The Impact of the Earned Income Tax Credit on the Labor Supply of Married Couples: A Structural Estimation

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Abstract. This paper examines the effect of the Earned Income Tax Credit on married couples' labor supply. Using data from the 1985-2003 waves of the Current Population Survey, a model of joint family labor supply is estimated that accounts for the nonlinear and nonconvex budget constraints that arise due to the EITC. Husbands' estimated elasticities are close to zero, while wives' estimated wage elasticities are .18 on the intensive margin and .03 on the extensive margin. Simulations suggest that the EITC has a small negative effect on hours worked of both husbands and wives, but little effect on the participation margin.

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1. Introduction

During the 1990's, the Earned Income Tax Credit (EITC) emerged as a fundamental part of the antipoverty effort in the United States. As evidence of the size to which the EITC has grown, the credit distributed an estimated $30 billion to over 18 million families in 2000, an average of over $1600 per family. As such, the EITC now constitutes the largest program for low income families, almost doubling the $16 billion spent on the Temporary Assistance to Needy Families (TANF) program. This paper examines the extent to which the Earned Income Tax Credit affects the labor supply behavior of married couples.

The EITC functions as a wage bonus for low income workers. Initially, the credit increases at the phase-in rate with a couple's earned income, up to a maximum amount. The credit stays flat over an additional range of earnings, and beyond a certain amount of earnings the credit declines at the phase-out rate with additional earnings until it is completely taxed away. Although the EITC is generally thought of as a program that encourages work among the poor, the few studies that have examined the effect of the EITC on married couples have found that the EITC tends to dampen work effort among this subset of the population, suggesting that any thought of expanding the EITC to encourage work among single females with children would have to be balanced against the negative labor supply effects on married couples. As a result, it is important to examine the robustness of these findings to alternative estimation strategies.

This paper, then, extends a methodology first proposed by Heim (2009) to estimate a model of family labor supply that accounts for the joint choice of hours for the husband and wife. This extension of the method also accounts for the nonlinear and nonconvex budget constraint that arises due to the income tax and EITC schedules, as well as AFDC-UP benefits and macroeconomic conditions of the labor market. Estimated on data from the 1985-2003 waves of the Current Population Survey consisting of low educated married couples with children, the resulting estimates imply small labor supply elasticities for both husbands and wives in the sample, with overall wage elasticities for husbands positive but close to zero, and overall wage elasticities for wives of approximately .18. Consistent with previous findings in the literature, simulations suggest that the EITC has a small negative effect on hours worked of both husbands and wives, with average decreases for husbands of about 4 hours annually and of about 9 hours annually for wives. Contrary to the previous literature, however, participation effects are found to be small or nonexistent.

The paper proceeds as follows. In Section 2, the relevant literature is reviewed. Section 3 presents the model and econometric methodology, Section 4 describes the data used, and Section 5 presents the estimation results. In Section 6, simulations are performed to examine the effect of previous EITC expansions on the labor supply behavior of husbands and wives, and Section 7 presents the simulated effects of some counterfactual policies. Section 8 concludes.

2. Relevant Literature

Several papers have examined the effect, both simulated and estimated, of the Earned Income Tax Credit and especially its expansions in the 1990's on the labor supply behavior of single women with children. Among them are Eissa and Liebman (1996), Keane and Moffitt (1998), Meyer and Rosenbaum (2000, 2001), Ellwood (2000), Hotz et al (2002), Grogger (2003), and others. These papers have generally found positive, and sometimes substantial, effects of the EITC on employment of single women, but negative and generally small effects on the hours of work of single women that are working.

In comparison, the body of evidence on the effect of the EITC on the labor supply of married couples is currently much less developed. Dickert, Houser and Scholz (1995) use previous structural estimates to simulate the effects of the EITC on the labor supply of married couples, and find that the EITC expansion that was part of the Omnibus Budget Reconciliation Act of 1993 (OBRA93) would induce men to reduce their work hours by between 0% and 3.14%, and women to reduce their work hours by between .57% and 4.37%. They also perform an estimation of labor force and program participation, and find that the OBRA93 expansion would lead primary workers to increase labor force participation by .7 percentage points, and decrease the labor force participation of secondary workers. Ellwood (2000) uses difference in difference techniques to examine whether the EITC expansions in the 1990s discouraged labor force participation among married women, and finds evidence that the EITC discouraged labor force participation for low wage married women. Finally, Eissa and Hoynes (2004, 2006) use data from the 1985-97 Current Population Surveys to estimate the effect of the EITC expansions on labor force participation and hours of work using both difference in differences and reduced form methods. Among couples with children, they find that married men were .1 percentage points more likely to work and married women were .6 percentage points less likely to work after the 1993 EITC expansion. Further, they find that women's hours of work decreased by 1 to 4% due to this expansion, and men's hours of work decreased by .5 to 1.5%.

Although the above studies provide some evidence on the labor supply effects of the Earned Income Tax Credit on married couples with children, some holes in our understanding remain. First, no study has looked at the response of husbands and wives on both the intensive and extensive margins using one comprehensive model of labor supply and labor force participation. Second, no study has examined the effects of the EITC in a behavioral model other than the wife as secondary earner model.

In the secondary earner model, the husband chooses his hours of work first, and the wife chooses her hours conditional on her husband's choice, so that the marginal tax rate that applies to the wife's first hour of work is assumed to be the rate that applied to the husband's last hour of work. As a result, in this model, the EITC phase-in range initially increases the husband's after tax wage, creating an incentive to work and to possibly work more hours (as the income and substitution effects work in opposite directions), while the income effect in the plateau range and both the income and substitution effects in the phase-out range would lead to reduced hours. For the wife, who is assumed to choose her hours conditional on her husband's choice, the EITC only serves as a work disincentive for a woman whose husband earns enough income to place the couple in the plateau or phaseout ranges of the EITC. Only in the case of a woman whose husband's income falls in the phase-in range would the EITC provide an incentive to work or to work more hours.

In a unitary model, on the other hand, the husband and wife jointly decide on their labor supplies, and so both members of the couple take the entire EITC schedule into account when optimizing. As a result, the EITC may incentivize either or both members of the couple to work more or less, depending on the income that the couple would have jointly earned in absence of the EITC. The effect that assuming this alternative behavioral model has on the resulting estimates and the implied effect of the EITC, however, is an empirical issue.

In this paper, a joint utility maximizing model of married couples that is an extension of the method used in Heim (2009) is estimated. That paper estimated the model on a cross section of data from the 2001 PSID, and was focused on the effect of tax rates in general, so that the Earned Income Tax Credit was not incorporated into the estimation method. There are several desirable features of this method. First, unlike the methods that allow for continuous hours choices in Hausman and Ruud (1984), Ransom (1986), Kapteyn et al. (1990), and Kooreman and Kapteyn (1990), it accounts for both heterogeneity in tastes for work and measurement or optimization error in hours of work, which have consistently been found to be important in labor supply estimation. In addition, since it allows for a continuous hours choice, simulations using estimates from the method can changes in hours that are smaller than those that are captured in a discrete choice framework.[1] Finally, it incorporates the entire nonlinear shape of the budget constraint, including federal, state, and payroll taxes

Several features of the model used in this paper differentiate it from Heim (2009), however. First, the focus of this paper is on estimating the effect of the EITC in particular, and so (as noted below) the estimation method is altered to account for the

[1] A recent paper by Van Soest, Das and Gong (2002) estimates a discrete choice model of individual labor supply that allows for 360 hours choices, which comes close to approximating a continuous hours model. However, papers that have estimated family labor supply have allowed for far fewer hours choices (see, for example, Van Soest (1995) and Hoynes (1996)).

nonconvex budget constraints that result when the EITC is incorporated. Second, the data used span the large recent increases in the generosity of the EITC, and the model incorporates state level EITCs. As a result, identification comes not only from variation in wages and incomes across couples, but also from variation across states and across time in the structure of the income tax code and the EITC, both at the federal and state levels. Third, since low educated couples are the focus of the study, the choice of receiving benefits from the AFDC-UP program is incorporated into the model. Finally, state level unemployment rates are incorporated into the structural model as affecting the participation margins of the husband and wife.

A clear benefit of estimating such a structural model is that the results can be used to simulate the effects of complex changes in the form of the Earned Income Tax Credit on labor supply and labor force participation. However, these abilities come at a cost of having to make many more assumptions than in a reduced form or difference-in-differences estimation, including making assumptions about the decision-making process of the household, the form of preferences, exogeneity of wages and income, and the distributions of the stochastic elements.

3. Model and Estimation Method

To estimate the effect of the EITC on work behavior of married couples with children, this paper extends a methodology proposed in Heim (2009). Each couple is assumed to have a unitary utility function, [2]

[2] There has been a fair amount of criticism of this unitary model of labor supply. (See McElroy and

$$U\left(h_h, h_w, C, v, \theta^0\right) \quad (1)$$

over hours of work for the husband, h_h, hours of work for the wife, h_w, and total consumption, C, where v denotes unobserved heterogeneity in tastes for work and θ^0 denotes a vector of the true parameters of the utility function. This utility function is assumed to be maximized subject to a single budget constraint, given by

$$C \leq Y + W_h h_h + W_w h_w - \sum_{j=1}^{J} t_j \left(I_j - I_{j-1}\right) 1\left(Y^{TI} > I_j\right) - \sum_{j=1}^{J} t_j \left(Y^{TI} - I_{j-1}\right) 1\left(I_j \geq Y^{TI} > I_{j-1}\right), \quad (2)$$

where W_h and W_w denote the husband's and wife's wages, respectively, Y denotes the family's nonlabor income, Y^{TI} denotes the family's taxable income (income less deductions and exemptions), $\{I_j\}_{j=1}^{J}$ denotes income tax bracket endpoints, t_j denotes the tax rate on income between I_j and I_{j+1}, and $1(\cdot)$ denotes the indicator function.

Estimation proceeds as follows. Given an hours finding algorithm, and given a draw from the couple's heterogeneity distribution (however specified), one solves numerically for the couple's utility maximizing hours conditional on parameters.[3] With these hours having been solved for, given a stochastic structure of the model that maps these utility maximizing hours to observed hours, one calculates the likelihood. Estimation then proceeds by finding the parameters that maximize the likelihood function

Horney (1981), Chiappori (1988), Schultz (1990), and Fortin and Lacroix (1997).) Donni (2003) examines the collective model in the presence of taxes, but does not estimate a model. Blundell, Chiappori, Magnac and Meghir (2007) and Bloemen (2004) estimate collective models labor supply, but do not account for taxes. Myck et al. (2006) calibrate a collective model of household labor supply using data from the UK, and then simulate the effect of reforms to the Working Families Tax Credit. They also implement this method on data from five other European countries. The approach used in this paper could plausibly be adapted to estimate a collective model of labor supply in the presence of taxes, since implicit in the calculation of the likelihood is the explicit solution of the structural model, which could be done just as well for other assumed theoretical models. Such extensions are left for future work.

[3] The initial starting points for the parameters were taken from Heim (2009). However, estimated parameters were robust to the several starting points.

using standard maximum likelihood techniques.[4]

Compared to Heim (2009), the method used in this paper differs in three ways. First, the Earned Income Tax Credit is incorporated into the budget constraint. Because the incorporation of the EITC creates a nonconvexity in the budget constraint, an alteration to the hours finding algorithm used in Heim (2009) is required. The modified hours finding algorithm searches for utility maximizing hours on two different budget constraints, the union of which constitutes the actual budget constraint that the couple faces. The first budget constraint accounts for the income tax without the EITC, and the second accounts for both the income tax and the EITC, but not the end of the phaseout range. After searching for utility maximizing hours on each of these budget constraints, the utility level corresponding to each of the locally optimal sets of hours to determine the global utility maximizing hours.

Second, AFDC-UP benefits are incorporated into the budget constraint. As noted in Committee on Ways and Means (Various), starting in 1961, various states extended AFDC benefits to married couples with children in which both husband and wife were unemployed, a program which was denoted AFDC-UP. By 1990, all states were required to operate an AFDC-UP program, but had an option to limit benefits to as few as 6 months in any 12 month period.[5] The primary worker of a couple could work up to 100 hours a month and still be eligible for AFDC-UP benefits, but benefits were reduced according to a formula that was a function of earnings and which varied by state if the

[4] Implicit in this model is this assumption that marital status, number of children, gross wages and nonlabor income are all exogenous. Although it may be desirable to weaken some of these assumptions, doing so would require a much more computationally complex model that that estimated here, and is beyond the scope of this paper.

[5] However, takeup of benefits was less than perfect. For example, Hoynes (1996) estimates a takeup rate of 77%. So, it is unclear to what extent these benefits were taken into account among the individuals in this sample when choosing hours of work. Thus, I also estimated the model without accounting for AFDC-UP benefits. The results were qualitatively similar to those presented here, and are available from the author.

individual had positive earnings. To simplify the incorporation of these benefits into the estimation procedure, I assume that the couple only receives AFDC-UP benefits if neither member of the couple worked at all during the year. Thus, these benefits are treated as if they were an addition to the couple's nonlabor income, with a fixed cost equivalent to this amount if either or both of the individuals work positive hours.[6]

Third, in the stochastic specification, I account for the possibility that individuals desired to work a positive number of hours, but could not find a job, and so were unemployed. Suppose that the unemployment rate in couple i's state in the year in which they are observed is u_{si}. I assume that with probability u_{si}, an individual who desired to work positive hours could not find a job, and with probability $1-u_{si}$, the individual could find a job.[7]

The technical details of the estimation method, including a description of the hours finding algorithm that is used, the derivation of the likelihood function, and the methods used to account for missing wages and unobserved heterogeneity in taste for work, are presented in the Appendix.

Letting $h_{hi}^{*}(\theta_0)$ and $h_{wi}^{*}(\theta_0)$ denote the solution to maximizing the utility function in (1) subject to the budget constraint in (2), the assumed data generating process is

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[6] As a result, the alteration to the hours finding method that allows for fixed costs described in Heim (2009) can be applied here. As in that paper, in the presence of fixed costs there is the possibility of multiple local maxima, and so there needs to be some tie-breaking rule in order for the likelihood function to be well defined. When the local utility maxima are equal, it is assumed that couples will choose to both work over either or both not working, and will choose the husband alone working over the wife alone working. Finally, they will choose any of these over both husband and wife not working. I also attempted to also estimate a term that represented either the stigma or transactions costs of the receipt of AFDC benefits (see Moffitt (1983)), but such a term was estimated imprecisely with a very large standard error, and so was left out of the specifications whose results are presented later.

[7] This is an admittedly simple way of accounting for macroeconomic factors, but one that is feasible given the available data. A more comprehensive specification might allow for the unemployment probability to depend on education, skills, job search, and other characteristics of the individual.

$$h_{hi} = \begin{cases} h^*_{hi}(\theta_0) + \varepsilon_{hi} & if \quad h^*_{hi}(\theta_0) > 0,\ h^*_{hi}(\theta_0) + \varepsilon_{hi} > 0, \text{ and } e_{hi} = 1 \\ 0 & if \quad h^*_{hi}(\theta_0) > 0 \text{ and } (h^*_{hi}(\theta_0) + \varepsilon_{hi} \le 0 \text{ or } e_{hi} = 0) \\ 0 & if \quad h^*_{hi}(\theta_0) = 0 \end{cases}$$

$$h_{wi} = \begin{cases} h^*_{wi}(\theta_0) + \varepsilon_{wi} & if \quad h^*_{wi}(\theta_0) > 0,\ h^*_{wi}(\theta_0) + \varepsilon_{wi} > 0, \text{ and } e_{wi} = 1 \\ 0 & if \quad h^*_{wi}(\theta_0) > 0 \text{ and } (h^*_{wi}(\theta_0) + \varepsilon_{wi} \le 0 \text{ or } e_{wi} = 0), \\ 0 & if \quad h^*_{wi}(\theta_0) = 0 \end{cases} \tag{3}$$

where and ε_{hi} and ε_{wi} represent measurement or optimization error, and e_{hi} and e_{wi} are draws from a Bernoulli distribution where $P[e_{hi} = 0] = P[e_{wi} = 0] = u_{si}$. In this specification, there are three reasons why a husband might be observed to be not working. First, the individual may desire not to work ($h^*_{hi}(\theta_0) = 0$). Second, the individual may desire to work, but due to a large negative draw of ε_{hi}, the individual reports working no hours ($h^*_{hi}(\theta_0) > 0$ and $h^*_{hi}(\theta_0) + \varepsilon_{hi} \le 0$). Finally, the individual may desire to work, but cannot find a job ($h^*_{hi}(\theta_0) > 0$ and $e_{hi} = 0$). Similarly, a wife may be observed to be not working for those same three reasons.

For the specification of the couple's preferences, I assume a quadratic utility specification,[8] in which the vector of parameters $\theta = [\beta_{hh}, \beta_{ww}, \beta_{CC}, \beta_{hw}, \beta_{hC}, \beta_{wC}, \beta_{C}, \alpha_h, \alpha_w]$ and

$$\begin{aligned} U(h_h, h_w, C, \nu, \theta) \quad = \quad & \beta_{hh} h_h^2 + \beta_{ww} h_w^2 + \beta_{CC} C^2 \\ & + \beta_{hw} h_h h_w + \beta_{hC} h_h C + \beta_{wC} h_w C \\ & + \beta_h h_h + \beta_w h_w + \beta_C C \end{aligned} \tag{4}$$

where

[8] For good descriptions of the properties of the quadratic utility function, see Stern (1986) and Goldberger (1987).

$$\begin{aligned} \beta_h &= X_h'\alpha_h + v_h \\ \beta_w &= X_w'\alpha_w + v_w \end{aligned} \quad . \tag{5}$$

In this equation, the vectors X_h and X_w contain observable preference shifters, and v_h and v_w denote unobservable heterogeneity in taste for work.[9]

Since this paper assumes a static model, there is no saving or borrowing. Hence, a couple's consumption, C, is calculated by figuring the couple's after tax income given the husband and wife's wages, their nonlabor income, their deductions and exemptions, their hours of work, and the amount of EITC and AFDC-UP for which they are eligible. To keep this measure of consumption comparable across years, the couple's after tax income is then inflated or deflated to real dollars from the year 2000, using the CPI-Urban Price Index.

4. Data

The data used for this study come from the 1985 to 2003 waves of the March Current Population Survey. In order to focus on a sample of married couples who are likely to be eligible to claim the EITC,[10] following Eissa and Hoynes (2004, 2006) the sample was cut to include only married couples with children where the wife has less than a high

[9] In a more flexible specification, other parameters of the utility function could be specified as functions of demographic characteristics. This more parsimonious specification was used because it was computationally feasible.

[10] Meyer (2008) estimates that 31.3 percent of recipients of the EITC in 2004 had less than a high school diploma. In addition, Eissa and Hoynes (2004) report that, in the 1985-97 CPS, 60 percent of married couples with less than a high school education were eligible to receive the EITC compared to only 20 percent of those with exactly a high school diploma.

school degree.[11,12] In addition, the sample was cut to include only those individuals who were part of the Outgoing Rotation Group during their March interview. This is done to facilitate the use of as close to a direct report of respondents' wages as possible, to minimize any possible division bias by constructing the wage variable by dividing labor income by hours of work.[13] Finally, I cut the sample to include only couples where both the husband and wife are between the ages of 25 and 55, in order to focus on labor supply behavior in the prime working years.[14] The sample sizes after various sample cuts are presented in Table 1.[15] In total, 3,961 observations were used in the estimation.

[Table 1 about here]

The wage used in this study comes from questions in which respondents are asked to report their hourly, weekly, or monthly wages. If the individual is not paid hourly (for example, salaried workers), I calculate an hourly wage for them by dividing the income they report by either their usual hours over that time span (if reported), or by a standard number of hours worked during that time period if their usual hours are not reported.[16] For a measure of nonlabor income, I use the reported asset income of the couple. To allow preferences to vary with observable demographic characteristics, I use information

[11] As a robustness check, Eissa and Hoynes (2004) selected an alternative sample based on the husband's education, and found that the results were qualitatively similar.
[12] In addition, the resulting simulations represent the effects of the EITC (or changes in the EITC) on those who are most likely to claim the credit.
[13] See, for example, Eklof and Sacklen (2000). Note, however, that division bias isn't completely eliminated using this data, since some individuals report only monthly or weekly wages, which are then divided by usual monthly or weekly hours. However, the division bias that results is less than that which would result if annual income were divided by annual hours to generate wage variables.
[14] Several other sample cuts are made. I exclude the self employed, as well as those who are students, retired or disabled. I exclude those for whom I cannot create a valid wage measure, due either to nonresponse or to topcoding. In addition, I exclude a handful of observations in which a member of the couple reports working an implausibly high number of hours (over 4200 hours annually, which corresponds to working more than 80 hours each week all year).
[15] Although it might be desirable to include couples with higher education levels that also might be relatively likely to claim the EITC, given the computationally intensive nature of the estimation method used here, expanding the sample size appreciably was not feasible.
[16] The particular numbers are 40 hours if paid weekly and 160 hours if paid monthly.

on the husband's and wife's age, education, race, number of children, and the presence of children under 6. In addition, I include region and year dummies in the observable demographic characteristics, to account for different tastes for work both across regions and across time.[17] Summary statistics for these variables are presented in Table 2.

[Table 2 about here]

In the estimation, I incorporate fairly detailed versions of federal and state tax systems.[18] I incorporate the standard federal income tax schedule, assuming that everyone claims the standard deduction and takes the exemptions available given their family size. Budget constraints also reflect state income tax schedules, the employee's share of the payroll tax, and AFDC-UP benefits. Finally, both state and federal Earned Income Tax Credit schedules are incorporated, including the investment income test (in applicable years) by which a couple is ineligible for the EITC if their investment income falls above a certain threshold.[19]

As is noted in the appendix, to account for the unobserved wages of individuals who do not work, I estimate a selection corrected auxiliary wage equation separtately for each year of data in the sample, then evaluate the likelihood at each wage in the predicted distribution of wages for each labor force nonparticipant and weight these by their respective probabilities.[20] For the wage regressions, included in both the participation

[17] A more flexible specification would include interactions between demographic characteristics and time dummies to allow the effect of demographic characteristics to differ across time. Such a specification, however, was not computationally feasible.

[18] The major parts of the tax system that are not incorporated are the Alternative Minimum Tax and itemized deductions. However, neither of these is likely to apply to the sample of low educated married women and their husbands that is used in this sample.

[19] This test is intended to keep taxpayers with temporary low earned income but substantial assets from claiming the credit. To implement this, a couple is deemed no eligible for the EITC if their nonlabor income variable (described above) exceeds the threshold for the year of observation..

[20] Another option for dealing with missing wages of nonworkers is to estimate them jointly with the labor supply model (as in van Soest, Das and Gong (2002) in an individual labor supply model), where the

and wage equations are age, education, and ethnicity variables. I exclude the number of children and a dummy for the presence of young children from the wage equation so that identification does not come solely from functional form. The coefficients of the wage equations were generally of the expected sign, and were of plausible magnitudes. Results from these auxiliary regressions are available from the author.

5. Results

Estimation results are presented in Table 3.

[Table 3 about here]

The first panel of the table contains the estimated coefficients on the squared terms in the utility function. These estimates imply that the marginal disutilities of work for both husbands and wives are increasing in their own hours, and increasing in each others hours. In addition, the marginal utility of consumption is positive over the relevant range, and is estimated to be decreasing in consumption. Finally, estimated preferences are quasiconcave for at least one type over the observed range of data.[21]

The next three panels contain the estimated values of and probability weights for

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likelihood of working 0 hours is the joint probability that the wage is low enough and the heterogeneity term is such that the individual desires to work zero hours. However, as noted in Heim (2009) this approach runs into some practical difficulties in this model. If the wage and heterogeneity distribution are discrete, then the likelihood function would be flat in most regions of the parameter space (areas in which a small changes in a node of the wage distribution would not change the desired hours of that type from 0 to positive or vice versa, and so would not change the likelihood), and would have large discontinuous in others (areas in which a small change in either a heterogeneity parameter or a node of the heterogeneity distribution would change the desired hours of that type from zero to positive, which would result in a discrete change in the likelihood). If the distribution is continuous, one would need to solve for the two dimensional region in heterogeneity space over which the desired hours are zero, which is computationally difficult.

[21] This implies that, for all hours observed in the data, there exists an estimated utility function such that the maximization of this utility function subject to a budget constraint could yield that set of hours as the utility maximum.

each of the nodes of the distribution of unobserved heterogeneity. A five heterogeneity node specification was used.[22] Given the quadratic utility specification, these $\beta' s$ can be interpreted as the marginal utility of work for the husband or the wife at 0 hours of work. Thus, for all five of the groups, the marginal utility of work for the husband is initially positive. Most likely, this is an artifact of the functional form employed, in that to capture the clumping around full-time hours, the parameters are driven to exhibiting a positive marginal utility of work at 0 hours of work. The marginal utility of working at 0 hours for the wife, on the other hand, is negative for two of the groups, and positive for the other three.

Considering next the stochastic elements, the standard deviation of measurement or optimization error is estimated to be 257 hours for men, and 694 hours for women. These errors are estimated to be slightly positively correlated.

The next panel presents the coefficients on the demographic variables that are entered as observable taste shifters. A number of the demographic variables in both the husband's and the wife's taste shifters enter significantly. To interpret these coefficients, note that a negative coefficient implies a greater marginal disutility of work at 0 hours, which in turn applies that (all else equal) the individual would work less. For husbands, husband’s and wife's education and husband’s and wife's age squared are estimated to significantly increase work, while the number of children and the husband being black are estimated to significantly decrease work. For wives, own education, age squared, the number of children, and the presence of young children are estimated to significantly

[22] In previous work on a simpler version of this model (Heim (2009)), one, six, and seven node specifications were also estimated. The one node specification yielded substantially higher elasticities, suggesting that accounting for unobserved heterogeneity has an important effect on the estimates. However, results from the six and seven node specification were qualitatively similar to five node specification.

decrease work, while being black or another nonwhite race are estimated to significantly increase work.[23]

To gauge the fit of the model, in Table 4 I present actual hours worked and labor force participation rates from the CPS sample used in the estimation. I then present the simulated hours worked and labor force participation rates that are predicted given the estimated coefficients in the previous table.

[Table 4 about here]

Comparing the actual to the simulated sample statistics, the wife's annual hours are quite close, though mean annual hours of husbands are underpredicted by about 40 hours. Turning to labor force participation, the simulated sample statistics are quite close for both husbands and wives, with labor force participation rates predicted within 2 percentage points of the actual. In addition, when looking at husband-wife pairs of labor force participation rates, all simulated sample statistics are within 2 percentage points of the actual counterpart.

To further gauge the fit of these results, Figure 1 contains histograms of the actual and predicted joint distributions of hours for husbands and wives. The top panel presents the actual hours distribution from the CPS data, and the bottom panel presents the simulated hours distribution using estimated parameters, the estimated heterogeneity distribution, and unemployment draws, but not measurement or optimization errors. These graphs, then, gauge how well the model fits the data without recourse to the error

[23] These results are somewhat different than those found in Heim (2009) using a similar estimation strategy on data from the full 2001 PSID. In that paper, more children and the presence of young children increased work among husbands (while here they are found do decrease work), the presence of young children increased work among wives (here it decreases work), and being nonwhite decreased work among wives (here it increases work). These differences are likely attributable to the lower-educated sample and the time period used in this study.

terms. In the model, the difference between the two is explained by measurement or optimization error.

From these graphs, it appears that the model fits the main features of the data relatively well. In the CPS data, there are two large spikes – one at around 2000 annual hours for the husband (which corresponds roughly to full-time full-year work) and no hours for the wife, and one at around 2000 hours for both the husband and wife. These spikes also appear in the simulated data, although they are slightly less concentrated. In the CPS data, there is a small spick at 0 hours for both the husband and wife, and a similar sized spike is found in the simulated data. In the CPS sample, there is a mass of observations running at 2000 hours for the husband and an amount between 0 and 2000 hours for the wife, while the simulated data also contains a mass in this area. Finaly, in the actual data, two other broad regions contain small numbers of observations (between 0 and 2000 hours for both husband and wife, and above 2000 hours for the husband and between 0 and 2000 for the wife), while the simulated data contains some mass each of these regions.

[Figure 1 about here]

To provide a better interpretation of these parameters, in Table 5, I present the elasticities, both on the intensive and extensive margin, that are implied by these estimated parameters. These elasticities were calculated by taking the difference in mean simulated hours or labor force participation that resulted from a one percent change in wage or income variables. Husband's labor supply elasticities tend to be close to 0 overall, and this is true on both the extensive and intensive margins. The overall own wage elasticity for husbands is estimated to be .025, with the cross and income elasticities being fractions of this size.

[Table 5 about here]

As expected, the estimates elasticities for wives are larger than their husbands', but are still quite small. The own wage elasticity is estimated to be .18, and the cross wage elasticity is estimated to be -.06. Wives are also found to be not very responsive to nonlabor income.

Looking at the extensive and intensive margins, the wives in this sample tend to have higher elasticities on the intensive than the extensive margins. On both of these margins, however, the elasticities are quite small, with elasticities of approximately .03 on the extensive margin, and of approximately .18 on the intensive margin.

It is interesting to note that these married women's elasticities, both on the extensive and intensive margin, are smaller than those estimated in Heim (2009), in which the same method was used to estimate labor supply elasticities for all married women in the 2001 wave of the PSID. In addition, they are smaller than the elasticities estimated when the 1986 PSID was used. Hence, it appears that married women with lower levels of education tend to have labor supply behavior that is much less responsive to wage and income, both on the extensive and intensive margins, than that of women with higher levels of education. Given the tight clumping of around 2000 hours among those who work in this sample, however, this may not be surprising.

6. Effects of EITC Expansion

During the period under analysis, the Earned Income Tax Credit was expanded several times.[24] In 1986, for example, the EITC was expanded as part of the Tax Reform Act of 1986. It was further expanded over three years due the Omnibus Budget Reconciliation Act of 1990, including being made larger for families with two or more children in 1991. A sizable expansion of the EITC was contained in the Omnibus Budget Reconciliation Act of 1993, in addition to a large additional increase for families with two or more children. Finally, the Economic Growth and Tax Relief Reconciliation Act of 2001 expanded, in three increments, the amount of income that a married couple could earn before the EITC begins to phase out.

In this section, then, I use the estimation results presented above to simulate the effects of these expansions on the labor force participation rates and annual hours worked of the married men and women in this sample. To account for the effects of other tax policy changes during this period, I simulate labor supplies of husbands and wives both in the presence and in the absence of the EITC for each year in the sample. Thus, the difference between these two can be interpreted as the effect of the EITC in that particular year.

To put the subsequent simulations in context, in Figure 2, I present sample statistics from the data used in this study. One should keep in mind, of course, that the sample size for each particular year is only about 200 couples, resulting in some noisiness in the trends in variables. That having been said, over the sample period, there seems to have been a general upward trend in annual hours of work for both husbands and wives. Of course, there is considerable variation around this trend. For example, husbands' hours of work decreased during the recession of the early 1990's, and also decreased in 2002.

[24] The literature contains several good descriptions of the history of the EITC. See Hotz and Scholz (2003), Meyer and Rosenbaum (2000), and Ventry (2000), for example.

Wives' hours of work exhibited a similar pattern, although less of a downturn is exhibited during the recession in the early 1990's.

Turning to labor force participation, husband's labor force participation rates are roughly constant over the time period, with well over 90% of the married men in the sample working in any given year. Wife's labor force participation rates are much lower, centering around 50% over the sample period, and display no obvious trend.

[Figure 2 about here]

In Figure 3, I simulate the annual hours of work for the husbands and wives in my sample, and the labor force participation rate of the wives, given the actual distribution of wages, incomes, and state level unemployment rates in each year, using observations only for the year in which they were observed.[25] I perform the simulation both in the presence and absence of the Earned Income Tax credit, so that one can interpret the difference between the two lines as the effect of the EITC on the labor force behavior of these married men and women.

[Figure 3 about here]

In panel (a), I present the simulated annual hours of work for the husbands in the sample. These simulations look qualitatively similar to the actual trends with an increase in husband's hours of work over the sample period, as well as decreases in the early 1990's and 2002. Looking at the difference between these two lines, it appears that the EITC had a dampening effect on the annual hours of these men, accelerating after 1993, of about 4 hours annually.

In Panel (b), the results from such a simulation for the wives in the sample are

[25] Since the husbands' estimated labor force participation elasticity is zero in both specifications, I do not present a graph depicting the effect of the EITC on male labor force participation, since that graph is simply a flat line at zero.

presented. In this panel, the upward trend in annual hours that was seen in the actual data is apparent. The EITC is simulated to have a much larger effect on the annual hours of these women than in the base specification. Prior to the 1993 expansion, the EITC had a minor negative effect on annual hours, but after the expansion the simulated effect on annual hours widens considerably. As a result, these simulations suggest that the EITC dampened the hours worked of married women by around 9 hours a year later in the sample, or about 1%. The effect of the EITC on labor force participation, however, appears to be negligible in panel (c), as the EITC and no EITC trends lay on top of one another.[26]

These estimates of the effects of the 1993 EITC expansions on hours of work of married couples fall within the range of estimates that were found in Dickert, Houser, and Scholz (1995) and in Eissa and Hoynes (2006). Dickert, Houser, and Scholz found predicted negative hours effects ranging from 0-3.14% for husbands, and of .57-4.37% for wives using estimates from the kinked budget constraint literature, and negative effects of around 1% using estimates from the NIT experiments. Eissa and Hoynes estimated hours of work decreased about 1-4% for married women. Thus it appears that this result is also robust to different estimation methodologies.

On the other hand, the absence of an effect of the EITC expansion on the participation margin is not consistent with the results in Dickert, Houser and Scholz (1995) and Eissa and Hoynes (2004). To precisely determine the cause for this difference

[26] One factor confounding these simulations, however, is the fact that as the years pass, the wage distribution of those observed in my sample changes. Thus, the effects confound somewhat the policy driven effects with the effects of the changes in the wage structure over this period. In results not presented here, I have simulated the annual hours of the husbands and wives, and the labor force participation rate of the wives, holding the wage distribution constant. When this is done, the graphs look very similar to those presented here, and so the changing wage distribution is not the primary driver of these results.

would require a step by step tracing through of the differences in sample selection and estimation methodology. However, as noted above, the data and sample selection used in this study are very similar to those in Eissa and Hoynes (2004),[27] and so it is unlikely that the differences on the extensive margin are driven by these differences. A more likely cause is the difference in estimation methodology. Using a similar method on data from the 2001 PSID, Heim (2009) found small elasticities on the extensive margin for married women, and small extensive margin elasticities are found in this study as well for a different sample and different time period.

It is also important to note that Figure 3 only plots mean hours and labor force participation. Although little effect of the EITC was found in these graphs, such graphs could be masking interesting and important effects that differ among subsets of the population. This is especially true in light of the fact that the EITC has differential incentives for work depending on the region of the EITC (phase-in, plateau, or phase-out) in which one is located.

To examine whether this is the case, in Table 6, I present the percent of individuals in the sample simulated to increase or decrease their hours due to the EITC, and the mean hours of this increase or decrease. The sample is also broken out by age group and number of children to examine whether the effects of the EITC differ along these lines.

[Table 6 about here]

From this table it appears that, especially in the post-1993 period, the vast majority of individuals are simulated to decrease their hours in response to the EITC, with less

[27] Both studies use the CPS, and both cut the sample to couples in which the wife has less than a high school diploma. The primary differences are that this study uses a longer timespan of 1985-2003 waves of the CPS, compared to 1985-1997 used in Eissa and Hoynes (2004), and that this study cuts the sample to the outgoing rotation group, while Eissa and Hoynes use the full sample.

than .4% of both husbands and wives simulated to increase their hours. Looking at the subgroups, these decreases tend to be larger for younger individuals, though by a small amount. In addition, the decrease in hours is larger for couples with two or more children, which is to be expected, given the larger EITC available to these families.

7. Policy Simulations

Using the estimates presented above, I perform some counterfactual policy simulations to examine the extent to which proposed changes in the structure of the EITC would affect the labor supply of the married couples in this sample. To do so, I first inflate each individual's wages and incomes to 2002 dollars and simulate the mean annual hours and labor force participation rates of the husbands and wives under the actual policy environment.

I then simulate the annual hours and labor force participation rates under four alternative policies. In the first, the phase-in rate, plateau, and phase-out rate are all increased by 10%. This increases the generosity of the EITC, without changing the range of incomes over which the EITC applies. The second policy simulates the effect of expanding the EITC for those couples with 3 or more children. To do this, I set the phase-in rate for those with three or more children at .46, the plateau at $5775 in 2002 dollars, and the phase-out rate at .26. The plateau is specified to be $3000 wide. In the third policy, I roll back the EITC parameters to their 1992 levels, inflated to 2002 dollars. This, then, examines the effect of rescinding the 1993 expansions of the EITC. Finally, in the fourth policy, I simulate the effects of moving from the current EITC to a wage based EITC, similar to a policy that was proposed at the state level in MaCurdy (2004). Under this policy, an individual's maximum EITC benefit is that which they would receive under the current schedule if they were to work full time. Beyond full time, the benefit schedule stays the same, but if the individual works less than full time, their benefit is prorated according to the proportion of full time hours that they work. By having the EITC increase over all hours short of full time, this policy is intended to eliminate the work disincentive effects that can occur if the phaseout range begins at a lower levels of hours.

The simulated effects of these policies are presented in Table 7. The first policy is simulated to have very small effects on the labor supplies of married couples. These policies decrease annual hours by less than one for the husband and slightly over one hour for the wife, and participation effects are nonexistent.

[Table 7 about here]

The expansion for families with three or more children is also simulated to have very small effect on the labor supplies of married husbands. However, hours of wives are dampened by about 3 hours on average by this policy.

For the final two policies, which both decrease the generosity of the EITC, larger effects are found. In both specifications, husbands' hours are simulated to increase by about 4 hours, and wives' hours are simulated to increase by about 10 hours. Thus, it appears that cutting back the generosity of the EITC by either rolling back the clock or by instituting a policy that is aimed at increasing hours like the wage based EITC would indeed increase the work hours of this population. Such an increase, however, would have to be weighed against the decreased benefits available for this subset of the population.

8. Conclusion

This paper provides new evidence on the effect of the EITC on the labor supply of married couples. Using a method in which labor supply responses on both the extensive and intensive margins could be estimated in one comprehensive model, and using data that span the largest expansions of the EITC, the estimates that resulted suggest modest effects of these changes in EITC policy.

In particular, the resulting estimates implied small labor supply elasticities for both husbands and wives in the sample, with elasticities for husbands positive but close to zero, and elasticities for wives of approximately .18. Simulations suggested that the EITC has a very small negative effect on hours worked of both husbands and wives, with up to a 1% decrease in wives' hours worked.

In addition, these results suggest that previous findings on the effect of the EITC on annual hours of work of married couples are largely robust to alternative behavioral models and sources of variation, as well as to using data from a different time period. However, previous findings of participation effects of the EITC were largely not reflected in this study.

The evidence provided by this study, then, provides policymakers with additional information that may be used to predict the effects that future possible changes to the

EITC may induce. These results suggest that the EITC does have a negative effect on the labor supply of married couples, but that they tend to be on the intensive rather than extensive margin. Hence, these results suggest that the EITC is not subsidizing married women to stay out of the work force, but rather on average subsidizes their ability to stay at home some additional hours during the year. As a result, reasonable changes to EITC parameters are likely to have small effects on the labor supply of married couples overall.

Tables

Table 1
Sample Sizes after Sample Cuts

Year	1985	1986	1987	1988	1989	1990	1991
Married couples in the CPS	35,614	34,642	34,141	34,236	31,931	34,431	34,095
Drop if self-employed	35,552	34,579	34,071	34,188	26,307	28,528	28,189
Keep if ages between 25 and 55	23,184	22,552	22,401	22,353	16,774	18,464	18,182
Drop if retired, disabled, or student	22,133	21,585	21,411	21,362	15,929	17,475	17,207
Keep if in Outgoing Rotation Group	4,243	4,062	3,955	3,991	3,548	4,083	3,891
Keep if wage and hours variables valid	3,598	3,456	3,420	3,416	3,162	3,602	3,468
Keep if wife's education < high school	433	417	400	395	365	465	454
Keep if at least one child	298	256	250	238	226	300	296

Year	1992	1993	1994	1995	1996	1997	1998
Married couples in the CPS	33,418	33,403	32,103	31,837	27,446	27,496	27,561
Drop if self-employed	27,764	27,751	26,502	26,434	22,834	22,801	22,888
Keep if ages between 25 and 55	18,054	18,033	17,298	17,338	14,953	15,068	15,090
Drop if retired, disabled, or student	17,040	16,931	16,070	16,046	13,850	13,982	13,998
Keep if in Outgoing Rotation Group	3,874	3,850	3,530	3,445	2,915	2,974	3,085
Keep if wage and hours variables valid	3,448	3,477	3,169	3,092	2,594	2,676	2,765
Keep if wife's education < high school	447	369	268	252	222	221	233
Keep if at least one child	295	241	170	147	143	151	139

Year	1999	2000	2001	2002	2003	Total
Married couples in the CPS	27,708	27,968	26,905	43,912	43,650	622,497
Drop if self-employed	23,187	23,473	22,741	36,823	36,280	540,892
Keep if ages between 25 and 55	15,225	15,439	14,837	26,020	25,359	356,624
Drop if retired, disabled, or student	14,050	14,230	13,719	24,251	23,465	334,734
Keep if in Outgoing Rotation Group	3,099	3,063	2,951	3,943	3,883	68,385
Keep if wage and hours variables valid	2,818	2,768	2,671	3,539	3,503	60,642
Keep if wife's education < high school	251	240	209	262	243	6,146
Keep if at least one child	154	167	146	181	163	3,961

Notes: Data from the 1985-2003 Current Population Survey.

Table 2
Sample Statistics

	Mean	St. Dev.	Min	Max
Annual Hours of Work of Husband	1972.04	663.76	0	4160
Annual Hours of Work of Wife	840.63	939.30	0	4160
Husband Annual Hours Positive?	0.95	0.21	0	1
Wife Annual Hours Positive?	0.51	0.50	0	1
Wage of Husband	9.75	4.90	3.35	47.1
Wage of Wife	7.71	3.47	3.35	77.25
Other Income of Couple	1603.12	5121.71	0	204167
Age of Husband	38.35	7.41	22	55
Age of Wife	35.73	6.88	25	55
Number of Children	2.27	1.20	1	7
Children Less Than 6?	0.43	0.50	0	1
Years of Education of Husband	9.87	3.18	1	18
Years of Education of Wife	8.58	2.44	1	12
Husband Black	0.07	0.26	0	1
Husband Other Race	0.07	0.25	0	1
Husband Hispanic	0.42	0.49	0	1
Wife Black	0.07	0.25	0	1
Wife Other Race	0.07	0.26	0	1
Wife Hispanic	0.42	0.49	0	1
N	3,961			

Notes: Data from the 1985-2003 Current Population Survey.

Table 3

Estimation Results

Squared and Interacted Terms		Heterogeneity Weights:	
β_{hh}x10^2	-6.790**	π_1	0.080**
	(0.505)		(0.005)
β_{ww}x10^2	-0.898**	π_2	0.476**
	(0.079)		(0.009)
β_{CC}x10^5	-0.240**	π_3	0.391**
	(0.089)		(0.009)
β_{hw}x10^4	-1.230**	π_4	0.023**
	(0.220)		(0.003)
β_{hC}x10^4	-0.120	π_5	0.030
	(0.132)		
β_{wC}x10^4	-0.242*		
	(0.139)		

Husband Nodes:		Wife Nodes	
β_h^1	111.909**	β_w^1	11.880**
	(8.602)		(1.413)
β_h^2	283.229**	β_w^2	29.272**
	(21.097)		(2.441)
β_h^3	283.260**	β_w^3	-37.782
	(21.173)		(164.562)
β_h^4	438.734**	β_w^4	-45.130
	(32.810)		(42501.090)
β_h^5	439.471**	β_w^5	29.361**
	(32.471)		(2.679)

Demographic Characteristics:

α_h:		α_w:	
Husband's Education	0.694**	Husband's Education	-0.112
	(0.136)		(0.105)
Wife's Education	0.493**	Wife's Education	-0.320**
	(0.138)		(0.118)
Husband's Age	-0.014	Husband's Age	-0.016
	(0.086)		(0.061)
Wife's Age	0.137	Wife's Age	0.083
	(0.089)		(0.065)
Husband's Age Squared/1000	0.346**	Husband's Age Squared/1000	-0.210
	(0.147)		(0.177)
Wife's Age Squared/1000	0.273*	Wife's Age Squared/1000	-0.329*
	(0.151)		(0.174)
Number of Children	-0.444**	Number of Children	-1.738**
	(0.145)		(0.189)
Children Less Than 6	-0.062	Children Less Than 6	-0.897**
	(0.216)		(0.249)
Black	-6.235**	Black	2.534**
	(1.940)		(0.790)
Other Race	-0.797	Other Race	1.796**
	(0.502)		(0.690)
Hispanic	0.339	Hispanic	-0.061
	(0.225)		(0.267)
Region Dummies	yes	Region Dummies	yes
Year Dummies	yes	Year Dummies	yes

Stochastic Elements:		Summary Statistics	
σ_h	257.27**		
	(2.61)	Log Likelihood	-47623.960
σ_w	694.48**	N	3961
	(14.39)		
ρ	0.039		
	(0.025)		

Notes: Data from the 1985-2003 Current Population Survey.
** denotes significance at 5% level; * denotes significance at 10% level

Table 4
Estimation Results - True versus Simulated Data

Sample Statistic	Actual	Simulated
Mean Annual Hours - Husband	1972.04	1931.89
Mean Annual Hours - Wife	840.63	845.04
Labor Force Participation - Husband	0.955	0.938
Labor Force Participation - Wife	0.513	0.533
Both Working	0.498	0.500
Husband Working, Wife Not	0.456	0.438
Wife Working, Husband Not	0.015	0.033
Both Not Working	0.031	0.029

Notes: Data from the 1985-2003 Current Population Survey. Simulated hours and labor force participation were calculated using the estimates in Table 2.

Table 5
Estimation Results - Implied Elasticities

Overall Elasticities		Extensive Margin Elasticities		Intensive Margin Elasticities	
Husband Hours w.r.t.		Husband LFP w.r.t		Husband Hours w.r.t	
Husband's Wage	0.0247	Husband's Wage	0.0000	Husband's Wage	0.0247
	(0.0065)		(0.0000)		(0.0065)
	[0.0088, 0.0342]		[0.0000, 0.0000]		[0.0088, 0.0342]
Wife's Wage	-0.0030	Wife's Wage	0.0000	Wife's Wage	-0.0030
	(0.0035)		(0.0000)		(0.0035)
	[-0.0150, -0.0017]		[0.0000, 0.0000]		[-0.0150, -0.0017]
Nonlabor Income	-0.0005	Nonlabor Income	0.0000	Nonlabor Income	-0.0005
	(0.0002)		(0.0000)		(0.0002)
	[-0.0009, -0.0002]		[0.0000, 0.0000]		[-0.0009, -0.0002]
Wife Hours w.r.t.		Wife LFP w.r.t.		Wife Hours w.r.t.	
Wife's Wage	0.1796	Wife's Wage	0.0279	Wife's Wage	0.1796
	(0.0588)		(0.0340)		(0.0563)
	[0.0259, 0.2254]		[0.0125, 0.0654]		[0.0259, 0.2253]
Husband's Wage	-0.0585	Husband's Wage	-0.0059	Husband's Wage	-0.0585
	(0.0210)		(0.0071)		(0.0210)
	[-0.0905, -0.0113]		[-0.0267, -0.0016]		[-0.0908, -0.0113]
Nonlabor Income	-0.0046	Nonlabor Income	-0.0011	Nonlabor Income	-0.0046
	(0.0017)		(0.0009)		(0.0017)
	[-0.0078, -0.0009]		[-0.0021, -0.0001]		[-0.0078, -0.0009]

Notes: Data from the 1985-2003 Current Population Survey. Elasticities were calculated using finite differences. Hours and labor force participation status were simulated for each unobservable type, then weighted by the estimated type weights to yield predicted hours and labor force participation probabilities for each couple, then averaged over all couples in the sample. These calculations were repeated while incrementing wage and income variables by 1% in sequence. The resulting percentage difference in average hours and labor force participation probabilities were divided by 1% to yield the implied elasticities. All elasticities take into account the estimated measurement or optimization error distribution. Bootstrapped standard errors (calculated using 100 draws from the distribution of estimated parameters) are in parentheses, and the 95% CI is in brackets.

Table 6
Heterogeneous Treatment Effects - Changes in Annual Hours

	Pre 1993 Expansion				Post 1993 Expansion			
	% Increased	Mean Increase	% Decrease	Mean Decrease	% Increased	Mean Increase	% Decrease	Mean Decrease
Overall								
Husbands	0.2%	0.26	75.4%	-2.00	0.00%	0.00	82.17%	-5.28
Wives	0.4%	2.16	74.2%	-4.65	0.00%	0.00	81.31%	-12.40
By Age:								
Under 40 Husbands	0.2%	0.08	79.0%	-2.01	0.00%	0.00	86.66%	-5.33
Over 40 Husbands	0.1%	0.83	69.5%	-1.97	0.00%	0.00	75.18%	-5.20
Under 40 Wives	0.6%	2.16	76.6%	-4.72	0.00%	0.00	83.75%	-12.87
Over 40 Wives	0.0%	0.00	67.3%	-4.41	0.00%	0.00	73.75%	-10.77
By Number of Children:								
One Child Husbands	0.1%	0.83	68.1%	-1.99	0.00%	0.00	75.85%	-3.96
Two or More Children Husbands	0.2%	0.08	78.8%	-2.00	0.00%	0.00	84.81%	-5.78
One Child Wives	0.2%	2.80	66.7%	-4.39	0.00%	0.00	73.17%	-7.54
Two or More Children Wives	0.5%	2.02	77.7%	-4.75	0.00%	0.00	84.71%	-14.16

Notes: Data from the 1985-2003 Current Population Survey. Changes in annual hours for each subgroup were calculated using the estimates in Table 2.

Table 7
Policy Simulations

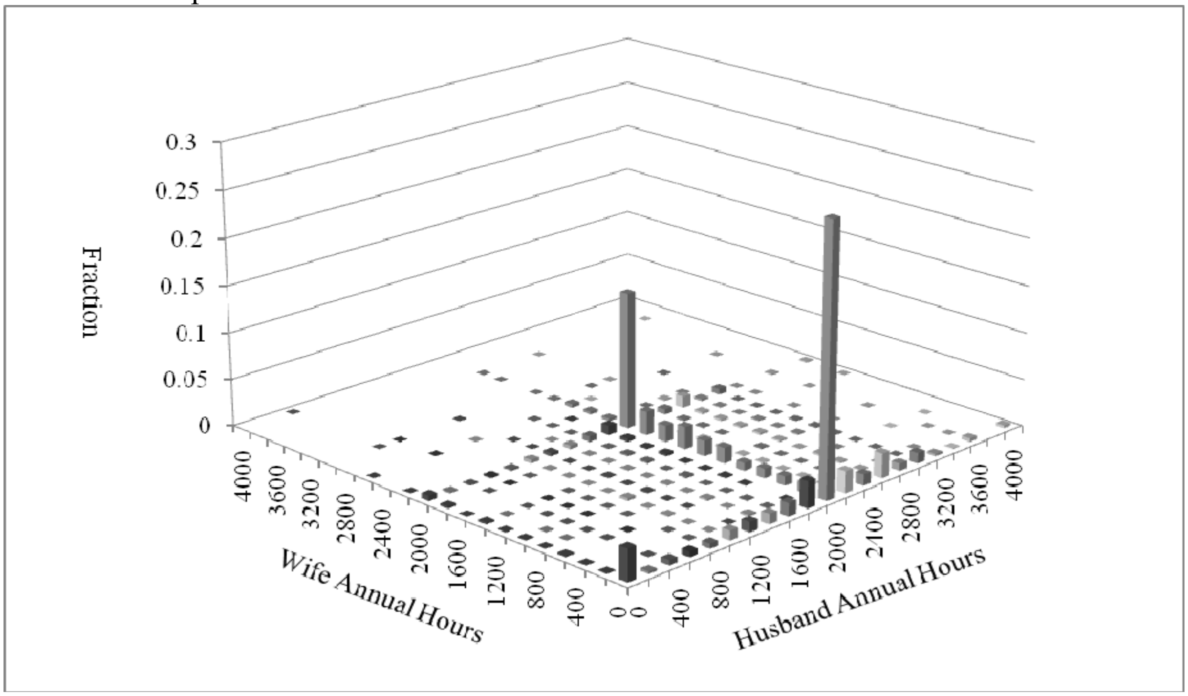
	Policy				
	Actual	10% Increase	Addition of 3rd Child EITC	Rollback to 1992 EITC	Wage Based EITC
Mean Annual Hours - Husband	1935.96	1935.47	1935.20	1939.95	1940.85
Mean Annual Hours – Wife	844.24	843.08	840.65	854.10	855.63
Labor Force Participation - Husband	0.941	0.941	0.941	0.941	0.941
Labor Force Participation - Wife	0.534	0.533	0.533	0.535	0.536

Notes: Data from the 1985-2003 Current Population Survey. Annual hours and labor force participation were simulated using the estimates in Table 2.

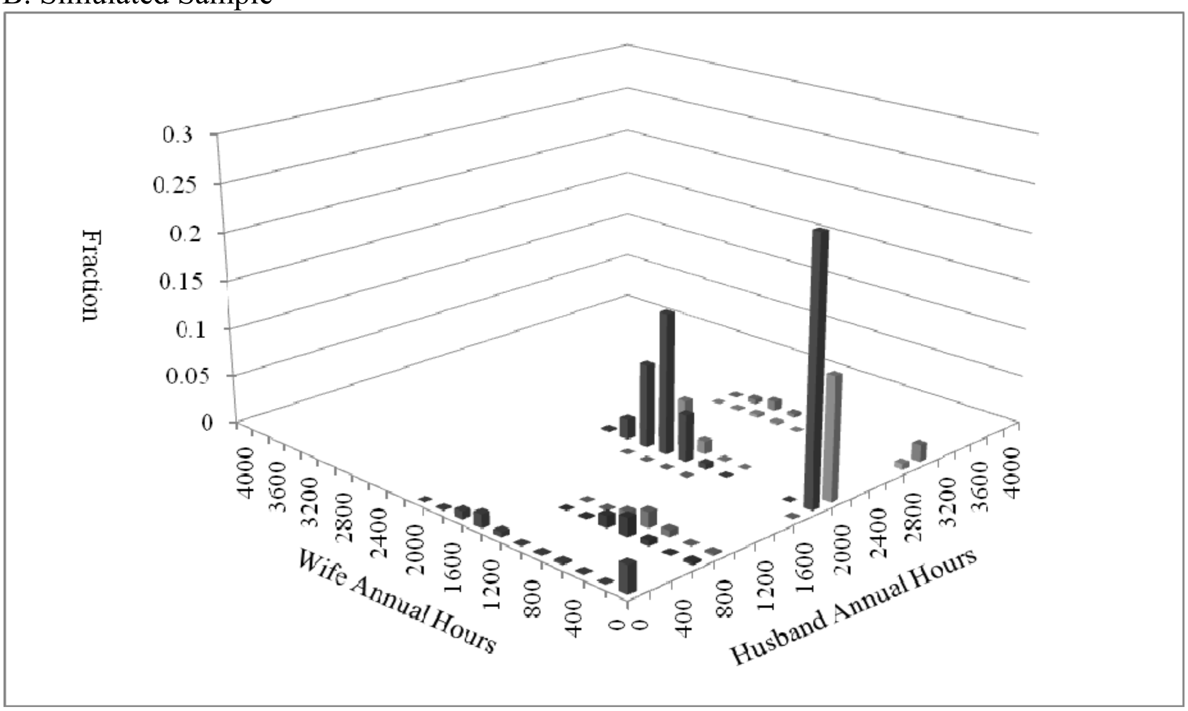
Figures

Figure 1
Actual and Estimated Distribution of Hours

A. Actual Sample

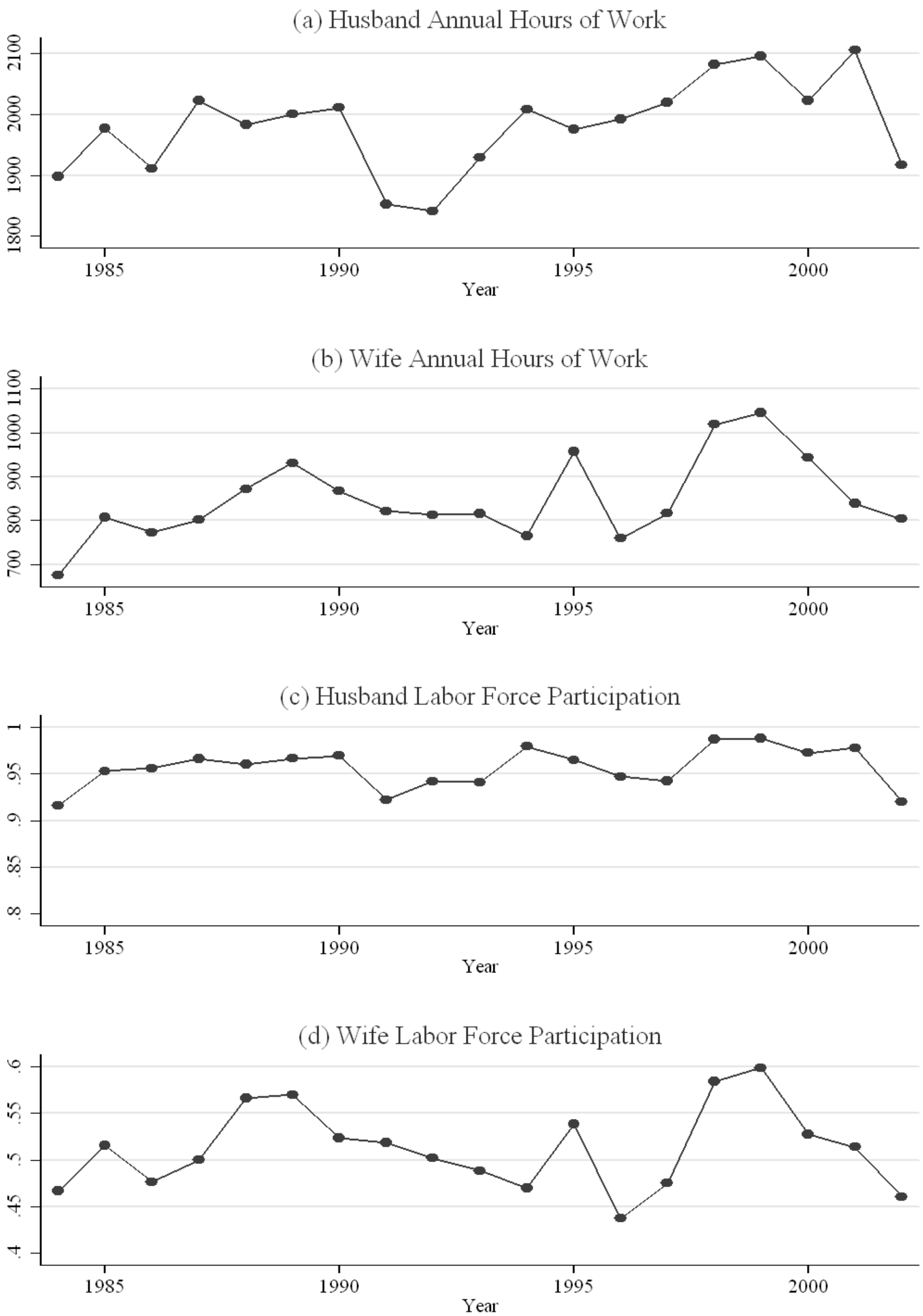


B. Simulated Sample



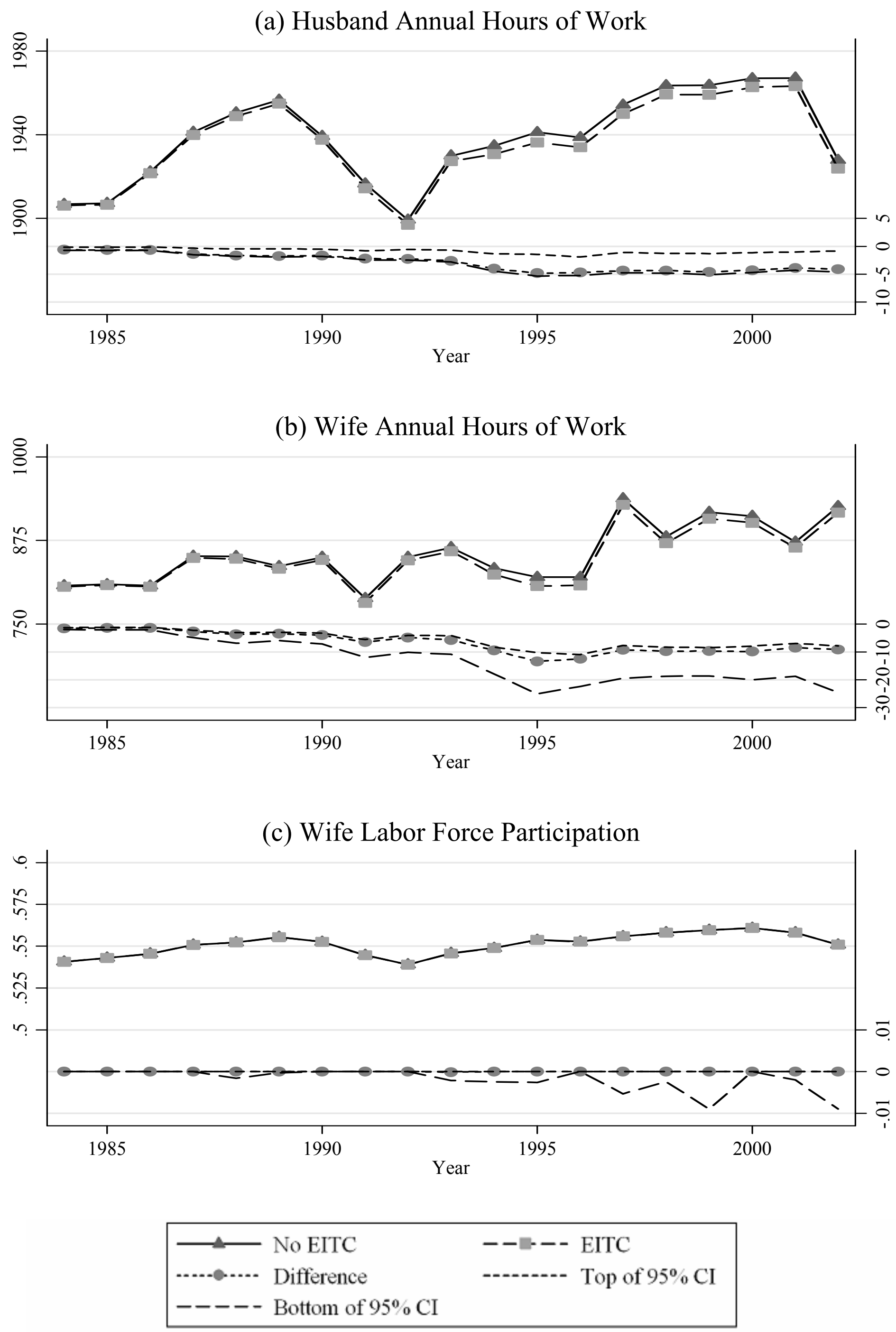
Notes: Data from the 1985-2003 Current Population Survey. Simulated annual hours were calculated using the estimates in Table 2.

Figure 2
Labor Force Participation and Annual Hours Worked – CPS Sample



Notes: Data from the 1985-2003 Current Population Survey.

Figure 3
Labor Force Participation and Annual Hours Worked - Simulated Sample



Note: Data from the 1985-2003 Current Population Survey. Simulated annual hours were calculated using the estimates in Table 2. The top and bottom of the 95% confidence interval were calculated by bootstrapping using 1000 draws from the estimated distribution of parameters.

Appendix. Technical Details of Estimation Method

This appendix describes more fully some technical details of the estimation method.

To understand the hours finding algorithm used as part of the estimation method in this paper, let $U(h_h, h_w, C, v, \theta)$ denote a couple's utility function, where h_h denotes the husband's hours of work, h_w denotes the wife's hours of work, C denotes consumption, v denotes unobserved heterogeneity in tastes for work and θ denotes a vector of parameters of the utility function. Suppose initially that the budget constraint is convex and is given by

$$C \leq B(h_h, h_w, \cdot), \tag{6}$$

The utility maximizing hours or work, h_h^* and h_w^*, clearly satisfy

$$h_h^* = \arg\max_{h_h} \left\{U\left(h_h, h_w^*, C, v, \theta\right): C \leq B(h_h, h_w^*, \cdot), \overline{H} \geq h_h \geq 0\right\} \tag{7}$$

and

$$h_w^* = \arg\max_{h_w} \left\{U\left(h_h^*, h_w, C, v, \theta\right): C \leq B(h_h^*, h_w, \cdot), \overline{H} \geq h_w \geq 0\right\} \tag{8}$$

where $\overline{H}$ denotes the endowment of hours each period.

Given this, a straightforward way to find the utility maximizing combination of hours is to maximize utility over the husband's hours conditional on the wife's hours, then maximize utility over the wife's hours conditional on the husband's hours. To perform each step, one need only search in sequence for the utility maximum along a line, for which several algorithms are available.[28] Then, iterate again in this way, and continue

[28] In practice, I use a bracketing method (see Judd (1998)). Though slow compared to other methods,

until the hours coordinates are changing less than the specified tolerance, so that we have found a fixed point of the system of equations

$$h_h = \arg\max_{h_h} \{U(h_h, h_w, C, v, \theta) : C \leq B(h_h, h_w, \cdot)\} \tag{9}$$

and

$$h_w = \arg\max_{h_w} \{U(h_h, h_w, C, v, \theta) : C \leq B(h_h, h_w, \cdot)\} \tag{10}$$

This algorithm is known as a coordinate direction method, and is guaranteed to find a fixed point to this system.[29]

If the budget constraint is linear, or if the fixed point of this system lies on a plane of a kinked convex budget constraint, we are guaranteed that the fixed point of this system is the unique utility maximum on the kinked budget constraint. However, if the fixed point that this algorithm finds lies along a kink, it is possible that the fixed point is not the utility maximum. Heim (2009) presents an easy fix to this problem: search along the kink segment of the budget constraint, then restart the hours finding iterations.

However, as noted in that paper, such an hours search algorithm will only be guaranteed to find the utility maximizing hours for the couple if the budget constraint is convex. This is because, when the budget constraint is nonconvex, the possibility of multiple fixed points to this system on plane and/or kink segments of the budget constraint exists. This causes a problem for the application of this method to estimation when the EITC is incorporated into budget constraints, since a nonconvexity arises at the end of the phaseout range, when each individual's after tax wage increases from

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bracketing methods have the desirable feature of not requiring the calculation of derivatives, and guaranteeing that a maximum will be found.

[29] See Judd (1998).

$W(1-t_{IncomeTax}-t_{EITC}^{phaseout})$ to $W(1-t_{IncomeTax})$.

To fix this problem, an insight in Hausman (1985) can be applied to adapt the hours finding algorithm to the case of nonconvex budget constraints. Namely, one can treat the nonconvex budget constraint as if it were a union of convex budget constraints. The first budget constraint accounts for the income tax, but not for the EITC. The second budget constraint accounts for both the income tax and the EITC, but does not incorporate the end of the phaseout range. As a result, the second budget constraint will lie above the first at hours below the end of the phaseout range, but the first budget constraint will lie above the second at hours after the end of the phaseout range. At the end of the phaseout range, these two will intersect. If one takes the union of the highest points of these two budget constraints, then, one yields the couple's actual budget constraint. One finds the utility maximizing hours on each of these component convex budget constraints, and compares the utility corresponding to each of these sets of hours to determine the global utility maximizing hours.[30]

Let $h_{hi}^{*}(\theta)$ be the solution to this hours finding algorithm for the husband, and $h_{wi}^{*}(\theta)$ be the solution to this hours finding algorithm for the wife.

To derive the likelihood, assume that ε_{hi} and ε_{wi} are distributed bivariate normal with standard deviations σ_h, σ_w, and correlation ρ. Let u_{si} denote the unemployment rate in couple i's state. The overall likelihood for couple i is

[30] Because the full budget constraint is nonconvex, the utility of these two sets of hours could be equal for some parameter values, and so there needs to be some tie-breaking rule in order for the likelihood function to be well defined. So, when the local utility maxima are equal, it is assumed that couples will choose the set of hours in which they do not claim the EITC over the set of hours in which they claim the EITC.

$$l_i(\theta)=\left[\left[\frac{1}{\sigma_h\sigma_w}b\left(\frac{h_{hi}-h_{hi}^*(\theta)}{\sigma_h},\frac{h_{wi}-h_{wi}^*(\theta)}{\sigma_w},\rho\right)(1-u_{si})^2\right]^{1\left(h_{hi}^*(\theta)>0,h_{wi}^*(\theta)>0\right)}\right]^{1\left(h_{hi}>0,h_{wi}>0\right)}$$

$$\times\left[\left[\Phi\left(\frac{\frac{-h_{wi}^*(\theta)}{\sigma_w}-\rho\left(\frac{h_{hi}-h_{hi}^*(\theta)}{\sigma_h}\right)}{\sqrt{1-\rho^2}}\right)(1-u_{si})^2+\frac{1}{\sigma_h}\phi\left(\frac{h_{hi}-h_{hi}^*(\theta)}{\sigma_h}\right)(1-u_{si})u_{si}\right]^{1\left(h_{hi}^*(\theta)>0,h_{wi}^*(\theta)>0\right)}+\left[\frac{1}{\sigma_h}\phi\left(\frac{h_{hi}-h_{hi}^*(\theta)}{\sigma_h}\right)(1-u_{si})\right]^{1\left(h_{hi}^*(\theta)>0,h_{wi}^*(\theta)=0\right)}\right]^{1\left(h_{hi}>0,h_{wi}=0\right)} \tag{11}$$

$$\times\left[\left[\Phi\left(\frac{\frac{-h_{hi}^*(\theta)}{\sigma_h}-\rho\left(\frac{h_{wi}-h_{wi}^*(\theta)}{\sigma_w}\right)}{\sqrt{1-\rho^2}}\right)(1-u_{si})^2+\frac{1}{\sigma_w}\phi\left(\frac{h_{wi}-h_{wi}^*(\theta)}{\sigma_w}\right)u_{si}(1-u_{si})\right]^{1\left(h_{hi}^*(\theta)>0,h_{wi}^*(\theta)>0\right)}+\left[\frac{1}{\sigma_w}\phi\left(\frac{h_{wi}-h_{wi}^*(\theta)}{\sigma_w}\right)(1-u_{si})\right]^{1\left(h_{hi}^*(\theta)=0,h_{wi}^*(\theta)>0\right)}\right]^{1\left(h_{hi}=0,h_{wi}>0\right)}$$

$$\times \left[\begin{array}{l} \left[\begin{array}{c} B\left(\frac{-h_{hi}^*(\theta)}{\sigma_h}, \frac{-h_{wi}^*(\theta)}{\sigma_w}, \rho\right)(1-u_{si})^2 \\ +\Phi(\frac{-h_{hi}^*(\theta)}{\sigma_h})(1-u_{si})u_{si} \\ +\Phi(\frac{-h_{wi}^*(\theta)}{\sigma_w})(1-u_{si})u_{si} \\ +u_{si}^2 \end{array} \right]^{1(h_{hi}^*(\theta)>0, h_{wi}^*(\theta)>0)} \\ + \left[\begin{array}{c} \Phi\left(\frac{-h_{wi}^*(\theta)}{\sigma_w}\right)(1-u_{si}) \\ +u_{si} \end{array} \right]^{1(h_{hi}^*(\theta)=0, h_{wi}^*(\theta)>0)} \\ + \left[\begin{array}{c} \Phi\left(\frac{-h_{hi}^*(\theta)}{\sigma_h}\right)(1-u_{si}) \\ +u_{si} \end{array} \right]^{1(h_{hi}^*(\theta)>0, h_{wi}^*(\theta)=0)} \\ \quad +1\left(h_{hi}^*(\theta)=0, h_{wi}^*(\theta)=0\right) \end{array} \right]^{1(h_{hi}=0, h_{wi}=0)},$$

where $b(k,l,\rho)$ denotes the p.d.f. of the standard bivariate normal distribution with correlation ρ, and $B(k,l,\rho)$ denotes the c.d.f. of the standard bivariate normal distribution, cumulative over $(-\infty,k]\times(-\infty,l]$. The sample likelihood is hence

$$L = \prod_i l_i(\theta). \tag{12}$$

Unobserved heterogeneity is accounted for in the same manner as in Heim (2009), by assuming that each couple is one of a finite number of types.[31] As such, let $\{v_h^j, v_w^j\}_{j=1}^J$ denote the nodes of a discrete distribution of heterogeneity in taste for work, and $\{\pi^j\}_{j=1}^J$ denote their respective probabilities. The likelihood function may then be adapted in two steps. First, replace $h_{hi}^*(\theta)$ and $h_{wi}^*(\theta)$ with $h_{hi}^*(\theta, v_h^j, v_w^j)$ and $h_{wi}^*(\theta, v_h^j, v_w^j)$, respectively, in the above likelihood function. This is the likelihood, given that the husband and wife's

[31] Hoynes (1996) also uses this approach.

values from the heterogeneity distribution are v_h^j and v_w^j, respectively. Denote this likelihood $l_i(\theta, v_h^j, v_w^j)$. The overall likelihood is calculated by weighting each of these j conditional likelihoods by the probability that the heterogeneity nodes take this value, and summing over all nodes of the heterogeneity distribution. Formally, the likelihood for couple i is

$$l_i(\theta) = \sum_{j=1}^{J} \pi^j l_i(\theta, v_h^j, v_w^j) \tag{13}$$

These nodes and weights are estimated along with the rest of the parameters, subject to some straightforward normalizations.

To account for the missing wages of nonworkers, I follow Heim (2009) in adapting a specification in van Soest (1993). Namely, I first estimate a selection corrected auxiliary wage equation for each year of data. I then evaluate the likelihood at each wage in the predicted distribution of wages for each labor force nonparticipant, and weight these by their respective probabilities.

Formally, the likelihood function is thus augmented as follows. Let $l_i(\theta, w_h^p, w_w^p)$ be the likelihood for a couple who both do not work, given predicted wages w_h^p and w_w^p. The overall likelihood for this couple is then

$$l_i(\theta) = \int_0^\infty \int_0^\infty l_i(\theta, w_h^p, w_w^p) dF^h(w_{hi}^p) dF^w(w_{wi}^p)$$

(14)

where $F^h(w_{hi}^p)$ denotes the distribution of predicted wages for the husband of couple i, and $F^w(w_{wi}^p)$ denotes the distribution of predicted wages for the wife of couple i. To evaluate this double integral, I use Gaussian quadrature techniques, replacing the double integral with a weighted double sum of the form

$$l_i(\theta) = \sum_{j=1}^{J}\sum_{k=1}^{K}\pi_j \pi_k l_i\left(\theta, w_{hj}^p, w_{wk}^p\right) \tag{15}$$

where $\left\{w_{hj}^p\right\}_{j=1}^J$ and $\left\{w_{wk}^p\right\}_{k=1}^K$ are the nodes at which the likelihood is evaluated, and $\left\{\pi_j\right\}_{j=1}^J$ and $\left\{\pi_k\right\}_{k=1}^K$ are the weights.[32] In practice, I use 10 nodes.

For couples with only one nonworking member, the likelihood is defined and calculated analogously to the method described above.

This approach has the benefit that one does not need to assume that wages are predicted exactly in order for the likelihood to be specified correctly, but has the undesirable property that the wage distribution is predicted outside of the structural model.

[32] As noted in Butler and Moffitt (1982), such an approximation is exact if the integrand is a function of the form $e^{-Z}g(Z)$, where $g(Z)$ is a polynomial of degree less than $2K-1$. Since the normal probability density function is of this form, this approach can calculate the likelihood with a higher degree of accuracy, given a number of evaluation nodes, than would a straightforward random draws approach.

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