 2021

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I am grateful for the guidance of Edward Harris and John McClelland on this project. I am also grateful to Robert Moffitt of Johns Hopkins University for reviewing and providing detailed comments on an earlier draft of this paper, and to Bruce Meyer of the University of Chicago for his useful comments on the methodology. The paper has also greatly benefited from the guidance of Wendy Edelberg (formerly of CBO) and Jeffrey Kling. Gloria Yiqun Chen and Justin Falk critiqued an earlier draft. Many colleagues currently or formerly at CBO offered insightful comments in seminars or in conversations, including William Carrington, Molly Dahl, Devrim Demirel, Mark Doms, Janet Holtzblatt, Shannon Mok, James Pearce, and Joseph Rosenberg. Nabeel Alsalam helped with programming, as did David Burk (formerly of CBO). Richard DiSalvo (formerly of CBO) provided excellent research assistance on the project, both with methodology and with programming. I also gratefully acknowledge editorial assistance provided by Scott Craver. (The assistance of external reviewers does not imply their responsibility for the paper's content.)

Abstract

This paper evaluates discrete choice models as tools for analyzing the effects of tax and transfer policies on labor supply. An advantage of discrete choice models is that they distinguish changes in labor force participation from changes in the hours of work. Such models can also capture the heterogeneity in labor supply response among and within demographic subpopulations.

In this paper, two types of discrete choice models are estimated using cross-sectional data from the Current Population Survey: quadratic models and quasi-linear models. The models are then used to simulate the labor supply responses to hypothetical policy changes. The resulting labor supply responses are then compared with findings in the empirical literature. The paper particularly focuses on a hypothetical policy in which the earned income tax credit is contracted by about the same magnitude as it was expanded in the 1990s. We find a broad consistency between the labor supply responses in the simulations and in the empirical literature, which suggests that the omitted variable bias in estimating labor supply with cross-sectional data may not be as large as is sometimes suspected.

Keywords: labor supply, extensive margin, labor force participation, discrete choices, random utility, omitted variables bias, earned income tax credit

JEL Classification: C35, H31, J22

Contents

Introduction

Many types of models are used to estimate the effects of tax and transfer policies on labor supply, from reduced-form approaches to life-cycle models. This working paper evaluates discrete choice models (DCMs) as an additional method for estimating labor supply responses. DCMs were introduced in the economics literature by McFadden (1974) and subsequently applied to labor supply by Fraker and Moffitt (1988) and van Soest (1995), among other researchers.

In DCMs, labor supply is estimated by relating the variation in hours worked to the variation in the net wage rate (NWR) in cross-sectional data. DCMs are structural models that estimate a utility function and consider the individuals' entire budget set. Those characteristics of DCMs make them well suited to modeling labor supply responses in the following circumstances:

- **Large Changes to the Tax and Transfer System.** Because the entire range of choices faced by an individual is evaluated in a DCM, such models are well-suited to assess large changes in the tax and transfer system that could cause people to make substantial changes in their hours of work, including entering and exiting the labor force. The discrete choice approach also circumvents the many difficult modeling issues in estimating an NWR when the budget constraint is characterized by kinks and cliffs because of tax provisions or the means-testing of transfer programs. In principle, the concept of virtual incomes can be used to construct a complex budget set that is continuous over hours of work (Blundell and Macurdy, 1999; Moffitt, 1986). However, DCMs are easier to understand and implement.

- **Novel Changes in Policy.** Structural models such as DCMs can flexibly estimate the consequences of novel changes to the tax and transfer system. That is a key advantage when there is no prior empirical evidence relevant to policy changes. DCMs can be estimated using the observed labor supply of individuals within the same population that is likely to be affected by the policy changes.

- **Modeling Labor Force Participation.** DCMs explicitly model the participation response by evaluating the choice of working zero hours and by including in the model the fixed costs of working. Explicitly modeling the participation response is especially important for policies that affect low-skilled workers because participation response is a potentially important channel through which tax and transfer policies could affect low-skill labor supply.

- **Heterogeneous Responses.** Because DCMs can be used to capture heterogeneous responses, both among and within demographic subpopulations, they are well suited to situations in which those differential responses are of interest. DCMs can also be used to integrate labor supply responses into a micro-simulation model, which can then be used to simulate policies' aggregate and heterogeneous effects repeatedly and easily.

DCMs also have some disadvantages. In particular, the estimates of the relationship between wage levels and labor supply derived from cross-sectional data may be biased. In cross-sectional data, people who earn higher wages tend to work more. In DCMs, that positive correlation is attributed to the causal effect of higher wages on labor supply. In reality, both higher wages and increased hours of work could be driven by another factor, such as a low taste for leisure.[1] In such a situation, there is an omitted variable bias, and DCMs would overestimate the effect of taxes on labor supply. However, the simulation results presented here are consistent with empirical evidence in the literature obtained by other methods. That convergence suggests that the omitted variable bias in the DCMs is likely to be small, which may be considered a key contribution of this paper.

Another disadvantage of DCMs as implemented in this paper is that all incomes are treated the same regardless of their source. Yet people could respond differently to changes in net income depending on whether those changes are driven by changes in market income, taxes, or transfers. People may be less responsive to changes in income from programs such as the earned income tax credit (EITC) if they view those changes as temporary relative to changes in market income, or if there are transaction costs or a stigma associated with receiving the benefits of the EITC. People may also respond differently to in-kind income, such as Medicaid or benefits from the Supplemental Nutrition Assistance Program (SNAP), than they would to the equivalent cash income. However, because taxes and transfers are highly correlated with market income, it is difficult to identify their separate effects in the static framework used in this analysis. It is therefore important to consider the source of changes in income when using the DCMs estimated here to evaluate labor supply response.

In the remainder of this paper, we summarize the theory underlying DCMs and describe the specific models estimated in this analysis—those with quasi-linear utility and those with quadratic utility. We then describe the Current Population Survey (CPS) data used to estimate the DCMs, and we characterize the estimated models. Next, the simulation results are described, and the responsiveness of labor supply in the estimated models is tested by tracing the impact of changes in return-to-work (RTW), the NWR, and nonlabor income. We present the results from simulations of several hypothetical policy experiments, including a rollback of the EITC to the level that prevailed before that credit expanded in the 1990s. We conclude that the simulation results from the DCMs are broadly consistent with the findings in the empirical literature and are not likely biased from omitted variables. Accordingly, such models may prove useful in analyzing the effects of policy on labor supply.

[1] One reason people earn higher wages is that they attained a higher level of education, which is less costly for those with a lower preference for leisure.

Discrete Choice Random Utility Models

Two key features of DCMs are that people choose from a limited number of discrete choices, and the utility from an alternative is in part ascribable to unobserved attributes of that alternative. Both features are explained below in further detail.

Discrete Choices

In DCMs, it is assumed that people choose from a limited number of distinct alternatives, for example, working zero, 10, 20, … or 60 hours per week. By limiting the alternatives to a small set, peoples' optimal choices can be modeled even when they face a nonlinear budget set, as is often the case because of kinks and cliffs introduced by progressive tax rates and means-tested transfers.

Systematic and Random Utilities

The utility that people derive from an alternative has two components: a systematic (or observed) component and an unobserved component that is treated as randomly distributed. Formally, the utility that individual i derives from alternative j is modeled as follows:

$$\mathrm{U}_{ij} = V_{ij} + v_{ij}$$

The systematic component of the utility, V_{ij} , is based on the observable attributes of the alternative. For example, two observable attributes of jobs that are important to people are net income and leisure. In a DCM, those two attributes are combined to yield systematic utility associated with any alternative. Formally, $V_{ij} \equiv V(L_{ij}, Y_{ij})$, where leisure is L_{ij} and income is Y_{ij}. Different functional forms may be chosen to model systematic utility as a function of leisure and income. Two such forms—quadratic and quasi-linear—are described in detail below.

DCMs reflect the fact that when choosing between jobs, people consider not only the labor-leisure trade-off but also several other attributes, such as the nature of the work, commuting distance, and the flexibility of hours. Each alternative yields additional utility to the individual because of those other attributes. Many of those attributes are unobservable by the researcher, and the additional utility is therefore referred to as the unobserved utility. Even if some of the attributes, such as commuting distance, could be observed in principle, individuals are not constrained to value such attributes identically. Instead, it is assumed that the utility associated with such attributes, v_{ij}, is a random draw from a distribution.

When comparing two alternatives, the individual would choose alternative 1 if $V_1 + v_1 > V_2 + v_2$ or, equivalently, if $v_1 - v_2 > V_2 - V_1$ (the subscript *i,* standing for the individual, is suppressed for convenience). In other words, alternative 1 is chosen when its unobserved utility exceeds the unobserved utility of alternative 2 by a measure that is sufficient to overcome the systematic utility advantage of alternative 2 over alternative 1, if any. When v_1 and v_2 are *independently and identically* drawn from a Gumbel distribution, then the difference $v_1 - v_2$ has a logistic distribution, and we obtain a logit choice model.[2] McFadden (1974) showed that the probability of choosing alternative 1 over alternative 2 is the cumulative logistic distribution evaluated at $V_1 - V_2$, as follows:

$$P(choice = 1) = \frac{e^{V_1 - V_2}}{1 + e^{V_1 - V_2}}$$

Applied to the DCM of labor supply, the probability that the individual *i* chooses to work h_j hours is given by the following:

$$P_{ij} = \frac{\exp(V(h_j, Y_{i,h_j}))}{\sum_{h_k \epsilon H} \exp(V(h_k, Y_{i,h_k}))}$$

wherein $H = \{h_1, h_2 \ldots . h_n\}$ is the set of all available work alternatives, and Y_{i,h_j} is the income of the individual *i* when working h_j hours.

In logit models, the relative odds of two choices are given by the following:

$$\frac{P_{ij}}{P_{ik}} = \exp\left[V\left(h_j, Y_{i,h_j}\right) - V\left(h_k, Y_{i,h_k}\right)\right]$$

Those odds depend only on the systematic utility of the two alternatives. For example, consider a choice set in which possible work hours are zero, 20, 40, and 60 hours per week. If the alternative of working 20 hours per week is removed from the choice set, then people currently working 20 hours per week would move to other choices. The logit model implies that in the new choice set, the relative odds of any two choices—say, 40 hours per week and 60 hours per week—would remain the same as before. This property is known as independence from irrelevant alternatives and is often characterized as a drawback of the logit model. However, as Train (2003, page 35) argues, independence from irrelevant alternatives is a natural outcome of well-specified models.

For *M* individuals indexed by i, where individual *i* is observed to work h_i^* hours per week, the joint likelihood of the individuals in the sample making the observed choices is as follows:

$$L = \prod_{i=1}^{M} \frac{\exp(V(h_i^*, Y_{i,h_i^*}))}{\sum_{h_k \epsilon H} \exp(V(h_k, Y_{i,h_k}))}$$

The parameters of the systematic utility function, $V(\,)$, are estimated to maximize the above likelihood. In addition, the random utilities for an individual may be chosen such that their current choice of work hours is indeed the optimal choice. Finally, the estimated model can be

[2] The cumulative distribution function of a standardized Gumbel distribution, also known as Type I extreme value distribution, is given by $F(v_{ij}) = e^{-e^{-v_{ij}}}$. It has a mean of 0.5772 and variance of π^2/6. The logistic distribution is nearly the same as the normal distribution but has slightly fatter tails.

used to evaluate the impact of policy changes on labor supply by tracing how each individual responds to the new trade-off between income and leisure.

Models to Be Estimated

This paper estimates two alternative specifications for systematic utility: quasi-linear and quadratic. The key difference between the two specifications is that the quasi-linear utility is characterized by a constant marginal utility of income, whereas in a quadratic specification, the marginal utility of income tends to decline with an increase in income. One implication of that difference is that the labor supply response to a given change in the NWR would generally be larger if the preferences are closer to the quasi-linear specification. For instance, consider an increase in the NWR that leads to a positive income effect for workers. If preferences follow a quadratic specification, that income effect would tend to blunt individuals' incentive to increase their hours of work. Conversely, the closer the preferences are to the quasi-linear specification, the smaller is this income effect and the greater is the incentive to increase hours of work. A similar reasoning applies when there is a decrease in the NWR.

Both specifications incorporate fixed costs of working, which helps explain the empirical finding that most people either do not join the labor force or work substantially (Cogan, 1981). Such fixed costs are the costs that a person must incur to take up work. Consider, for example, that most jobs are in metropolitan areas where the cost of living is high. Workers spend money and time commuting to work, and those with young children must pay for their daycare. Those costs are fixed to the degree that they do not vary with the number of hours a person works. In addition to the monetary costs of working, there may also be nonmonetary costs, such as the loss of leisure in commuting and constraints on one's lifestyle.

DCMs of labor supply typically do not attempt to measure directly those fixed costs of working. Rather, unobserved costs are incorporated in the models by including an indicator for working status (regardless of the number of hours) in the systematic utility function. The coefficient of that indicator is an estimate of the loss of utility from starting to work, taking into account both monetary and nonmonetary costs of working as well as any unobserved preference for working, as opposed to staying out of the labor force. As a result of those fixed costs, there is a discontinuous change in utility between zero hours of work and the least number of hours that a person may work.

Economic theory suggests that in the presence of substantial fixed costs it is worthwhile to work only when the utility surplus from working—the value of income minus the value of foregone leisure—exceeds the fixed cost of working. In such a situation, each person's labor supply is characterized by a reservation number of hours: A person would either work at least that number of hours or not work at all. Previous research also suggests that there could be significant differences among men and women, as well as among married and single persons, with regard to their attachment to the labor market. Accordingly, we estimate each model separately for three subpopulations: married couples, single men, and single women.

Quasi-Linear Utility. In a quasi-linear specification, the utility is linear in income but nonlinear in hours worked. For a person with such a utility function, the marginal utility of income is constant, whereas the marginal disutility of work increases with each additional hour of work. The quasi-linear specification is particularly popular in the literature on optimal taxation because it makes it possible to ignore income effects in the welfare analysis of tax policies.[3] However, that utility function may not be appropriate when income effects are expected to be large.

Single Men and Single Women. The quasi-linear utility function used for single adults in this analysis is as follows:

$$V_h = \alpha Y + \beta H^6 + \left(f_0 + f_k * \text{Children}_{\text{age}<5}\right) I_{H>0}$$

In the above equation, Y [≡ Y(H)] is the net income associated with working H hours per week. The term for hours of work, H, has 6 as its exponent because that value nearly maximizes the model fit and because it yields a labor supply function with constant elasticity of 0.2 with respect to the NWR in the absence of random utility. That elasticity is close to the median estimate of labor supply elasticity in the empirical literature (see McClelland and Mok, 2012). The term $I_{H>0}$ is an indicator variable that is 1 if the individual is working and is zero if otherwise. We interpret the coefficient of that indicator variable as the fixed cost of working. The coefficient reflects both the monetary costs of working and the unobserved preferences for work. For instance, both men and women may face the same monetary costs of working. However, when the models are estimated separately for men and women, estimated fixed costs would typically be lower for men if a greater fraction among them are employed than the fraction employed among women. The coefficient $\left(f_0 + f_k * \text{Children}_{\text{age}<5}\right)$ is allowed to vary with the number of children in the household below the age of 5 because free public schooling typically starts at that age, which lessens the need for paid childcare for such children.

Married Tax Filers. The quasi-linear utility function used for married couples in this analysis is as follows:

$$V_{h,w} = \alpha Y + \begin{pmatrix} \beta_h H^6 + \beta_w W^4 \\ + \beta_{hw} H * W \end{pmatrix} + \begin{pmatrix} f_{0h} + \\ f_{kh} Children_{age<5} \end{pmatrix} I_{H>0} + \begin{pmatrix} f_{0w} + \\ f_{0w} Children_{age<5} \end{pmatrix} I_{W>0}$$

In the above equation, H denotes the husband's hours of work and W denotes the wife's hours of work. A lower exponent is used for the wife's hours of work than for the husband's, which is expected to result in a larger elasticity of labor supply for married women than for married men. For both men and women, the fixed cost of working also depends on the number of children below age 5. Income Y [$\equiv Y(H, W)$] depends on hours of work by each spouse.

Quadratic Utility. The quadratic utility function is commonly used in the DCMs of labor supply. Generally, a quadratic function is expected to approximate an arbitrary function to the

[3] For example, see Diamond (1998) and Saez (2001). Quasi-linear specification has also been used by Chetty (2012) to reconcile micro and macro elasticities of labor supply.

first order of approximation. In the case of the quadratic specification, the marginal disutility of hours worked increases with more work (at least eventually), and the marginal utility of income tends to decline with an increase in income. That specification may better fit the data because it has more degrees of freedom.

Single Men and Single Women. The quadratic utility function used for single adults in this analysis is as follows:

$$V_h = \alpha_1 Y + \beta_1 H + \alpha_{11} Y^2 + \beta_{11} H^2 + (f_0 + f_k * Children_{age<5}) I_{H>0}$$

Married Tax Filers. The quadratic utility function used for married couples in this analysis is as follows:

$$V_{h,w} = \begin{pmatrix} \alpha_1 Y + \alpha_{11} Y^2 + \beta_{1h} H + \beta_{11h} H^2 \\ +\beta_{1w} W + \beta_{11w} W^2 + \beta_{hw} HW \end{pmatrix} + \begin{pmatrix} f_{0h} + \\ f_{kh} Childen_{age<5} \end{pmatrix} I_{H>0} + \begin{pmatrix} f_{0w} + \\ f_{kw} Children_{age<5} \end{pmatrix} I_{W>0}$$

Allowing Labor-Leisure Preferences to Vary With Demographic Characteristics. The quasi-linear and quadratic utility functions outlined above are estimated separately for three demographic groups: single men, single women, and married couples. Also, fixed costs are allowed to vary with the number of children below age 5. That strategy allows us to account for heterogeneity in relative preferences for labor and income in broad subpopulations. However, it is possible that the relative labor-income preferences vary with other characteristics of the individuals, such as age or the presence of young children in the family.

Therefore, for both quasi-linear and quadratic specifications, an additional variant of the basic model is estimated—one in which the coefficients in the systematic utility function are allowed to vary by individual characteristics. After experimenting with a number of such characteristics, a set was chosen that seemed to maximize the fit of the model to the data. In the case of single adults and the quasi-linear specification, the following model is estimated:

$$V_h = \begin{pmatrix} \alpha_0 + \\ \alpha_c Children_{age<18} \end{pmatrix} * Y + \begin{pmatrix} \beta_0 + \\ \beta_c I_{age<18} \end{pmatrix} H^6 + \begin{pmatrix} f_0 + f_k * Children_{age<5} \\ +f_a Age + f_{a2} Age^2 \end{pmatrix} I_{H>0}$$

In the above equation, the coefficient on income depends on the number of minor children, and the coefficient on hours depends on the presence of children under age 18. Fixed costs are expected to vary with the age of the taxpayer and the number of children younger than age 5.

The variation in coefficients on income and hours is modeled similarly in other cases—quadratic (married and single individuals) and quasi-linear (married individuals).[4] Generally, there seems

[4] In the case of married couples, the coefficient on a husband's hours of work also depends on whether the wife worked or not, and the coefficient on the wife's hours of work varies with her age. In the case of the quadratic utility function, an additional interaction is that the household's preference for the wife's leisure also depends on the husband's working status.

to be no significant advantage in using these more complex specifications instead of the simpler versions, which seem to perform just as well and are easier to interpret.

Description of the Data

The models outlined above are estimated using data from the March 2016 Annual Social and Economic Supplement sample of the CPS—the most recent data available when work on this paper began. In that sample, respondents generally recall their hours of work and incomes for the previous calendar year. The sample is restricted to adults ages 19 to 64 residing in households in which the head of household is neither retired nor in school nor disabled. Also excluded are people who reported working more than 65 hours per week, on average, because such excessive hours of work are possibly attributable to reporting errors. With those restrictions, the sample includes about 80,000 people representing a population of about 140 million.

For those individuals, information is available regarding their age, gender, marital status, the number and ages of their children, educational attainment, and nonlabor income. For those who work, information is also available regarding wages earned in 2015, the number of weeks worked in 2015, and the usual number of hours worked in those weeks. The hourly wage rate is then calculated by dividing wage income by the estimated number of hours worked during the year (the usual hours per week multiplied by the number of weeks worked). For nonworkers, hours of work are zero, and wage rates are imputed using age, level of education, marital status, and the number of children as explanatory variables in separate regressions for men and women.

It is likely that the potential wage rate of nonworkers is less than the wage rate of workers, even after controlling for age, level of education, and other observable characteristics. That difference is attributable to endogenous self-selection into the labor force by people with relatively high labor market productivity. A simple OLS regression of wages on individual characteristics cannot adjust for that self-selection bias.

It is common in labor economics to address the self-selection bias by using a Heckman correction (Heckman, 1979). That correction is implemented by using as selection variables the presence of children (in various age groups) and the receipt of nonlabor income. The selection variables are appropriate because the presence of children and the receipt of nonlabor income affect peoples' participation in the labor force but are not predictive of their wage rate given other explanatory variables already included in the equation for the wage rate.[5] The two-stage Heckman model uses those selection variables to predict labor force participation in a first-stage equation. In the second stage, gross wage rates are predicted using the explanatory variables described above, as well as the predicted probability of participation from the first-stage

[5] That assumption may not be completely accurate. Mothers of young children are likely to face lower wages because they have less flexibility in location choices, timing of work, or because of employers' biases. For those reasons, their true wage might be less than what is suggested by the first-stage regression. The estimated equation would then tend to overestimate the value of leisure in the utility function and underestimate the labor supply response to a given change in the wage rate. See Juhn and McCue (2017) for further discussion.

equation. The inverse Mills ratio for both men's and women's regressions is statistically significant, thus confirming selection bias.[6]

Gross income for each choice of work hours is calculated as the sum of wage income (the wage rate multiplied by the number of hours of work) and nonlabor income. To calculate net income, estimated taxes are subtracted from gross income, and transfer benefits are added. Return-to-work (RTW) is calculated as the difference in net income when not working and when working the observed number of hours. Taxes for each possible choice are calculated using the National Bureau of Economic Research's TAXSIM calculator (Feenberg and Coutts, 1993) and include payroll taxes as well as federal and state income taxes. Table 1 presents the labor supply, NWRs, and RTWs in the sample.

Transfers and benefits from three major government programs are estimated in a stylized manner using program rules in place in 2015. The take-up rate is assumed to be 100 percent, and no attempt is made to match the count of recipients or aggregate receipts with the administrative totals. Those simplifications are acceptable because the objective of the calculations is only to ensure that in estimating the DCMs, income gains from working are not greatly overstated by ignoring the potential loss of program benefits. The three programs are:

- **Supplemental Nutrition Assistance Program.** SNAP payments are calculated using the program rules that were in place in 2015. Although the calculations are stylized, they take into account the variation in standard deductions and shelter deductions that apply to households in Alaska and Hawaii.

- **Medicaid.** The value of Medicaid to a tax unit depends on the number of people in the unit and their ages. We assign the benchmark value of $3,000 to the head of the tax unit if his or her age is between 19 and 24. For older tax filers, that benchmark value is adjusted by a multiplicative factor to account for the increase in health care costs with age. That factor ranges from 1 (for people ages 20 to 24) to 5 (for people age 64). The value of Medicaid to spouses in the tax units comprising married couples is calculated similarly. For dependent children, we assume a value of $2,000 for each child below age 18 and $2,400 for each dependent child age 18 or above.[7] Medicaid eligibility is determined using state-specific criteria (the largest variation in eligibility criteria is between the states that chose to expand

[6] Selection bias is larger for men. For men, the inverse Mills ratio is 1.65 with a standard error of 0.42. For women, the inverse Mills ratio is 0.27 with a standard error of 0.07.

[7] The benchmark Medicaid benefits were based on per capita adjusted expenditures on Medicaid and the Children's Health Insurance Program (CHIP) in 2015, as previously estimated by CBO–see Appendix C in Habib (2018). According to the tables in that appendix, adjusted aggregate benefits for Medicaid/CHIP in 2015 were $142.1 billion and $126.9 billion for adults and children, respectively. The estimated counts of adults and children benefiting from Medicaid/CHIP were 37.8 million and 47.8 million, respectively. Therefore, the average benefit was about $3,759 and $2,655 for adults and children, respectively. Compared with those average benefits, the value of Medicaid in the present analysis is assumed to be lower for younger individuals and higher for older individuals.

eligibility for Medicaid following the enactment of the Affordable Care Act and those that did not).

- **Subsidies for Insurance Purchased on Health Insurance Exchanges.** The value of the health exchange subsidy is equal to the difference between the premium for a reference health insurance plan and the required household contributions for the insurance purchased on exchanges. The required household contribution increases with income. The reference premium is set to equal the value of Medicaid as described above. That modeling simplification allows a smooth transition in the budget constraint as people move from Medicaid to eligibility for the health exchange subsidy.

Estimated Models

The DCMs described above are estimated using data from the March 2016 Annual Social and Economic Supplement sample of the CPS. Table 2 presents measures of model fit, as well as estimates of fixed costs and of the marginal rate of substitution (MRS) between hours of work and income.[8] Generally, whereas the quadratic specification results in a better model fit as measured by McFadden's R-squared, quasi-linear specifications yield more plausible estimates of fixed costs and the MRS. Allowing the coefficients on income and hours worked to vary with demographic characteristics does not greatly improve the model fit.

Model Fit and Implied Distribution of Hours

For a multinomial choice model, one way to measure the fit of the model to the data is to compare the log-likelihood of the null model (which assumes that all the choices are equally likely) with the log-likelihood of the estimated model. That measure is known as McFadden's R-squared, defined as the percentage increase in the log-likelihood when the estimated model is substituted for the null model. McFadden's R-squared ranges from 0.09 to 0.22 in the estimated models, as shown in Table 2. The quadratic specification fits the data better than the quasi-linear specification by that measure, which is not surprising because the quadratic model has more degrees of freedom than the quasi-linear model. Using the heterogeneous versions of the basic models improves the model fit only slightly.

Once the parameters of the systematic utility function are estimated, the probability that any person would work a given number of hours is easily calculated. Those probabilities can be used to obtain the expected distribution of hours of work in the sample. Unsurprisingly, the predicted distribution of hours does not perfectly match the actual distribution except at zero hours.[9] Figure 1 illustrates the error in the prediction of the distribution of hours in the sample. It is seen that although the models can capture the broad contours of the distribution of work hours, every

[8] The MRS is defined as the change in net income that is needed to induce a worker to take up one additional hour of work per week.

[9] The fixed cost parameter in the utility function works as a "dummy" variable to indicate working status. Consequently, the predicted fraction of nonworkers completely matches the fraction of nonworkers in the sample.

specification underpredicts the fraction of working 40 hours per week and overpredicts the fractions at 30 hours and 50 hours of work. The quadratic specifications perform better than the quasi-linear specifications except at predicting 30 hours or 50 hours.

Estimates of Fixed Costs

Table 2 also presents estimates of fixed costs with various specifications. With the quadratic specifications, estimated fixed costs seem to be too high.[10] For instance, in the specification without heterogeneity, the fixed cost for single women is $2,015 per week, which is more than four times the average wage earned in that group. In contrast, the quasi-linear specifications give estimates of fixed costs that are quite reasonable. In those specifications, fixed costs are estimated to be in the range of $200 to $250 per week for single men and single women. Estimated fixed costs are similar for single men and single women when there are no children. The presence of children generally raises fixed costs substantially for mothers but not for fathers. That finding reflects the empirical pattern that single fathers do not have a lower propensity to be employed than single men without children.

Among married individuals, fixed costs are estimated to be low for men. With the quasi-linear specifications, fixed costs for married men are even negative, which reflects very high labor force participation rates in that subgroup.[11] In contrast, fixed costs are estimated to be quite high for married women, and they increase by about 20 percent to 30 percent if the women have children younger than school-age.

Table 2 also presents the mean MRS between hours of work and income in the systematic utility function for various specifications and demographic groups. The MRS is defined as the change in net income that is needed to induce a worker to take up one additional hour of work per week. If the net income of a worker changes by the reported MRS in the table, and if the worker also works an additional hour, his or her systematic utility index would be the same as before. Most people in the sample work 40 hours per week. Therefore, comparing the MRS at 40 hours with the NWR of the workers can give some indication of whether the DCM fits the data well. As seen in Table 2, all the specifications return plausible estimates of the MRS at 40 hours of work except for the case of married men when using the quadratic specifications. Married men's usual hours of work exceed 40 hours per week (see Table 1), which is likely why the estimated MRS for married men is low at full-time employment.

[10] In the case of the quasi-linear specification, the dollar equivalent of fixed costs does not vary with the hours of work. For the quadratic specification, fixed costs are estimated at 40 hours of work and $1,000 per week in income.

[11] Recall that estimated fixed costs in the utility function depend on both monetary costs of working and unobserved preferences for working. Estimated fixed costs are typically positive when there are more individuals at zero hours of work than at 10 hours of work. However, only a very small fraction (about 3 percent) of married men do not work. Consequently, estimated fixed costs are negative for married men, reflecting their strong attachment to the labor force.

Calibrating Unobserved Utility to Match Labor Supply Choices in the Sample

Despite the prediction error described above, by appropriately calibrating unobserved utility, it is possible to match the predicted hours of work for most individuals to the hours of work observed for that individual in the sample. The procedure used for that purpose follows Creedy and Kalb (2005) and is described as follows:

- We draw a vector of unobserved utilities for each person (or married couple) with as many elements as there are choices of hours (7 choices for single filers and 49 choices for married filers). The vector can be thought of as representing each person or couple's idiosyncratic tastes for each alternative. Each element of the vector is drawn independently from the extreme value distribution and represents the unobserved utility from a work alternative.

- Then, taking into account the systematic utility of each person from various choices, we find the optimal work hours for the person (or married couple) with those tastes. If the choice of optimal hours matches the observed choice for the individual, we keep the vector of draws. Otherwise, we discard it. Unless the systematic utility is too low for the surveyed individual's chosen alternative, it should generally be possible to obtain a vector that need not be discarded. In some cases, when it does not prove feasible to draw a successful vector despite as many as 100 attempts, we assume that the person's taste for the observed choice is so large that he or she would not modify their labor supply regardless of the policy change.

- We obtain up to 10 such vectors for each person (or married couple) by repeating the process described above. In principle, keeping only one successful vector should suffice to simulate the effect of a policy change. However, given that each surveyed person represents many people, it is desirable to have multiple vectors such that there is heterogeneity in the responses to the policy change, and it may be possible to identify small effects.

Simulating Labor Supply Responses With Estimated Models

Once the parameters of the systematic utility function are estimated and random utilities are calibrated, DCMs may be used to simulate the labor supply response to any policy that alters net income from work. This section reports results from simulations of several such hypothetical changes in taxes, transfers, and benefits policy, particularly focusing on a hypothetical rollback of the expansion of the EITC that occurred between 1993 and 1996. The effects of that expansion on labor supply have been much studied in the empirical literature. By comparing the simulation results with the historical experience, we can assess the extent of any upward bias in estimated labor supply response in DCMs attributable to omitted variables.

This section also simulates uniform changes in RTW, the NWR, and nonlabor income. Other hypothetical experiments are considered here, namely various other changes in the EITC, changes in Medicaid benefits, and changes in SNAP benefits. It should be emphasized that all those other experiments are carried out in a stylized fashion. The evaluation of any actual proposal to change the programs mentioned above would involve consideration of several details that are ignored in these hypothetical exercises.

Uniform Changes in Return-to-Work, the Net Wage Rate, and Nonlabor Income

The policy experiments mentioned above lead to nonuniform impacts among the affected individuals—average and marginal taxes increase for some people and decrease for the others. Also, the changes introduce new cliffs in the budget sets or move existing cliffs. To understand the simulation results, it is helpful to know the labor supply response that the DCMs predict for a given change in RTW, in the NWR, or in nonlabor income. Therefore, we begin by considering uniform changes in RTW, in the NWR, and in nonlabor income. The estimated elasticities of labor supply in the DCMs are compared with the estimates in the empirical literature.

Uniform Changes in Return-to-Work. In DCMs, a person's decision to enter the labor force is mostly influenced by the RTW for that person. The RTW at a given hours of work is the difference between net income after transfers and taxes at those hours, Y_h, and income at zero hours, Y_0 (net income at zero hours consists of nonlabor income, private transfers, and net transfers and benefits from public programs). Formally, RTW for single individuals is given by the following:

$$RTW_h = Y_h - Y_0$$

RTW for married individuals is calculated analogously, holding the labor supply of the spouse constant at his or her observed hours of work. Figure 2A shows the responsiveness of the labor force participation rate (LFPR) to uniform changes in RTW in various DCMs. The solid lines show the models without heterogeneity in coefficients, and the dotted lines show the models with heterogeneity. For instance, the figure shows that when RTW for each possible work choice is increased by 10 percent, the resulting elasticity of the LFPR is about 0.12 in the quasi-linear model and 0.09 in the quadratic model. When coefficients are allowed to vary, the elasticity of the LFPR is somewhat lower than in the main models. Thus, the quadratic models predict lower responsiveness on the extensive margin.

The elasticity of the LFPR is higher for decreases in RTW than it is for increases in RTW. As mentioned above, for a 10 percent increase in RTW, the elasticity is 0.13 in the quasi-linear model and 0.08 in the quadratic model. When RTW instead declines by the same magnitude, the elasticity is about 0.17 in the quasi-linear model and 0.10 in the quadratic model. Furthermore, the elasticity is not constant within the positive or negative range of changes considered in Figure 2A. In the quasi-linear model, elasticity increases from about 0.17 to 0.20 when the decrease in RTW ranges from 10 percent to 50 percent. Nonconstant elasticities are a feature of the DCMs because of the boundary condition. On the upper end, the LFPR cannot exceed 100 percent, and the closer it gets to that boundary, the less responsive it is to an increase in the incentives to work.

How do elasticities vary with gender, marital status, and wage rate? Table 3 provides those details, given a 10 percent change in RTW. With either of the two specifications, elasticities do not vary greatly when coefficients are allowed to vary with demographic characteristics. Therefore, the discussion below focusses on the basic specifications.

All the models predict a very low elasticity of the LFPR for *married men*, both for increases and decreases in RTW. That result is consistent with the empirical literature, which generally reports that the participation elasticity of married men is nearly zero (Heim, 2009). In contrast, participation elasticity among *married women* is higher than that among single men or women but only in the quasi-linear specification. In the quadratic specifications, participation elasticity for married women is comparable to that for single men and single women.

The wider variation in the participation elasticity for married women across the simulations is consistent with the greater dispersion of estimates in the empirical literature in that regard. For instance, in their review of the literature, McClelland and Mok (2012) suggested a range of zero to 0.1 as the participation elasticity for single men and single women, but the suggested range for married women was much wider, at zero to 0.3, in part because of Blau and Kahn (2007), which estimated the participation elasticity for married women to lie in the range of 0.27 to 0.29. Higher elasticity among married women—as expressed in the quasi-linear specification in the simulations—would be consistent with the traditional view that married women's labor supply is most elastic. However, the lower elasticity estimated by the quadratic specification is consistent with other studies that conclude that married women's labor supply elasticities have declined over time and may no longer be higher than that of single women (Kumar and Liang, 2016; Heim, 2007).

Participation elasticities implied by the simulations and as presented in Table 3 are generally similar in magnitude for single men and single women.[12] Although elasticities are greater in the quasi-linear specifications, both the specifications yield elasticities that are generally consistent with the empirical literature. In the case of *single men*, the quasi-linear estimate is 0.12 for an increase in RTW and 0.16 for a decrease in RTW (the corresponding estimates in the quadratic specification are slightly smaller). Those estimates align well with Juhn and others (2002), who estimated the participation elasticity of working-age men as between 0.05 and 0.29 with a weighted average of 0.13.

For *single women*, the participation elasticity in the quasi-linear specification is 0.18 for an increase in RTW and 0.20 for a decrease in RTW. The quadratic specification results in smaller elasticities, more so for single women than for single men. How do these simulation results compare with findings in the empirical literature? Bishop, Heim, and Mihaly (2009) estimated a participation elasticity of 0.22 for single women ages 25 to 55 using CPS data from 2003.

[12] One exception is the case of the quasi-linear model, but only when RTW increases. That is probably because of a higher LFPR among single men than among single women in the base scenario, making it more difficult to increase participation further for single women.

Although that estimate is higher than such estimates in the simulations, those same researchers also found that the elasticity was higher still—at 0.28—in 1979. If the elasticities have continued their downward trend beyond 2003, it is possible that the elasticities estimated from later years of the survey data would be closer to the simulation results.

Table 3 also reports variation in the elasticity of the LFPR by the quintiles of the wage rate. For high-wage earners, the gains from working exceed their fixed costs by a wide margin; therefore, the elasticity of the LFPR for high-wage earners is expected to be quite small. That expectation is borne out by Table 3. The participation elasticity ranges from 0.01 to 0.03 in the top quintile (Quintile 5) when RTW increases and from 0.06 to 0.08 when RTW decreases.

Although the participation elasticities reported in Table 3 are substantially higher in the lower quintiles of wage rates as compared with the top quintile, they are still not as high as some of the findings in the empirical literature regarding low-wage earners. That may be because much of the empirical literature has used variation in the EITC to identify participation elasticity in lower-income mothers—a group whose initial LFPR was particularly low prior to the expansion of the EITC. The importance of the initial LFPR is underlined in Table 3 in the asymmetry of response between increases and decreases in RTW. For decreases in RTW, estimates are comparable across the first four quintiles of the wage rate, but for increases in RTW, the elasticity estimates are higher at the lower end of the wage distribution.

In summary, comparing the simulated elasticities with the estimates in the empirical literature is not a straightforward exercise because of the differences in populations being studied and because there is no consensus in the literature about the magnitude of the participation elasticity. Nevertheless, it appears that, on the whole, participation elasticities implied by the simulations are plausible in their magnitude. In particular, we do not observe in the DCMs any obvious bias toward overestimating the responsiveness of labor supply.

Uniform Changes in the Net Wage Rate. The NWR is the gross wage rate minus the individual's marginal tax on income earned by working another hour. A change in the NWR changes the attractiveness of leisure relative to working and can thereby induce some workers to change their preferred hours of work. When RTW was proportionately changed at all hours of work in the previous experiment, it also changed the NWR in the same proportion. Therefore, the behavior of workers who continued to be in the labor force before and after the change in wage rates captures the response of labor supply on the intensive margin.

Figure 2B shows how the elasticity of average hours worked changes when the NWR is varied from a 50 percent decrease to a 50 percent increase. The figure considers the average hours only among those who were in the labor force both before and after the change in the NWR. There is a substantial difference between the responsiveness of the labor supply in the quasi-linear and in the quadratic models with regard to the intensive margin. The elasticity of hours worked is only about one-third as large in the quadratic models as in the quasi-linear models. In the latter, the intensive margin response of labor supply is almost as large as the extensive margin response, whereas in the quadratic models it is less than half of the extensive margin response.

The last four columns of Table 3 show the variation in the intensive margin response of the labor supply by demographic groups and by the quintiles of the wage rate for a 10 percent change in the NWR. It is instructive to first look at the estimates in the quintiles. The quadratic specification implies that the hours-of-work elasticity is very low in all the quintiles, lying in the range from 0.01 to 0.05. The quasi-linear specification also yields similarly low elasticities in the first three quintiles but only when the NWR increases. The estimated elasticities are larger in the fourth quintile, and much larger in the fifth quintile, for increases in the NWR; and they are larger in all the quintiles for decreases in the NWR. The larger intensive margin response with the quasi-linear specification is likely attributable to the constant marginal utility of income and is a key difference between the two specifications.

Empirical estimates of the hours-of-work elasticity are particularly disparate. For instance, in their review of the literature, McClelland and Mok (2012) concluded that most estimates for the elasticity of average hours worked ranged between -0.1 and 0.2 for all men and single women, and between 0.1 and 0.3 for married women. The range for single women and men is broad enough that simulations in all the DCMs imply an elasticity that lies within that range except for married women in the case of quadratic specifications.

Uniform Changes in Nonlabor Income. In additional simulations, income at each choice of work hours is changed by a percentage of total after-tax income (both labor and nonlabor) at workers' *current* choice of work hours. Each simulation either increased or decreased income by an amount varying between 10 percent and 25 percent of a person's base income. In a given simulation, the change in income for any person is the same at each choice of work hours (including at zero hours), and therefore there is no change in RTW or in the NWR in this experiment. For that reason, the resulting changes in labor supply produce an estimate analogous to an income elasticity. In the case of quasi-linear specifications, there is no change in labor supply, because the marginal utility of money is constant in that specification. With the quadratic specification, the income elasticity is small with or without heterogeneity in coefficients of the utility function, as described below.

When nonlabor income is increased by 10 percent of base income, the elasticity of the LFPR with respect to income is about -0.04.[13] The elasticity of the LFPR is about half as much, at -0.02, for decreases in nonlabor income. The elasticity of average hours worked with respect to nonlabor income is also negative—about -0.03 for increases in income and -0.02 for decreases in income. For both participation and hours worked, those elasticities are in the range of estimates in the empirical literature. For instance, Bishop, Heim, and Mihaly (2009), as well as Heim

[13] The income elasticity of the LFPR is roughly constant in the range considered in these simulations. For instance, when the increase in income is 25 percent instead of 10 percent, the elasticity changes only marginally, from -0.040 to -0.043.

(2009), estimate income elasticities to be close to zero. In their review of the literature, McClelland and Mok (2012) concluded that -0.1 to zero was the plausible range of elasticity of hours worked with respect to changes in income without accompanying changes in the NWR.

Comparing the income elasticities of labor supply across demographic groups, we find that married women are somewhat more responsive to nonlabor income on the participation margin, and single men are more responsive on the intensive margin. On the whole, it would be fair to conclude that the DCMs imply an income elasticity of the LFPR and average hours worked that is consistent with the empirical research. We now turn to a study of hypothetical policy changes that lead to nonuniform changes in RTW and the NWR.

Expansion of the Earned Income Tax Credit Under the Omnibus Budget and Reconciliation Act of 1993

The EITC is structured such that only people with low earned income receive the credit. It provides a tax credit for every dollar of *earned* income until the total income of the household reaches a certain threshold. The credit does not change in a range of income above that threshold, referred to as the income plateau. If income exceeds a second threshold marking the end of the income plateau, each additional dollar of income reduces the credit at a phaseout rate until the credit reaches zero.[14] Figure 3 schematically represents how the EITC changes the income of wage earners. The box accompanying the figure describes how the changes in RTW and the NWR stemming from the EITC affect peoples' incentives on the extensive and intensive margins of labor supply.[15]

The EITC rate was 10 percent when the program began in 1975. Although the credit rate was raised intermittently in the following decades—most notably by the Tax Reform Act of 1986—the EITC was still relatively small in 1992. Adults without children were not eligible to receive any credit; the credit rate for parents of one child was 17.6 percent; and the credit rate for parents of multiple children was 18.4 percent. The program became significantly more generous—especially for parents with low earned income—with the passage of the Omnibus Budget and Reconciliation Act of 1993 (OBRA-93), which was phased in over three years. By 1996, the rate was almost doubled, to 34 percent, for parents of only one child, and it increased to 40 percent for parents of two or more children. A small EITC was made available to working adults without children at the rate of 7.65 percent. That differential expansion of the EITC among parents and

[14] Credit rates, income plateaus, and phaseout rates all differ according to marital status and number of children. Eligible individuals must be at least 25 years old and must be younger than 65 years old at the end of the tax year. Their investment income cannot exceed a certain threshold ($2,300 in 1996 and $3,500 in 2018). Several states have their own EITCs that are relatively modest and often tied to the federal credit.

[15] For a fuller description of the EITC's incentives and their effect on work, see Nichols and Rothstein (2015).

childless adults provided a quasi-experimental setting for researchers and spawned a significant body of literature studying the effects of the expansion on labor supply.[16]

In general, the empirical literature has found that the expansion of the EITC in the 1990s led to a substantial increase in labor force participation among single mothers. In contrast, the expansion discouraged labor force participation among married mothers, although the effect was small. (As explained in Figure 3, RTW of secondary earners in married households could decline with the expansion of the EITC because the credit is based on total family income).[17] There was little effect on labor force participation among women without children. The earlier literature found no effect on the intensive margin of hours worked. However, some recent studies have concluded that the EITC has had a small effect on that margin of labor supply.

Results of a Simulated Rollback of the Expansion of the Earned Income Tax Credit Under the Omnibus Budget and Reconciliation Act of 1993

In this section, we report the results of a simulation that rolls back the expansion of the EITC under OBRA-93.[18] In the simulation, the EITC rates are reduced from 45 percent to 18.4 percent for households with three or more children; from 40 percent to 18.4 percent for households with two children; from 34 percent to 17.6 percent for households with a single eligible child; and from 7.65 percent to no credit for adults without children. The results of the simulation are then compared with the estimates in the empirical literature studying the effects of the expansion of the EITC under OBRA-93. We should not necessarily expect the simulation results to match those estimates closely, because the DCMs used in the simulation are fitted to the labor supply preferences of people in 2015, which could be different from such preferences in the 1990s. Nevertheless, the comparison provides a good yardstick for evaluating whether the DCMs are useful in estimating the effects of policy changes on labor supply and whether the bias from omitted variables is large in such models. As we show below, the results of the simulated rollback of the EITC expansion substantially conform to the labor supply responses estimated in the empirical literature.

[16] Some of the papers that examined the impact on single mothers are Eissa, Kleven, and Kreiner (2008); Eissa and Liebman (1996); Ellwood (2000); Hoynes and Patel (2015); Keane and Moffitt (1998); Kleven (2019); Meyer and Rosenbaum (2001); and Rothstein (2005). Fewer papers have focused on married couples, but one such study is Eissa and Hoynes (2004). A comprehensive review of that research is provided by Hotz and Scholz (2003) and more recently by Nichols and Rothstein (2015).

[17] To illustrate how RTW of *married* individuals could rise with a less generous EITC, consider a household that would be eligible for the EITC when one of the spouses works but whose income would be too high to qualify for any EITC if both spouses worked. With a less generous EITC, RTW of the individuals in that tax unit would increase because of a decrease in income at zero hours of work.

[18] The experiment is implemented by estimating the EITC that each tax unit in the sample would be eligible for under the 1992 and 1996 tax rules. That is done by first using the consumer price index for urban consumers to deflate each tax unit's income and other relevant tax variables from their levels in 2015 to levels in 1994. The National Bureau of Economic Research's TAXSIM calculator is then used to estimate the amount of the EITC, both federal and state, due to the tax unit in 1992 and in 1996. The difference in the tax credits is the change attributable to OBRA-93, which is then inflated to 2015 dollars using the consumer price index. Corresponding to each choice of hours, the net income of the tax units in 2015 is then reduced by that difference.

Table 4 provides details of changes in RTW and the NWR in the simulation. The first panel, labeled "All Individuals", shows average changes in the entire population. The remaining panels in the table show the labor supply responses separately among single women, married women, single men, and married men. Within each panel, we separately identify changes in RTW and NWR depending on the number of children. Less-educated parents are especially likely to be affected by changes in the EITC, and their labor supply response to the expansion of the EITC has been extensively studied in the literature. Therefore, we separately identify changes in their RTW and NWR in each panel.

Table 4 shows that about 22 million people see their RTW decrease by 4.6 percent, on average, at a base RTW of $499 per week. Most of those people are single parents, who benefited the most from the expansion of EITC in the 1990s and are most adversely affected by the rollback. About 17 million people see their RTW increase by 6.2 percent, on average.[19] Most of those people are married and in households with incomes in the phaseout range of the EITC. The current EITC regime reduces their RTW because part of their income is offset by reductions in the EITC, and the rollback nullifies that decrease. The effect on the NWR among workers is generally positive, especially among single people.

Table 5, which is organized similarly to Table 4, presents the predicted labor supply response in the simulation. The first panel, labeled "All Individuals", shows that in the case of the quasi-linear specification, the labor force declines by approximately 1 percent (about 220,000 people) among those who saw their RTW decline. Partly offsetting that decline, the labor force increases by approximately 0.7 percent (about 127,000 people) among those experiencing an increase in their RTW. On balance, the labor force declines by about 90,000 people, which equals about 0.1 percent of the aggregate labor force. Compared with the quasi-linear model, the quadratic model predicts less of a change in the LFPR with the rollback of the EITC, which is consistent with the lower responsiveness of the LFPR to decreases in RTW in the quadratic model (see Panel B in Table 3).

Relative to the extensive margin response, the response on the intensive margin is smaller, more so in the quasi-linear specification. For the workers whose RTW declined, average work hours increased by about 0.2 percent (the NWR for such workers increased on balance). Workers whose RTW increased saw very little change in their NWR, and, consequently, their intensive margin response was nearly zero in both the quadratic and the quasi-linear models. Among people whose RTW decreased, the decline in the LFPR is consistent with an elasticity of 0.14 to 0.22, depending on the model. Among those whose RTW increased, the LFPR increases, but the implied elasticity is smaller, at about 0.08 to 0.12.[20]

[19] For nonworkers, the change in RTW is calculated at 40 hours of work. For workers, it is calculated at their current hours of work.

[20] As discussed previously, the asymmetry in response is a feature of the logit model because there is relatively little scope for increasing participation rates from their current levels, but there is ample scope for decreasing them.

How do those elasticities compare with the results from the experiment using uniform changes in RTW and the NWR? The average negative change in RTW with the rollback is about 4.6 percent. The resulting elasticities of the LFPR are 0.22 in the quasi-linear and 0.14 in the quadratic models. Those elasticities are somewhat higher than the elasticities suggested by the uniform changes experiment as shown in Figure 2A.[21] The differences are likely driven by compositional effects and highlight the advantage of the DCM approach over using aggregate elasticities when the policy change affects individuals heterogeneously.

The remaining panels in Table 5 show the labor supply responses among single women, married women, single men, and married men. Results within each panel are arranged according to the number of children because as that number increases, so does the change in RTW. Less-educated parents are especially likely to be affected by changes in the EITC, and their labor supply response to the EITC expansion has been extensively studied in the literature. We therefore separately identify the effect on their labor supply in each panel. We find that the labor supply of single women decreases the most in this experiment, and the labor supply of married men is virtually unchanged. The labor supply of single men also decreases, but the decline is much more modest than that of single women. Consistent with the literature, we find that *increasing* the RTW of married women increases their labor supply. In all the panels, there is no change in the labor supply of childless individuals because there is very little change in their RTW.

Figure 4 shows how the LFPR varies with the magnitude of change in RTW. In the figure, people are first divided according to whether they have a positive or negative change in RTW and are then grouped in quintiles based on that change. In each quintile, the LFPR responds in the expected direction. The response is larger for decreases in RTW than for increases in it.

Comparison of the Results of the Simulated Rollback of the Earned Income Tax Credit With Findings in the Empirical Literature

The key findings from the empirical literature on the expansion of the EITC under OBRA-93 are: (a) large and positive effects on labor force participation among single mothers (although some recent literature has tended to question that finding); (b) smaller and negative effects on participation among married mothers; (c) essentially no effect among men; and (d) little to no effect on the intensive margin of hours in all groups (see Nichols and Rothstein, 2015). The simulation results in the DCMs match those empirical findings qualitatively. However, in terms of magnitude, the simulations predict smaller changes in the LFPR as compared with the empirical literature. One possible explanation of the smaller changes predicted in the simulation is that women were more attached to the labor force in 2015 than they were in the 1990s. The

[21] Figure 2A suggests that the elasticity of the LFPR when RTW declines uniformly by 5 percent is about 0.17 in the quasi-linear model and 0.09 in the quadratic model. The average positive change in RTW with the rollback is about 6 percent, and the resulting elasticities of the LFPR are 0.12 and 0.08 in the quasi-linear and quadratic models, respectively. Comparing the results in Figure 2A, when RTW increases by 5 percent, we find that corresponding elasticities are 0.14 and 0.08. Thus, there is a closer match between the uniform change elasticities and the rollback elasticities for the people who would see an increase in RTW with the rollback, who, as mentioned earlier, are likely to be married couples.

simulation results also imply little to no change in the intensive margin of hours worked, which is consistent with the empirical literature. A brief review of the salient findings from the empirical literature on the EITC is provided below.

Empirical Literature. Several studies have estimated the effects of the expansion of the EITC in the 1990s, usually focusing on the labor supply of single mothers. Using a probit model to isolate the effects of the expansion from those of other tax changes and welfare reforms, Meyer and Rosenbaum (2001) estimated that the expansion increased single mothers' LFPR by about 3.1 percentage points between 1992 and 1996. Other research typically relying on difference-in-difference estimates, without controlling for contemporaneous confounding changes, has generally found larger effects on the LFPR. For example, Eissa, Kleven, and Kreiner (2008) estimated that the LPFR among single mothers increased by about 6 percentage points. Some of the more recent research, however, did not find consistent evidence of sizeable effects from expansions of the EITC. Kleven (2019), for example, argued that the large increase in the LFPR following the expansion of the EITC in the 1990s was attributable to the unique features of that decade, such as welfare reforms and a strong economy.[22] However, Schanzenbach and Strain (2020) disagreed with the methodology used in Kleven (2019) and concluded that, in general, a $1,000 increase in the size of the maximum EITC is associated with an increase of about 3 percentage points in the employment rate of single mothers without a high school diploma.

Single Mothers. In the empirical literature, an increase in the labor force participation of single mothers is the most salient result of the expansion of the EITC under OBRA-93. As seen in Table 5, the DCMs predict that rolling back the EITC would cause the LFPR of single mothers to decline by about 1.6 percent in the quasi-linear model and by 0.9 percent in the quadratic model. The base LFPR for that group is 83 percent. Therefore, the simulated decline in the LFPR among that group is 1.3 and 0.7 percentage points in the quasi-linear and quadratic models, respectively. Those results tend to agree with conclusions in the more recent literature, which finds that the difference-in-difference estimates likely overstate the effect of the EITC. However, the effect of the EITC is still sizeable: The implied elasticity of the LFPR with respect to RTW is about 0.47 and 0.26 in the quasi-linear and quadratic models, respectively.

The empirical literature has found that labor supply expanded more for single mothers with multiple children than for single mothers with one child.[23] And because workers with low wages

[22] Those welfare reforms, which culminated in 1996 with the Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA), generally reduced entitlement assistance to low-income individuals and replaced it with in-work assistance. The resulting decline in participation tax rates encouraged low-wage individuals to take up work. That decrease in the participation tax rates was greater for single mothers because means-tested transfers were tied to family size and because single mothers likely had lower potential wages. The strong economy of the 1990s might also have drawn more single mothers into the labor force relative to the number of childless single women (the LFPR of the latter was already quite high and thus had less scope to increase further).

[23] Eissa, Kleven, and Kreiner (2008) estimated that the LFPR of single mothers with one child increased by 5 percentage points and the LFPR of single mothers with two or more children increased by nearly 11 percentage points. The increase in the LFPR for single mothers as a whole averaged about 6 percentage points.

are more likely to be eligible for the EITC, the increase in the LFPR was especially large for single mothers without a high school education.[24] Table 5 shows that the simulation results follow the same pattern for the opposite experiment of a rollback of the expansion of the EITC: a decrease of 2.2 or 1.1 percentage points in the LFPR among single mothers of multiple children (a 2.8 percent or 1.4 percent change on the base LFPR of 80 percent) compared with a decrease of 1.3 or 0.7 percentage points, depending on the model, in the LFPR of single mothers as a whole. The LFPR among single mothers with multiple children and *without a high school diploma* decreased by 2.6 or 1.3 percentage points, depending on the model (a 4.1 percent or 2.0 percent change on the base LFPR of 65 percent).

Married Mothers. Table 4 shows that rolling back the expansion of the EITC under OBRA-93 would increase RTW of married mothers (most married couples receiving the EITC are in the phaseout range of the EITC). That increase in RTW is, in turn, expected to increase the LFPR among married women. Table 5 shows that that is indeed the case, although the change in labor force participation among married mothers could be slightly higher in comparison to the empirical literature. For example, Eissa and Hoynes (2004) estimated that the expansion of the EITC under OBRA-93 reduced the labor supply of married mothers with less than 12 years of schooling by about 0.6 percentage points, or about 1.2 percent.[25] By comparison, for the opposite experiment of a rollback of the expansion, DCMs estimate an increase in the LFPR of 3.8 percent or 4.0 percent (depending on the model) for married mothers with two or more children and without a high school diploma.[26]

The simulation results from the quasi-linear model indicate that although about 133,000 *single* mothers would leave the labor force if the expansion of the EITC under OBRA-93 was rolled back, that decrease would be partially offset by about 24,000 *married* mothers entering the labor market because of an increase in their RTW, given the rollback. The corresponding results from the quadratic model are a decrease of 72,000 single mothers and an increase of 14,000 married mothers in the labor force.

Single and Married Men. As shown in Table 5, the LFPR response of single fathers is only about one-third of that of single mothers in the quasi-linear model and about one-half in the quadratic specification. In comparison, the empirical literature has found no discernible effect of the expansion of the EITC under OBRA-93 on the labor supply of single men. That finding in the literature reflects the fact that it is difficult to statistically identify modest changes that affect

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[24] Using the Merged Outgoing Rotation Group sample of the CPS, Bhardwaj (2017) found that in the years following the expansion of the EITC under OBRA-93, the employment rate of all single mothers increased by about 4 percentage points (on a base LFPR of 66 percent), whereas that of single mothers without a high school diploma increased by 5 percentage points (on a smaller base LFPR of 56 percent).

[25] See Eissa and Hoynes (2004), pp. 1953 and 1955.

[26] The increase in the LFPR of married mothers with only one child who do not have a high school diploma is not shown in Table 5. That increase is likely to be smaller than 3.8 percent but still more than the 1.2 percent change estimated by Eissa and Hoynes (2004).

small populations. Thus, yet another strength of DCMs is that they can estimate the consequences of small tax changes affecting only small populations.

The response of married fathers is essentially zero in all the cases except for the most intensely treated subgroup (married fathers of two or more children and no high school diploma), in which it is also quite small. On the whole, the low labor supply response of men in the DCMs is consistent with the generally accepted view that the labor supply elasticity of men—especially married men—is quite low.

Simulations of Other Hypothetical Changes to the Earned Income Tax Credit

Table 6 presents several simulations of other hypothetical changes to the EITC. Panel A shows simulations in which the federal and state EITC, under current law, is either scaled up or down, while leaving the eligibility rules and various income thresholds unchanged. Those experiments help us understand whether the EITC's effects on labor supply vary linearly with the size of the credit. Panel B presents yet another experiment in which the current EITC program is replaced by one with more generous benefits for childless adults.

The results in Panel A suggest that the aggregate employment effects of the EITC are rather small. For instance, if the program were eliminated, the simulation results suggest that the labor force might decline by only 0.15 percent (in the quasi-linear model), and some of the decrease in labor supply on the extensive margin would be reversed by an increase in labor supply on the intensive margin. If that simulation result is correct, it implies that both federal and state EITCs are together adding no more than 300,000 workers to the labor force. That small effect of EITC on aggregate employment is likely because the EITC acts as a disincentive for the labor supply of secondary workers among married couples. Single parents are encouraged by the EITC to increase their labor force participation. However, married couples often have incomes in the phaseout range of the EITC, which, in such families, acts to reduce both RTW and the NWR of the secondary workers.

Of the two models, the quadratic model predicts a much smaller participation effect, but it predicts a stronger impact on work hours than does the quasi-linear model. In fact, in the case of the elimination of the EITC, the quadratic specification predicts that the increase in hours worked would more than compensate for the decrease in participation such that labor supply would actually increase.

In the final experiment involving the EITC (see Panel B of Table 6), the tax credit is made more generous initially and is expanded for childless adults. All workers receive a dollar-for-dollar credit on the first $3,000 of their earned income ($6,000 for married households) regardless of whether they have children. After that threshold, there is a long plateau, and the credit begins phasing out at $30,000 of income at a rate of 15 percent. Children only affect the credit in the case of heads-of-household filers with dependent children, for whom the phaseout begins at $80,000 instead of $30,000 (for single filers) or $60,000 (for married filers). This new credit replaces only the current federal EITC. The amounts of state EITCs are left unchanged in this simulation.

The quasi-linear DCM predicts that such an EITC program would expand labor supply by about 0.8 percent on the extensive margin, but it would contract labor supply even more on the intensive margin such that there would be a decrease in the aggregate labor supply measured as full-time equivalent employment. In the quadratic specification, the responses are smaller on both the margins and nearly cancel each other out.

Hypothetical Changes to Medicaid Benefits and Benefits From the Supplemental Nutrition Assistance Program

This section further illustrates the sensitivity of labor supply in the estimated DCMs by simulating hypothetical changes to Medicaid benefits and SNAP benefits. It must be emphasized that all these hypothetical experiments are conducted in a stylized manner and only give a sense of how the DCMs might behave if used to evaluate various policy proposals. We ignore many of the details that would be relevant in estimating the labor supply effect of any particular legislative proposal. Moreover, we do not attempt to match the case counts or implied program spending to administrative totals. Table 7 presents the summary results, which illustrate the sensitivity of labor supply to changes in means-tested programs to the first degree of approximation. The results also show that there is a significant asymmetry in labor supply response between increases or decreases in means-tested transfers.

The first two experiments in Table 7 consider changes to the Medicaid program. The income used for estimating the DCMs included the value of Medicaid as nonlabor income (as explained in the earlier section of this paper titled “Description of the Data”). In the first experiment, we assumed that the costs or benefits of the Medicaid program change to lower the value of Medicaid to recipients by $1,000 for both adults and children. Lower means-tested benefits tend to increase RTW. As a result, the LFPR increases by about 0.40 percent in both models. The intensive margin response is also similar in both models, and the total full-time-equivalent labor supply grows by about 0.5 percent in both models.

However, the similarity in the responses of the two models fails to carry over to the case of an increase in the value of Medicaid by $1,000. An increase in the value of Medicaid decreases RTW and labor supply on both the margins. The response in the quasi-linear model is substantially larger on both the margins. These results—especially in the quadratic model—are consistent with the empirical literature that suggests that Medicaid has only a small effect on labor supply.[27]

The next set of experiments considers changes to the SNAP benefit, also known as food stamps. SNAP benefits can mostly be spent only on food items. Such benefits are classified as income

[27] Moffitt and Wolfe (1992) estimates that such an impact of Medicaid on labor force participation is limited to only those people with extensive medical needs. Also see Baicker and others (2014).

because they allow recipients to spend their cash income on other necessities. Generally, households are eligible for SNAP benefits if their income is below 130 percent of the federal poverty line. SNAP benefits also depend on family size, with larger families receiving more benefits. In fiscal year 2015, the average SNAP benefit received by households enrolled in the program was about $254 per month. Benefits are reduced by 30 cents for every dollar of income over a certain threshold, constituting what is known as the standard deduction. A few other SNAP deductions are also allowed from earned income.[28] In this set of experiments, the maximum possible SNAP benefit is varied by scaling it up or down. No change in eligibility is considered, nor is a change in allowed deductions. A decrease in the SNAP benefit is expected to increase RTW and encourage work.

The simulation results shown in Table 7 suggest that if the SNAP program were eliminated, the labor supply could increase by about 1.0 percent, mainly on the extensive margin. The scenarios in which the maximum SNAP benefit is scaled up or down suggest that the labor supply response is more significant for increases in SNAP benefits than for decreases. That asymmetry is a direct result of there being a greater scope for LFPRs to go down rather than to go up. For both increases and decreases in SNAP benefits, the response appears to be linear in the scaling factor. Paralleling the results in the Medicaid experiments, the labor supply responses between the two models are similar in the case of a decrease in SNAP benefits but not in the case of their increase. In the latter case, the quadratic model yields smaller responses, especially on the intensive margin.

Conclusion

This working paper described DCMs and how they might be used to estimate the impact of tax and transfer policies on the labor supply. We considered models with quadratic and quasi-linear utility functions. Those models were estimated using data from the CPS for calendar year 2015. We then used the estimated models to simulate the effects of several hypothetical policy changes on LFPRs and hours of work.

The main policy that we considered was a rollback of the EITC comparable in magnitude to its expansion between 1993 and 1996. A comparison of the simulation results with the empirical literature showed that, in terms of magnitude, the predicted labor supply responses largely matched the historical changes in labor supply following the expansion of EITC in the 1990s.

After simulating the impact of uniform changes in RTW, the NWR, and nonlabor income, we found that the labor supply elasticities implied by the effect of those changes are mostly within the range of estimates in the empirical literature. The results from those two sets of experiments suggest that the omitted variable bias in the DCMs is probably not very large.

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[28] Although the program varies from state to state, typically 20 percent of earned income can be disregarded because it is presumed to pay for work expenses like commuting. Additionally, deductions could be available for dependent care, medical expenses for elderly or disabled people, excess shelter costs, or the like.

A number of other hypothetical policy experiments—scaling of EITC benefits, changes to Medicaid and SNAP—were also simulated. However, those policy changes were considered in a highly stylized manner because the aim was only to illustrate the flexibility and ease of estimating labor supply using DCMs.

Taken together, the simulation results presented here illustrate several advantages of DCMs: They deliver plausible results; they can readily distinguish the changes in labor force participation from changes in the intensity of work by current workers; and they can identify heterogeneity in the effects of policy across subpopulations. We therefore conclude that, in conjunction with other methods, the discrete choice approach may also be useful in analyzing the effect of policy on labor supply, especially when there are large or novel changes to taxes and transfers.

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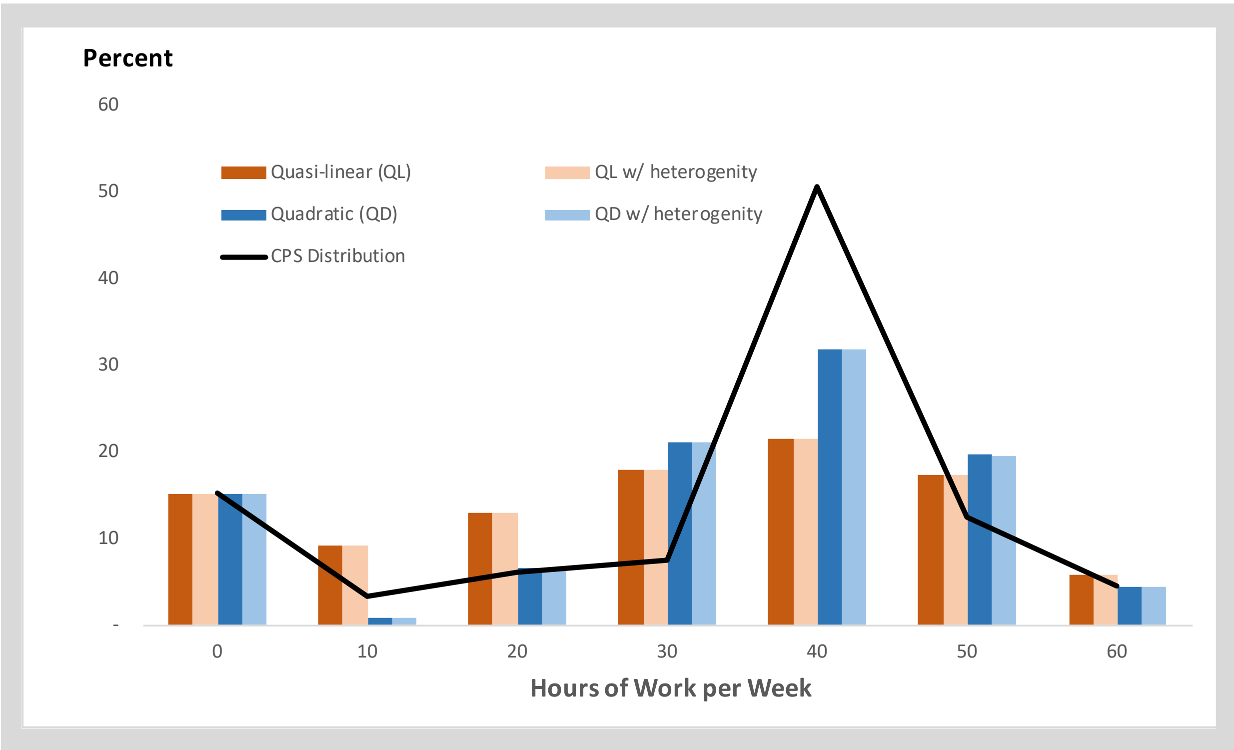
Figures

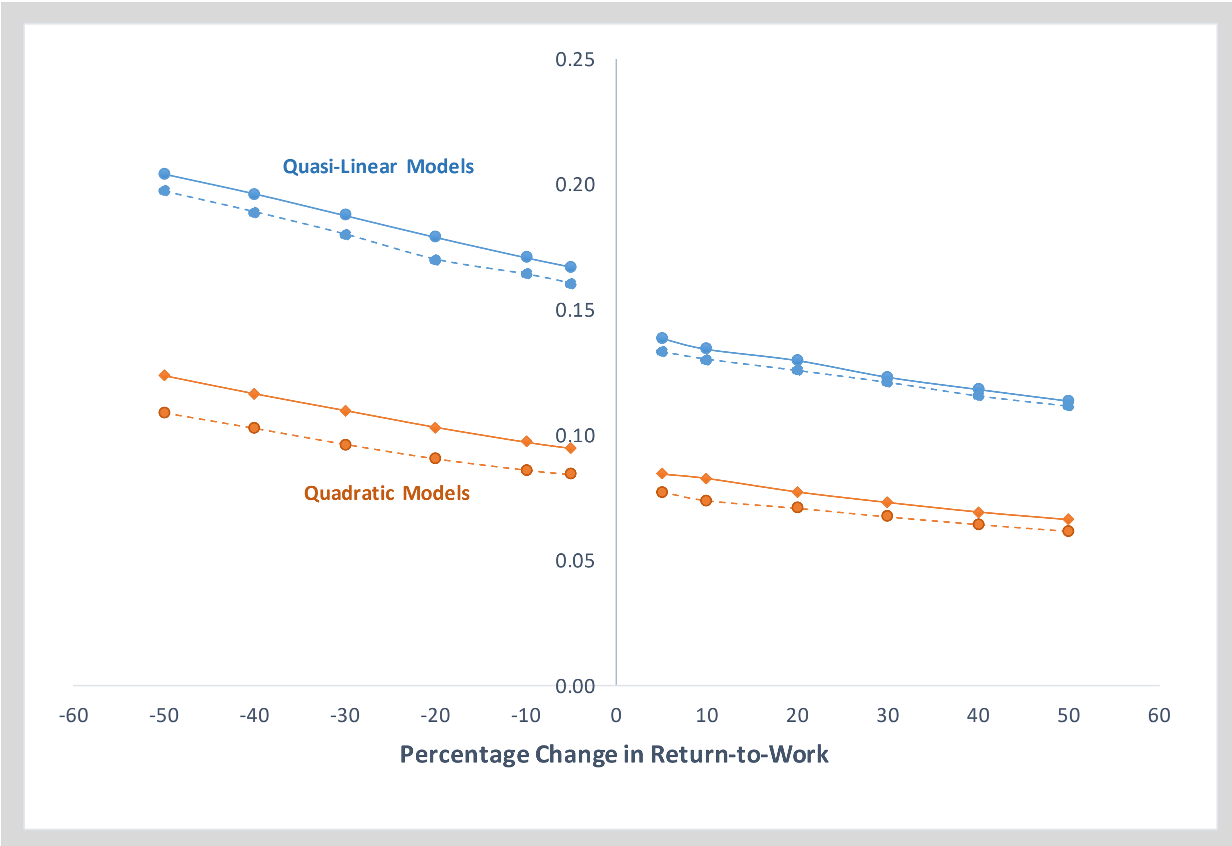
Figure 1. Distribution of Hours of Work in the Sample: Actual and Prediction by Discrete Choice Models [Return to Text]



Data source: Author's estimates, using data from the Annual Social and Economic Supplement sample of the Current Population Survey for calendar year 2015.

The sample comprises people ages 19 to 64 who are not disabled, retired, or in school.

Figure 2A. Elasticity of the Labor Force Participation Rate With Respect to Return-to-Work
[Return to Text 1, 2, 3]

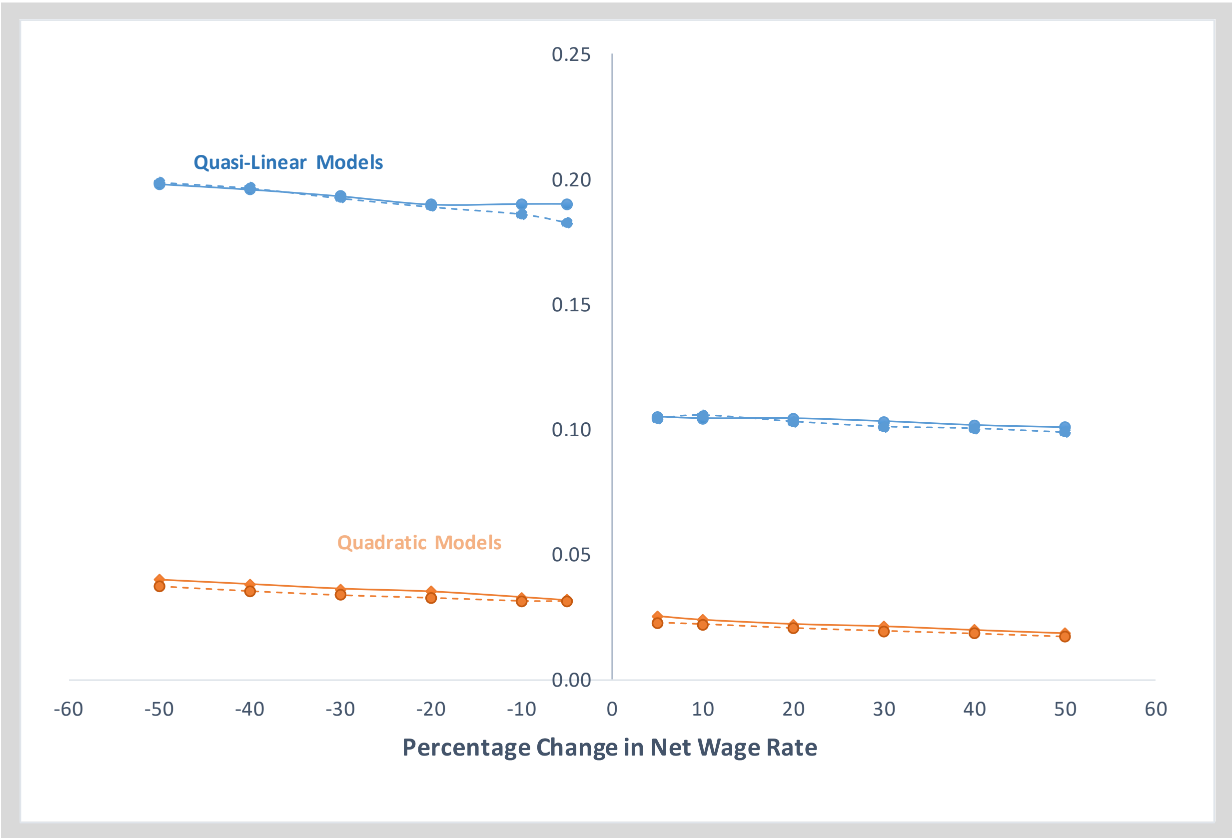


Data source: Author's estimates, using data from the Annual Social and Economic Supplement sample of the Current Population Survey for calendar year 2015.

The sample comprises people ages 19 to 64 who are not disabled, retired, or in school.

The solid lines show the models without heterogeneity; the dotted lines show the models with heterogeneity.

Figure 2B. Elasticity of Hours Worked With Respect to Net Wage Rate **[Return to Text]**

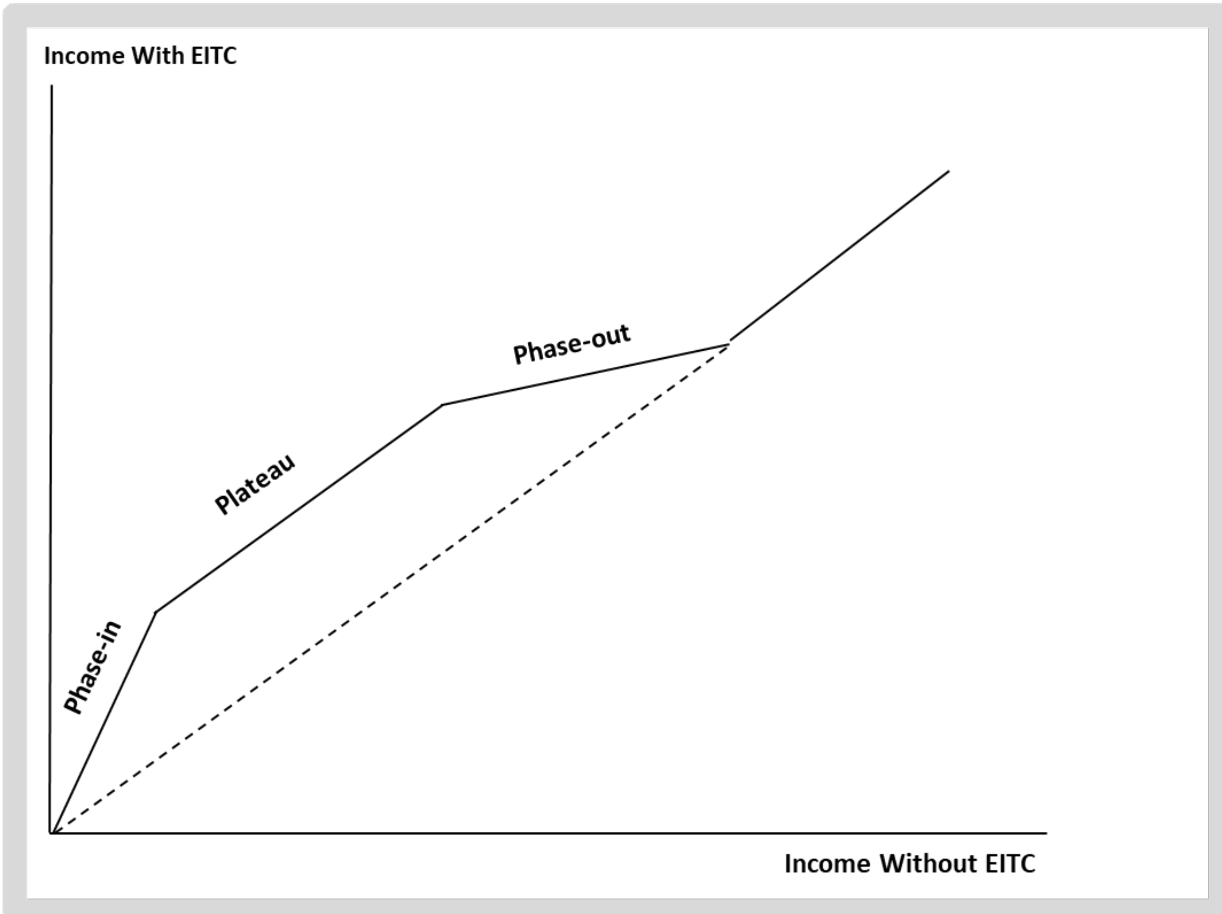


Data source: Author's estimates, using data from the Annual Social and Economic Supplement sample of the Current Population Survey for calendar year 2015.

The sample comprises people ages 19 to 64 who are not disabled, retired, or in school.

The solid lines show the models without heterogeneity; the dotted lines show the models with heterogeneity.

Figure 3. The Effect of the Earned Income Tax Credit on Net Income and Work Incentives
[Return to Text 1, 2]



The structure of the earned income tax credit (EITC) creates a mixed set of work incentives along the hours and participation margins.

Return-to-Work: For single tax filers, the EITC unambiguously increases Return-to-Work (RTW) because income after the credit always exceeds or equals before-credit income. That encourages labor force participation among single tax filers. However, that is not necessarily the case for married tax filers, because the credit is based on the total earned income of the household. When the tax unit is in the phaseout range, the EITC could reduce RTW for the secondary workers.

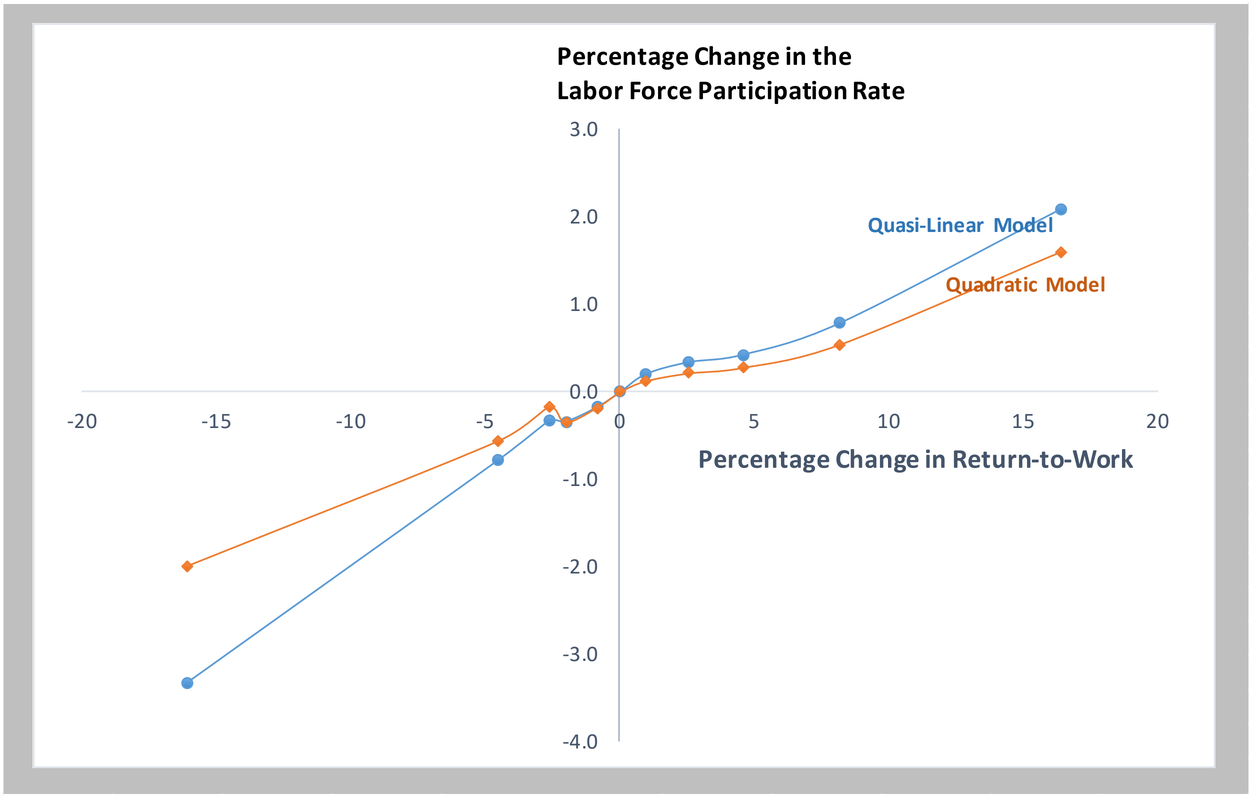
Net Wage Rate: The effects of the EITC on hours of work varies with the earned income of the tax unit.

Phase-in range: The EITC increases the Net Wage Rate (NRW), but its effect on hours of work is uncertain because of the offsetting substitution and income effects.

Plateau range: The EITC does not change the NWR. The EITC discourages hours of work in this range because of the income effect.

Phaseout range: The EITC reduces the NWR, discouraging additional hours of work in this range through reinforcing income and substitution effects.

Figure 4. Variation in the Labor Force Participation Rate Response With the Magnitude of Change in Return-to-Work [Return to Text]



Data source: Author's estimates, using data from the Annual Social and Economic Supplement sample of the Current Population Survey for calendar year 2015.

The sample comprises people ages 19 to 64 who are not disabled, retired, or in school.

Tables

Table 1. Labor Supply and Wage Rates in the Sample [Return to Text 1, 2]

Panel A: By Sex and Marital Status	Single Men	Single Women	Married Men	Married Women	All
Observations	15,667	17,062	23,307	23,307	79,343
Modeled Population (Millions)	32	31	38	38	140
			Labor Supply		
Average Work Hours per Week (If working)	38	36	42	36	38
Fraction of Modeled Population					
Not working	0.12	0.16	0.03	0.29	0.15
Working fewer than 35 hours per week	0.19	0.22	0.09	0.20	0.17
Working 35 to 45 hours per week	0.52	0.52	0.58	0.41	0.51
Working more than 45 hours per week	0.17	0.11	0.30	0.10	0.17
			Wage Rates (Dollars)*		
Mean Gross Wage Rate per Hour	21	19	32	23	24
Mean Net Wage Rate per Hour	14	13	20	14	16
Mean Return-to-Work (per week)	531	446	866	415	572

Panel B: Wage Rates, by Quintile	Q1	Q2	Q3	Q4	Q5	Any
Observations	15,820	16,123	15,758	15,805	15,837	79,343
Modeled Population (Millions)	28	28	28	28	28	140
Fraction of Married Persons	0.37	0.49	0.55	0.63	0.70	0.55
Fraction of Women	0.58	0.58	0.50	0.47	0.35	0.50
			Labor Supply			
Average Work Hours per Week (If working)	34	38	39	40	40	38
Fraction of Modeled Population						
Not working	0.23	0.25	0.11	0.14	0.03	0.15
Working fewer than 35 hours per week	0.28	0.16	0.15	0.13	0.13	0.17
Working 35 to 45 hours per week	0.39	0.47	0.56	0.53	0.58	0.51
Working more than 45 hours per week	0.09	0.11	0.18	0.21	0.26	0.17
			Wage Rates (Dollars)*			
Range of the Quintile of Wage Rate	5 to 11	11 to 15	15 to 22	22 to 33	33 to 250	5 to 250
Mean Gross Wage per Hour	9	13	19	26	54	24
Mean Net Wage Rate per Hour	6	9	12	17	34	16
Mean Return-to-Work (per week)	175	269	447	617	1,352	572

Data source: Author's estimates, using data from the Annual Social and Economic Supplement sample of the Current Population Survey for calendar year 2015.

The sample comprises people ages 19 to 64 who are not disabled, retired, or in school.

* = Wage rates of nonworkers are imputed using their level of education and other characteristics.

Table 2. Estimated Systematic Utility Functions: Model Fit and Marginal Rates of Substitution Between Work and Income at Selected Hours [Return to Text 1, 2, 3, 4]

Model	Goodness of Model Fit (McFadden's R2)	(Unit for MRS = dollars per week) MRS at Zero Hours (= Fixed cost)	MRS at 40 Hours per Week
	<u>Single Men</u> ($21 per hour, 34 percent, $531 per week)*		
Quasi-linear	0.095	214	13.16
Quasi-linear, Varying Coefficients	0.097	196	13.02
Quadratic	0.159	1,701	15.70
Quadratic, Varying Coefficients	0.162	1,895	19.17
	<u>Single Women</u> ($19 per hour, 33 percent, $446 per week)*		
Quasi-linear	0.109	249	14.61
Quasi-linear, Varying Coefficients	0.111	242	14.85
Quadratic	0.156	2,015	24.36
Quadratic, Varying Coefficients	0.160	1,853	28.34
	<u>Married Men</u> ($32 per hour, 37 percent, $866 per week)*		
Quasi-linear	0.126	(161)	12.18
Quasi-linear, Varying Coefficients	0.127	(163)	12.20
Quadratic	0.222	4,728	(0.08)
Quadratic, Varying Coefficients	0.224	4,975	(0.67)
	<u>Married Women</u> ($23 per hour, 38 percent, $415 per week)*		
Quasi-linear	0.126	478	21.43
Quasi-linear, Varying Coefficients	0.127	478	21.42
Quadratic	0.222	3,223	37.29
Quadratic, Varying Coefficients	0.224	3,735	36.86

Data source: Author's estimate, using data from the Annual Social and Economic Supplement sample of the Current Population Survey for calendar year 2015.

The sample comprises people ages 19 to 64 who are not disabled, retired, or in school.

McFadden's R2 is the same for married men and married women because it comes from the same regression model.

Estimated coefficients of discrete choice models are not comparable across samples because those coefficients are not identified independently of the variance of the error term; however, ratios of two coefficients may be compared across models because these ratios are independent of the variance terms (see Train, 2003). Therefore, Table 2 does not report raw coefficients. Instead, fixed costs and the marginal rates of substitution are reported, which are both ratios. Fixed costs are obtained by dividing the coefficient on working positive hours by the coefficient on income. Similarly, the MRS is obtained by dividing the coefficient on income by the coefficient on hours.

MRS = marginal rate of substitution; * = Bracket contains gross wage rate, marginal tax rate, and mean return to work.

Table 3. Labor Supply Response to Uniform Changes in Return-to-Work and Net Wage Rate
[Return to Text 1, 2, 3, 4, 5, 6]

	Extensive Margin Response: Elasticity of the Labor Force Participation Rate With Respect to RTW				**Intensive Margin Response:** Elasticity of Average Hours Worked With Respect to the NWR Among Those Working Both Before and After the Change in the Wage Rate			
Model	QL	QD	QL	QD	QL	QD	QL	QD
Heterogeneity	No	No	Yes	Yes	No	No	Yes	Yes
Panel A: 10 Percent Increase in RTW and NWR								
All	0.13	0.08	0.13	0.07	0.10	0.02	0.11	0.02
By Gender / Marital Status								
Single Women	0.18	0.11	0.17	0.10	0.11	0.03	0.12	0.03
Single Men	0.12	0.10	0.11	0.09	0.12	0.04	0.12	0.03
Married Women	0.26	0.12	0.25	0.11	0.10	0.01	0.10	0.01
Married Men	0.02	0.02	0.03	0.02	0.09	0.02	0.09	0.01
By Quintiles of Wage Rate								
Quintile 1	0.14	0.12	0.12	0.10	0.03	0.03	0.03	0.03
Quintile 2	0.23	0.15	0.21	0.14	0.03	0.03	0.03	0.03
Quintile 3	0.12	0.07	0.12	0.06	0.05	0.03	0.05	0.03
Quintile 4	0.19	0.08	0.19	0.07	0.08	0.03	0.09	0.03
Quintile 5	0.03	0.02	0.03	0.01	0.27	0.01	0.27	0.01
Panel B: 10 Percent Decrease in RTW and NWR								
All	0.17	0.10	0.16	0.09	0.19	0.03	0.19	0.03
By Gender/ Marital Status								
Single Women	0.20	0.12	0.18	0.10	0.17	0.04	0.17	0.04
Single Men	0.16	0.12	0.15	0.11	0.18	0.05	0.18	0.04
Married Women	0.31	0.13	0.31	0.12	0.17	0.03	0.17	0.03
Married Men	0.05	0.03	0.06	0.03	0.22	0.03	0.21	0.03
By Quintiles of Wage Rate								
Quintile 1	0.17	0.10	0.17	0.08	0.09	0.02	0.09	0.02
Quintile 2	0.20	0.11	0.20	0.09	0.15	0.03	0.15	0.03
Quintile 3	0.22	0.12	0.21	0.10	0.21	0.04	0.21	0.04
Quintile 4	0.19	0.11	0.18	0.10	0.26	0.04	0.25	0.04
Quintile 5	0.08	0.06	0.08	0.06	0.21	0.02	0.20	0.02

Data source: Author's estimate, using data from the Annual Social and Economic Supplement sample of the Current Population Survey for calendar year 2015.

The sample comprises people ages 19 to 64 who are not disabled, retired, or in school.

NWR = net wage rate; QD = quadratic model; QL = quasi-linear model; RTW = return-to-work.

Table 4. Effects on Return-to-Work and Net Wage Rates of Rolling Back the 1993 Expansion of the Earned Income Tax Credit [Return to Text 1, 2, 3, 4]

	Total Population (Millions)	LFPR	Average Hours per Week, If Working	Aggregate Labor Supply (FTE, in millions)	Average RTW (Dollars per week)	Average NWR Among Workers (Dollars)	Percentage Change in RTW	Percentage Change in NWR, If Working
Individuals Facing				**All Individuals**				
Decrease in RTW	21.9	0.86	35.2	16.5	499	11.91	-4.6	5.4
Increase in RTW	17.3	0.84	40.2	14.6	501	13.70	6.2	-1.2
No Change in RTW	100.7	0.85	39.7	84.5	694	17.38	0.0	0.0
All Individuals	139.8	0.85	39.0	115.6	640	16.07	0.0	0.5
Number of Children				**Single Women**				
None	23.1	0.85	37.2	18.3	520	13.16	-0.1	0.2
One or More	8.0	0.83	36.3	6.0	495	11.62	-3.4	5.7
Two or More	3.9	0.80	36.1	2.8	496	11.35	-6.1	6.9
Two or More, No HS	0.6	0.65	32.6	0.3	361	8.20	-15.4	9.7
Number of Children				**Married Women**				
None	14.8	0.74	37.8	10.4	566	15.09	0.0	0.0
One or More	23.3	0.69	35.8	14.4	528	15.51	0.6	0.0
Two or More	14.9	0.66	35.2	8.7	515	15.62	1.1	0.2
Two or More, No HS	1.3	0.39	32.3	0.4	219	6.78	10.7	3.3
Number of Children				**Single Men**				
None	28.4	0.87	38.4	23.7	576	14.37	-0.1	0.2
One or More	4.1	0.92	39.8	3.8	615	13.48	-1.3	3.9
Two or More	1.8	0.91	39.2	1.6	601	12.61	-3.2	6.0
Two or More, No HS	0.3	0.92	37.4	0.3	448	7.59	-7.7	18.3
Number of Children				**Married Men**				
None	14.8	0.96	42.0	15.0	882	20.11	0.0	0.0
One or More	23.3	0.97	42.9	24.2	894	20.49	0.7	0.5
Two or More	14.9	0.97	43.2	15.5	905	20.61	0.9	0.8
Two or More, No HS	1.6	0.95	39.6	1.5	452	9.95	0.9	8.0

Data source: Author's estimates, using data from the Annual Social and Economic Supplement sample of the Current Population Survey for calendar year 2015.

The sample comprises people ages 19 to 64 who are not disabled, retired, or in school.

FTE = full-time equivalent (40 hours per week); HS = high school diploma; LFPR = labor force participation rate; NWR = net wage rate; RTW = return-to-work.

Table 5. Effects on Labor Force Participation and Average Hours Worked of Rolling Back the 1993 Expansion of the Earned Income Tax Credit [Return to Text 1, 2, 3, 4, 5, 6]

	Change in LFPR		Change in Average Hours Worked per Week[a]		Change in Aggregate Labor Supply		Elasticity of LFPR With Respect to RTW		Elasticity of Hours Worked With Respect to NWR[a]	
	QL	QD	QL	QD	QL	QD	QL	QD	QL	QD
	Percentage						*Numeric Value*			
Individuals Facing	**All Individuals**									
Decrease in RTW	-1.0	-0.7	0.2	0.4	-0.7	-0.2	*0.22*	*0.14*	*0.03*	*0.07*
Increase in RTW	0.7	0.5	-0.1	0.0	0.6	0.5	*0.12*	*0.08*	*0.06*	*0.01*
All Individuals	-0.1	0.0	0.0	0.0	-0.1	0.0				
Number of Children	**Single Women**									
None	0.0	0.0	0.0	0.0	0.0	0.0	*0.53*	*0.36*	*0.17*	*0.16*
One or More	-1.6	-0.9	0.4	0.4	-1.0	-0.3	*0.47*	*0.26*	*0.07*	*0.07*
Two or More	-2.8	-1.4	0.3	0.3	-2.2	-1.0	*0.45*	*0.24*	*0.05*	*0.05*
Two or More, No HS	-4.1	-2.0	0.2	0.5	-4.0	-1.4	*0.27*	*0.13*	*0.03*	*0.05*
Number of Children	**Married Women**									
None	0.0	0.0	0.0	0.0	0.0	0.0	*0.68*	*0.09*	*0.00*	*0.00*
One or More	0.3	0.2	-0.1	0.0	0.2	0.2	*0.54*	*0.32*	*	*
Two or More	0.6	0.4	0.0	0.0	0.5	0.4	*0.50*	*0.33*	*-0.25*	*0.04*
Two or More, No HS	3.8	4.0	0.3	0.1	4.2	4.7	*0.36*	*0.37*	*0.08*	*0.02*
Number of Children	**Single Men**									
None	0.0	0.0	0.0	0.0	0.0	0.0	*0.36*	*0.32*	*0.23*	*0.23*
One or More	-0.5	-0.5	0.0	0.3	-0.4	-0.1	*0.41*	*0.37*	*0.01*	*0.08*
Two or More	-1.0	-0.8	0.0	0.3	-1.0	-0.4	*0.32*	*0.25*	*0.00*	*0.05*
Two or More, No HS	-2.1	-1.5	-0.3	0.4	-2.4	-1.0	*0.27*	*0.19*	*-0.02*	*0.02*
Number of Children	**Married Men**									
None	0.0	0.0	0.0	0.0	0.0	0.0	*0.00*	*0.00*	*0.50*	*0.00*
One or More	0.0	0.0	-0.1	0.0	-0.2	0.0	*-0.03*	*0.00*	*-0.26*	*0.04*
Two or More	0.0	0.0	-0.1	0.0	-0.1	0.0	*-0.04*	*0.00*	*-0.12*	*0.04*
Two or More, No HS	-0.1	0.0	0.1	0.3	-0.1	0.3	*-0.15*	*-0.01*	*0.01*	*0.04*

Data source: Author's estimates, using data from the Annual Social and Economic Supplement sample of the Current Population Survey for calendar year 2015.

The sample comprises people ages 19 to 64 who are not disabled, retired, or in school.

HS = high school diploma; LFPR = labor force participation rate; NWR = net wage rate; QD = quadratic model; QL = quasi-linear model; RTW = return-to-work; * = Elasticity cannot be estimated because the average change in the NWR is zero.

a. Changes in average hours worked per week are calculated among those employed both before and after the rollback.

Table 6. Effects of Other Hypothetical Changes to the Earned Income Tax Credit

[Return to Text 1, 2]

	Change in Labor Force Participation Rate		Change in Average Hours Worked If Employed Both Before and After Change to EITC		Change in Aggregate Labor Supply	
	QL	QD	QL	QD	QL	QD
			Percentage			
Panel A: Scaling EITC Benefits Up or Down						
Elimination of the EITC Program	-0.15	-0.05	0.04	0.08	-0.09	0.05
50 Percent Reduction in Credits	-0.07	-0.02	0.02	0.04	-0.04	0.03
25 Percent Reduction in Credits	-0.03	-0.01	0.01	0.02	-0.02	0.02
25 Percent Increase in Credits	0.00	0.01	-0.16	-0.02	-0.18	-0.02
50 Percent Increase in Credits	0.00	0.01	-0.32	-0.05	-0.37	-0.05
Doubling of Credits	-0.01	0.02	-0.64	-0.11	-0.74	-0.11
Panel B: Replacing the Current EITC Program With a New Program						
Extending the EITC to Childless Adults[a]	0.59	0.40	-1.07	-0.29	-0.73	0.05

Data source: Author's estimates, using data from the Annual Social and Economic Supplement sample of the Current Population Survey for calendar year 2015.

The sample comprises people ages 19 to 64 who are not disabled, retired, or in school.

EITC = earned income tax credit; QD = quadratic model; QL = quasi-linear model.

a. The tax credit is made more generous and is expanded for childless adults. All workers receive a dollar-for-dollar credit on the first $3,000 of their earned income ($6,000 for married households) regardless of whether they have children. After that threshold, there is a long plateau, and the credit begins phasing out at $30,000 of income at a rate of 15 percent. Children only affect the credit in the case of heads-of-household filers with dependent children, for whom the phaseout begins at $80,000 instead of $30,000 (for single filers) or $60,000 (for married filers). This new credit replaces only the current federal EITC. The amounts of state EITCs are left unchanged in this simulation.

Table 7. Effects on Labor Supply From Hypothetical Changes to the Value of Medicaid and Benefits From the Supplemental Nutrition Assistance Program [Return to Text 1, 2, 3]

	Change in Labor Force Participation Rate		Change in Average Hours Worked[a]		Change in Aggregate Labor Supply	
	QL	QD	QL	QD	QL	QD
			Percentage			
Changes in Value of Medicaid						
A Reduction of $1,000 per Recipient per Year	0.40	0.36	0.09	0.08	0.46	0.44
An Increase of $1,000 per Recipient per Year	-0.68	-0.42	-0.53	-0.09	-1.22	-0.52
Changes in Maximum Possible SNAP Benefit						
Elimination of SNAP	0.87	0.78	0.19	0.17	1.01	0.95
Maximum SNAP Benefits Reduced by 50 Percent	0.42	0.39	0.11	0.10	0.51	0.49
Maximum SNAP Benefits Increased by 50 Percent	-0.69	-0.44	-0.62	-0.11	-1.33	-0.57
Maximum SNAP Benefits Doubled	-1.40	-0.90	-1.26	-0.22	-2.68	-1.13

Data source: Author's estimates, using data from the Annual Social and Economic Supplement sample of the Current Population Survey for calendar year 2015.

The sample comprises people ages 19 to 64 who are not disabled, retired, or in school.

The income used for estimating the discrete choice models included the value of Medicaid as nonlabor income. That benchmark value was assumed to be $3,000 per year, which was approximately the average spending on adults and children in the Medicaid and CHIP programs in 2015.

QD = quadratic model; QL = quasi-linear model; SNAP = Supplemental Nutrition Assistance Program.

a. The change in average hours is computed only among those workers who did not enter or exit the labor force in the experiment—that is, those who worked positive hours both before and after the experiment.