TAX CREDITS, LABOR SUPPLY, AND CHILD CARE

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Abstract—We explore the impact of the child care tax credit in the U.S. income tax system on the labor supply decisions of married women with young children by incorporating the cost of child care into a structural labor supply model. Using data from the 1986 NLSY, we find that government subsidies to child care increase labor supply substantially. Our policy simulations show that an increase in the value of the child care tax credit (i.e., percent of expenditures subsidized) would have a much larger effect on labor supply than an increase in the annual expenditure limits of the subsidy or making the subsidy refundable.

I. Introduction

IN 1992 60% of the women in the United States with children under the age of six participated in the labor force, and almost 9 million children under the age of five received some kind of nonmaternal child care (U.S. Bureau of the Census (1993)). Since the pioneering work of Becker (1965) and Heckman (1974), economists have recognized the importance of child care costs in women's labor market decisions. However, much of the empirical research in this area is new, and conflicting results concerning the labor supply effects of child care costs have been reported (Ribar (1992) and Michalopolous et al. (1992)). Using data from the 1986 wave of the youth cohort of the National Longitudinal Surveys of Labor Market Experience, we find that government subsidies to child care substantially increase the labor supply of married women with young children.

The federal government subsidizes child care through a myriad of programs. One of the largest of these in dollar terms is the Child Care Tax Credit (CCTC), which has been a part of the U.S. income tax system since 1976. The revenue loss attributable to this credit was estimated to be $3.8 billion dollars in 1988. In that same year the average tax credit claimed per family was $423 (Robins (1991, table 2)).

The CCTC directly reduces the tax liability of a family. It is worth 30% of annual child care expenditures for a family with an adjusted gross income (AGI) of $10,000 or less. The subsidy rate declines by one percentage point for every $2000 of additional AGI. For families with AGI greater than $28,000 the subsidy rate is 20%. In addition, the CCTC limits the annual expenditures eligible for the credit to $2400 for one-child families and $4800 dollars for families with two or more children. Table 1 presents the specific details of the CCTC. Because the CCTC is not refundable, it is limited to the amount of an individual's tax liability.[1]

This paper examines the impact of child care costs and the CCTC on the labor supply decisions of women with young children by incorporating the cost of child care into a structural model of labor supply. Our model is unique in that we explicitly account for the piecewise linear nature of the budget set created by the presence of the CCTC and the federal income tax system. While recent research has modeled the structural relationship between child care and labor supply, and made reference to the kinked budget set that such subsidies create, none has explicitly incorporated the nonlinearities in their estimation. (See, for example, Ribar (1990) and Michalopoulous et al. (1992).) Because we account for the full nonlinear budget set, our method also allows us to simulate the effects of specific policy changes to the CCTC.

The paper is organized as follows. In section II we describe the theoretical framework that incorporates child care costs into a standard labor supply model. Section III outlines the estimation method. Section IV describes the data we use and presents the empirical results from estimating the structural labor supply function. Section V describes the results of policy simulations, and section VI offers conclusions.

II. Theoretical Framework

The labor supply estimation presented below is derived from a static model that incorporates the constraints faced by households with young children who require continuous care.[2,3] We adopt a household production framework that specifies the mother as the primary child caregiver, and we assume that the husband's income is exogenous to the wife's labor supply decision.[4] Since preschool-aged children require full-time care, the mother's own time allocation decision is determined jointly with the decision about child

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[1] Robins (1991) notes that as part of the Omnibus Budget Reconciliation Act of 1990 there is a new refundable tax credit for families with children under the age of one. This credit is not available for families who elect to use the existing nonrefundable child care tax credit.

[2] See Connelly (1992) and Ribar (1992) for related specifications.

[3] See Averett et al. (1992) for the full development of a formal model of labor supply and choice of child care. In that theoretical specification we also allow for the possibility that the CCTC can affect the choice of quality of formal child care (i.e., the hourly cost) and the choice of formal versus informal care. To make the estimation tractable, in this paper we abstract from these other behavioral responses and focus exclusively on the mother's labor supply function. We leave the more complex estimation for future work.

[4] For simplicity, it is also assumed that fertility is exogenous. See Blau and Robins (1989) for a model that examines the relationship between fertility, labor supply, and the child care tax credit. They find some indication that higher child care costs have a negative effect on fertility.

TABLE 1.—CURRENT CHILD CARE TAX CREDIT

Adjusted Gross Income ($)	Credit (%)	Maximum Credit ($)	
		One Child	Two+ Children
10,000	30	720	1440
12,000	29	696	1392
14,000	28	672	1344
16,000	27	648	1296
18,000	26	624	1248
20,000	25	600	1200
22,000	24	576	1152
24,000	23	552	1104
26,000	22	528	1056
28,000	21	488	1008
28,001+	20	480	960

TABLE 2.—1986 MARGINAL TAX RATES

Taxable Income ($)	Marginal Tax Rate (%)
0–3,670	0
3,671–5,940	11
5,941–8,200	12
8,201–12,480	14
12,481–17,270	16
17,271–21,800	18
21,801–26,550	22
26,551–32,270	25
32,271–37,980	28
37,981–49,420	33
49,421–64,750	38
64,751–92,370	42
92,371–118,050	45
118,051–175,250	49
More than 175,250	50

care. Thus, entering the labor market is equivalent to participating in the child care market, and the labor supply decision of a mother with young children is dependent on the cost of child care.

Some studies suggest treating child care costs as a fixed cost of work (Killingsworth (1983)). In this paper we characterize child care costs as a cost per hour of work. This characterization comes directly from a time constraint where preschool children must be cared for by either the mother or some alternative form of child care. Thus for each hour the mother is working, she is purchasing some form of child care.

We distinguish between two modes of child care: formal and informal.[5] Formal child care is explicitly purchased in the market and includes day care centers, paid care in the child's home, and paid care in someone else's home. Our definition of formal care coincides with the federal government's definition of child care costs that are eligible for the CCTC.[6] Informal child care includes care provided by relatives such as the father, grandparents, or older siblings and nonpaid care by neighbors or friends. We assume that there are no monetary payments associated with this kind of care. Instead, informal care has an unobserved shadow price that reflects, for example, the time costs of future obligations incurred in trade for child care services. We also assume that hours of formal care demanded and hours of informal care demanded are equal to the mother's hours of market work.

The cost of child care, the CCTC, and the federal income tax enter the model through the budget constraint. In a standard labor supply model the slope of the budget constraint is the gross wage rate (w). In our model the slope of the budget constraint is the effective wage (w^*), defined as the gross wage net of taxes and child care costs. Let h_f equal the number of hours of formal child care purchased at a price per hour p_f, and let h equal the total number of hours worked. Then $h - h_f$ is the number of hours in informal care, with a shadow price per hour p_i. The effective wage can be specified as follows:

$$w^* = w(1 - t_b) - (1 - s_b)p_f\left(\frac{h_f}{h}\right) - p_i\left(\frac{h - h_f}{h}\right) \tag{1}$$

where s_b is the percentage of child care costs that are subsidized on budget segment b and t_b is the marginal tax rate (MTR) on that segment. Note that the CCTC only applies to formal child care expenses. The first term on the right-hand side is the after-tax wage, the second term is the hourly reduction due to formal care, and the last term is the hourly reduction due to informal care. As a woman supplies more labor to the market, her effective wage changes according to the schedules in tables 1 (CCTC) and 2 (MTR). Kink points are created in her budget set at discrete intervals at the points where the CCTC subsidy rates and the MTRs change.[7] For example, for low-income women whose nonearned income is high enough so that they incur a tax liability, the first segment of the budget set is associated with a CCTC rate of 30% and an MTR of 11%, and for them the budget set is strictly convex. For those low-income women whose nonearned income is so low that they have no tax liability, the first segment of the budget set is associated with an MTR of zero and no CCTC. Once they work enough hours to incur a tax liability, they have a CCTC of 30% and an MTR of 11%. For these women there is the possibility of an initial nonconvexity in the budget set.[8]

One problem in implementing the measure of the effective wage specified in equation (1) is that the shadow price of informal care is unobserved. Although unobserved, a woman must incur some nonmonetary costs of informal care, such as psychic costs, quid-pro-quo agreements, or implicit

[5] Ribar (1992) and Blau and Robbins (1988) make a similar distinction between formal and informal care.

[6] Monetary payments made to immediate family members or to other individuals who are claimed as dependents for income tax purposes are not eligible for the CCTC.

[7] The subsidy rate is a function of adjusted gross income, and the MTR is a function of taxable income. The difference between taxable and adjusted gross income is the personal exemption and itemized deductions, if the family itemizes. In order to make the CCTC and the MTR cutoffs comparable, we redefine the CCTC cutoff points on the basis of taxable income.

[8] The nonconvexity occurs as long as the CCTC is greater than the tax liability. Note that the rates on the first segment depend on the level of the woman's nonearned income.

claims in time or resources. Economic theory tells us that at the margin the price of formal and informal care should be equal for those who use both kinds of care.[9] Thus as long as the amount of formal versus informal care is chosen such that $p_i = (1 - s_b)p_f$, we can use the price per hour of formal care demanded as a reasonable approximation for the full price of child care per hour worked.[10] This argument leads to the following specification of the effective wage[11]:

$$w^* = w(1 - t_b) - (1 - s_b)p_f. \tag{2}$$

The implications of this model are similar to those obtained in a standard static labor/leisure model. A woman will choose her hours of work so that the marginal rate of substitution between household production and consumption goods is just equal to the effective wage. Women whose productivity of time in the home is greater than their effective wage will choose not to participate in the labor market.

Some of the child care literature has argued that the appropriate measure of child care costs is the dollars paid per hour worked (Connelly (1992)). This measure is equivalent to assuming that the shadow price of informal care is zero. The measure could be interpreted as a lower bound on the average cost of child care.[12] We present empirical results using this alternative measure of child care costs in appendix A.

III. Estimation Methodology

Labor supply is measured in annual hours of work. The key exogenous variables of interest are the mother's hourly wage rate, the hourly cost of formal child care, and the mother's nonwage income. The inclusion of both the subsidy created by the CCTC and the federal income tax is problematic for estimation purposes because the observed CCTC rate and the MTR are endogenous variables. Since s_b and t_b are a function of taxable income, and taxable income is a function of labor supply, the observed w^* is endogenous because women with greater tastes for work will receive lower subsidies and pay higher income taxes. Consistent estimation of the parameters in this model requires the use of econometric procedures developed for models with piecewise-linear budget sets. (See Hausman (1981) and Moffitt (1986).) These techniques have been applied to a number of tax/transfer programs, but this study is the first to apply these techniques to the CCTC.

The CCTC has some important features that we incorporate into our estimating model. For example, the amount of the annual child care expenditures that are eligible for the tax credit is limited. As stated earlier, the current law allows \$2400 in expenditures for one-child families and \$4800 for families with two or more children. This constraint implies that when child care expenditures exceed the limit, the mother's wage reverts back to the no-subsidy wage rate. In addition, the CCTC is not refundable, which means that the credit is limited to the amount of the taxpayer's liability. The impact of nonrefundability is to create an initial nonconvexity in the budget set.

To implement our estimation procedure we first construct a budget set for each woman in the sample. The budget set is exogenously determined by her nonwage income, hourly wage rate, the CCTC schedule, and the federal income tax schedule. A maximum of 25 budget segments and 24 interior kink points can be faced by a given woman. However, some women may face fewer segments because of the level of nonwage income. The number of hours associated with the bth kink in the budget set (h_b^*) is a function of the woman's gross wage rate (w), her nonwage income (Y), the CCTC, and the federal income tax,

$$h_b^* = (C_b - Y)/w \tag{3}$$

where C_b represents the income levels at which there is a change in the CCTC or the federal income tax. Virtual income (Y_b) for a woman on a given segment is measured at the intersection of that segment with the vertical axis, i.e., at zero hours of work (Hausman (1981)). Virtual income can be calculated as

$$Y_b = Y + (w_b^* - w_{b+1}^*)h_b^*. \tag{4}$$

In our analysis we use both an instrumental-variables estimator and a variant of the nonlinear budget set model, sometimes called the dual-error term model, which allows for two sources of random error. (See Moffitt (1986, 1990) for a more detailed description of this method.) The advantage of the dual-error term specification over the simpler instrumental-variables estimator is that the latter does not allow modeling of the kinks in the budget set. By explicitly accounting for the full nonlinear budget set, the dual-error term method also allows us to simulate the effects of very specific policy changes to the CCTC.

In the dual-error term model unobserved heterogeneity of preferences is represented by ϵ_h, an additive zero-mean random error which shifts the indifference curves along the budget set. This error term is assumed to be fixed for a given individual and is normally distributed across the population, with zero mean and variance equal to σ_h^2. The other source of random error is ϵ_r, which represents measurement or optimization error. This error term is also fixed for a given

[9] Of those paying for child care, 51% used both formal and informal modes of child care.

[10] Our measure will be an upper bound on the cost of child care for those families who use only informal care.

[11] Our measure of costs is most similar to that of Ribar (1992) and Hotz and Kilburn (1991), although they calculate costs per child. In contrast, Connelly (1992) measures child care costs as the cost of formal care per hour worked. Blau and Robins (1988) use weekly child care expenditures averaged over families living in the same geographic area, and Michalopoulos et al. (1992) use total monthly expenditures on child care.

[12] In order for there to be any demand for formal care when the price of formal care is greater than the price of informal care, it must be true that, holding quality constant, the supply of informal care is inelastic, and that the availability of informal care differs across individuals.

individual, assumed uncorrelated with ϵ_h, and normally distributed across the population with zero mean and variance equal to σ_r^2.

Adopting a linear specification of the labor supply function, we express desired hours on the *b*th budget segment as

$$h_b = SEG_b + \epsilon_h \tag{5}$$

where

$$SEG_b = \beta[w(1 - t_b) - (1 - s_b)p_f] + \delta Y_b + \alpha' Z. \tag{6}$$

Here Z denotes a vector of demographic variables and b ranges over the 25 possible budget segments.[13] The parameters α, β, and δ of the model are assumed to be fixed across individuals. Because the budget set is nonlinear, equation (5) holds conditional on being located on a specific segment on the budget set, with the wage and virtual income corresponding to that budget segment being substituted into equation (5).

For the convex portion of the budget set desired hours will be on the *b*th budget segment only if h_b falls between the two bordering kink points as follows:

$$h^*_{b-1} - SEG_b < \epsilon_h < h^*_b - SEG_b. \tag{7}$$

Alternatively, it is possible that a woman desires to locate exactly on a kink in her budget set. In this case desired hours are expressed as

$$h_b = h^*_b, \quad \text{if } h^*_b - SEG_b < \epsilon_h < h^*_b - SEG_{b+1}. \tag{8}$$

For women who face the initial nonconvexity of the budget set due to the nonrefundability of the CCTC, we specify the explicit form of the indirect utility function and solve for the value of the heterogeneity error term that equates utility on segments 1 and 2. Following Hausman (1985), the indirect utility function that corresponds to a linear labor supply function can be written as

$$V(w_i, Y_i, \epsilon_h) = \exp\,[Y + (\beta/\delta)w_i - (\beta/\delta^2) + z(\alpha/\delta) + (\epsilon_h/\delta)]. \tag{9}$$

Let $m(1, 2)$ be the value of ϵ_h that equates utility on segments 1 and 2. Desired hours will occur on segment 1 if

$$-SEG_1 < \epsilon_h < m(1, 2) - SEG_1 \tag{10}$$

and on segment 2 if

$$m(1, 2) - SEG_2 < \epsilon_h < h^*_b - SEG_2. \tag{11}$$

Note that location at the first kink in the budget set is not feasible for those women who face the initial nonconvexity.

The presence of the measurement error term implies that observed hours are not necessarily equal to desired hours. Instead observed hours of work (h) are equal to desired hours of work plus measurement error (ϵ_r),

$$h = SEG_b + \epsilon_h + \epsilon_r. \tag{12}$$

In appendix B we describe the detailed specification of the likelihood function for workers and nonworkers. In general terms it can be expressed as

$$L = \prod f(h) \prod F(h = 0). \tag{13}$$

The first product in equation (13) is the contribution to the likelihood function for the workers (appendix B, eq. (B.1)) and the second product is the contribution for the nonworkers (appendix B, eq. B.2)).[14]

IV. Data and Empirical Results

The data are from the 1986 wave of the National Longitudinal Surveys of Labor Market Experience of Youth (NLSY).[15] Respondents in the 1986 wave of the NLSY were 21–29 years old. To be included in our sample, a woman must be married with spouse present and have at least one child under six years of age in the household. Eliminating women with missing observations on key variables leaves a sample of 749 women.

The wage and income variables pertaining to the 1986 calendar year are from the 1987 wave of the NLSY. Wages are calculated by dividing annual earnings by annual hours. Total family income includes all sources of nonwage income and labor earnings of husband and wife. We subtract the wife's labor earnings from the total family income to obtain a measure of her nonwage income. Nonwage taxable income is measured by subtracting the number of personal exemptions from this total. The personal exemption was \$1080 per dependent in 1986.[16]

[13] The lower limit of desired hours of work is assumed to be zero and the upper limit is 8760, the total number of hours in a year. Triest (1990) makes the same assumption. Because of child care costs and the progressivity of the MTR and the CCTC, some of the women in our sample reach a point where their net wage (w*) becomes negative. Economic theory tells us that women will never desire to work to the point where the wage becomes negative. Therefore the upper limit of desired hours for these women is the number of hours associated with the last kink point before their net wage becomes negative.

[14] Moffitt (1986) demonstrates how the bivariate densities can be factored into two univariate densities, one conditional and one unconditional. The likelihood function expressed in univariate densities is available from the authors upon request.

[15] The *NLS Handbook* (1988) contains a detailed description of the data.

[16] We assume that each family claims at least three exemptions, two for the parents and one for each child. Because we do not know if a family itemizes, we assume that they take the standard deduction. The IRS mandates that couples claiming the CCTC must file jointly, and we use the appropriate tax schedule for such families. We ignore state taxes and the earned income tax credit (EITC) as they further complicate an already complex estimation procedure. State taxes are a small portion of income tax revenues (Whittington (1993)). The EITC would affect less than 10% of our sample at their chosen hours of work. Flexible spending accounts are another avenue for reducing the burden of child care costs, but were not

In 1986 the NLSY asked all women with children in the household about their child care usage during the last four weeks prior to their interview date. Respondents report up to two kinds of care for each child in the family. They are then asked how many hours each child spends in each type of care and how much in total they spend per week on child care. We calculate the hourly price of child care as total expenditures per week divided by total hours demanded per week.[17]

The means of the variables are presented in table 3. Seventy percent of the 749 women in our sample work, and 44% of the working women use some formal child care.[18] Of those paying for child care, 75% use more than one mode of care. Note that women who use formal child care have on average higher incomes, higher wages, more work experience, and fewer children than those women who use only informal child care.

To estimate the structural model we need a measure of each woman's effective wage rate. Calculation of this variable requires an hourly wage and an hourly price of formal child care for every woman in the sample. Wages are only observed for working women. We construct a wage for all women in the sample, using standard techniques to correct for possible selectivity bias (Heckman (1979)). These results are reported in appendix C.[19]

The price of formal child care is endogenous because it depends on the choice of quality. We instrument this price using estimates of the cost of formal care derived from the sample of working women who purchase care.[20] To control for multiple selection criteria, we first estimate a variant of the bivariate probit model of employment and, conditional on employment, the choice between formal and informal care (see Wynand and Bernard (1981)). We then estimate the cost of formal child care, including as regressors the selection terms calculated from the bivariate probit. To control for tastes for quality of formal child care we include the mother's education and the family income net of the mother's earnings. We also include measures of the number and ages of her children to account for factors that would shift the cost of the formal child care function.

TABLE 3.—SAMPLE MEANS

	All Women	Working	Working, Use Some Formal Care[b]	Working, Use Only Informal Care	Nonworking
Annual hours	1029.63	1446.89	1711.15	1240.08	—
	(889.11)	(711.77)	(541.70)	(759.77)	
Mother's age	25.49	25.61	25.76	25.49	25.19
	(2.30)	(2.27)	(2.24)	(2.29)	(2.36)
Nonearned income ($1000)	21.70	21.10	21.88	20.49	23.18
	(15.05)	(14.62)	(14.89)	(14.39)	(15.99)
Labor market experience	4.51	5.17	5.84	4.64	2.90
	(2.70)	(2.58)	(2.48)	(2.55)	(2.26)
Number of children	1.68	1.63	1.57	1.68	1.81
	(0.78)	(0.79)	(0.73)	(0.83)	(0.81)
Age of youngest child	1.71	1.76	1.76	1.76	1.58
	(1.51)	(1.52)	(1.47)	(1.57)	(1.47)
Education	12.24	12.49	12.62	12.39	11.62
	(1.95)	(1.85)	(1.86)	(1.84)	(2.05)
Hourly wage	7.21	7.21	7.39	7.06	—
	(6.50)	(6.50)	(4.90)	(7.51)	
Hourly cost of child care per hour purchased	—	—	1.66	—	—
			(2.81)		
Two children[a]	0.39	0.37	0.34	0.38	0.46
Three or more children[a]	0.13	0.12	0.11	0.12	0.15
Any child age 6–12[a]	0.23	0.30	0.27	0.25	0.22
Other relative in household[a]	0.08	0.08	0.07	0.10	0.08
SMSA[a]	0.72	0.73	0.72	0.74	0.69
North Central[a]	0.22	0.22	0.21	0.23	0.20
West[a]	0.21	0.19	0.17	0.22	0.24
South[a]	0.42	0.43	0.47	0.39	0.41
Black[a]	0.15	0.17	0.18	0.17	0.10
Hispanic[a]	0.17	0.15	0.18	0.13	0.21
Sample size	749	533	234	299	216

Note: Standard deviations are in parentheses. Hourly wage and hourly cost of formal child care are only observed for working women and working women who pay for child care.
[a] Proportion of sample with given characteristic.
[b] This sample includes some women who use both formal and informal care.

The results from predicting the cost of formal child care are shown in table 4. We focus our discussion on the estimates of the probability of choosing formal versus informal care (column 2) and on the cost of child care equation (column 3), because the employment equation results are relatively standard. The results from column 2 indicate that having more children reduces the probability of purchasing formal child care, although the estimated coefficients are not statistically significant. Higher nonwage income increases the probability of purchasing formal care. Working Hispanic women are also more likely to choose formal child care modes. This result is similar to the findings of Leibowitz et al. (1988), who report that Hispanic women are more likely to pay for home care for infants. We also find that education has a significant and negative impact on the probability of choosing formal care. This result is in contrast to Connelly (1991), who reports a positive, but statistically insignificant effect of education. We expect that the cost of informal care and the probability of choosing formal care

widely available in 1986. In addition, until 1989 families could use both the CCTC and a flexible spending account (Robins, 1990).

[17] Our measure of child care costs is the total cost per hour purchased rather than per child. The data report total expenditures for all children jointly, but total hours demanded is reported separately for each child. For example, a woman with two young children who purchases only formal care and who works 20 hours per week might report 40 hours of child care purchased—20 for each child. To avoid double counting, the number of hours demanded is measured by dividing the total hours purchased for all children by the number of children.

[18] The relatively high labor force participation rate is due to the fact that we define participation as any work during the previous year rather than the more commonly cited measure of any work during the week just prior to the survey.

[19] We use the unconditional expected wage as our instrument.

[20] Twenty-five nonworking women in our sample reported paying for care. Hotz and Kilburn (1991) provide evidence that the structure of child care demand functions depends on whether or not the mother is working. In this paper we focus on child care for working women, and we model child care as a cost that alters the slope of the budget constraint. Therefore in the selection equation and in the estimates of child care costs we ignore any child care purchased by nonworking women.

TABLE 4.—BIVARIATE PROBIT ESTIMATES FOR EMPLOYMENT, USE OF FORMAL CHILD CARE AND COST OF CHILD CARE

	Bivariate Probit		Linear Regression, Hourly Cost of Child Care
	Employed	Use Formal Care	
Constant	−1.517[d] (0.403)	0.780[f] (0.440)	0.972 (0.773)
Two children	—	−0.147 (0.110)	0.701[d] (0.213)
Three or more children	—	0.003 (0.180)	0.877[e] (0.358)
Any children ages 6–12	—	−0.076 (0.142)	0.050 (0.270)
Age of youngest child	0.131[d] (0.038)	−0.017 (0.035)	0.091 (0.068)
SMSA	0.004 (0.115)	−0.115 (0.276)	—
North Central	0.299 (0.191)	−0.051 (0.169)	—
West	0.056 (0.192)	−0.119 (0.179)	—
South	0.152 (0.173)	0.149 (0.155)	—
Black	0.368[e] (0.170)	−0.038 (0.156)	—
Hispanic	−0.032 (0.151)	0.384[e] (0.155)	—
Nonearned income ($1000)	−0.017[d] (0.004)	0.009[d] (0.003)	0.004 (0.008)
Education/10	0.735[e] (0.289)	−0.538[f] (0.300)	0.274 (0.656)
Other relative in household	0.003 (0.172)	−0.232 (0.186)	—
Labor market experience	0.334[d] (0.074)	—	—
Experience squares/10	−0.090 (0.082)	—	—
λ_A	—	—	−0.668 (0.662)
λ_B	—	—	0.427 (0.507)
ρ	0.94[d] (0.06)		
R^2	—	—	0.11
Log likelihood	−698.53		—
Test statistic[b]	226.62[d]		3.32[d]
Sample size[c]	746	530	231

Note: Unconditional mean predicted cost of child care per hour demanded = $1.95. Standard errors are in parentheses.
[a] λ_A = term for selection into paid child care; λ_B = term for selection into labor force.
[b] The test statistic for the bivariate probit is a likelihood ratio; the test statistic for the linear regression is an F-statistic.
[c] Three women with costs less than $0.25 or greater than $40 per hour were eliminated from the estimation of the cost of child care, though a cost is predicted for them.
[d] Statistically significant at the 1% level.
[e] Statistically significant at the 5% level.
[f] Statistically significant at the 10% level.

would be lower in households that include older siblings or adults other than the mother and father. Surprisingly this variable is not significant.[21,22]

The estimates of the determinants of expenditures on child care are reported in the last column in table 4. As expected, families with more than one child pay significantly more for formal child care. Specifically, a family with two children can expect, holding all else constant, to pay about $0.70 per hour more for formal child care than a one-child family. Nonwage income and the mother's education are included as proxies for the demand for quality, but neither is statistically different from zero. The estimated coefficients λ_A and λ_B, the terms for selection into the paid child care market and selection into the labor force, respectively, are not significantly different from zero. Taken at face value, this indicates that least squares could be used to predict the cost of child care for all families, i.e., that those women who are not currently participating in the market for formal child care could be predicted to pay the same amount for formal child care as those who are participating, all else equal.

Maximum-likelihood parameter estimates from the structural labor supply model are presented in table 5.[23] The first

TABLE 5.—STRUCTURAL AND REDUCED-FORM LABOR SUPPLY ESTIMATES

	Tobit Model	Instrumental-Variables Model	Dual-Error Model
Constant	6324.87[a] (703.21)	4761.02[b] (589.42)	6434.11[a] (887.88)
Effective wage	405.19[a] (29.84)	480.86[a] (29.02)	744.45[a] (63.72)
Nonearned income ($1000)	−9.86[a] (2.60)	3.77[c] (2.68)	12.34[a] (3.55)
Age of youngest child	134.06[a] (28.44)	148.25[a] (28.61)	180.71[a] (37.31)
Any children ages 6–12	680.56[a] (106.77)	641.20[a] (107.00)	813.74[a] (142.50)
Mother's age	−217.68[a] (24.39)	−190.30[a] (22.04)	−250.78[a] (31.87)
Education	−127.62[a] (29.67)	−71.08[a] (27.82)	−156.58 (40.38)
South	−52.17 (120.44)	−36.56 (123.74)	−83.51 (159.11)
West	−32.30 (135.96)	−25.64 (139.24)	−30.33 (180.81)
North Central	119.95 (133.61)	166.12 (138.12)	−7.11 (164.41)
Black	41.82 (112.60)	154.89[c] (118.43)	98.61 (145.91)
Hispanic	−19.49 (111.63)	5.75 (113.52)	105.71 (147.32)
SMSA	−127.74[c] (83.51)	−89.23 (85.62)	−235.84[b] (105.72)
Other relatives in household	14.39 (120.37)	−1.31 (126.23)	−72.11 (163.71)
σ	959.76[a] (36.18)	986.93[a] (39.67)	—
σ_h	—	—	1147.17[a] (69.97)
σ_r	—	—	301.12[a] (57.15)
Log likelihood	−904.5[d]	−917.1[d]	−783.9[d]

Note: Standard errors are in parentheses.
[a] Statistically significant at the 1% level.
[b] Statistically significant at the 5% level.
[c] Statistically significant at the 10% level.
[d] Dependent variable was divided by 1000 when maximizing function; the log-likelihood function reflects this.

[21] Better proxies for cheaper access to informal care might include length of time in one's current residence and distance to the nearest relatives, but these variables are not available in the 1986 wave of the NLSY.

[22] The estimated correlation between employment and purchase of formal child care is −0.94, with a standard error of 0.062. Although this estimated correlation is close to −1, slope coefficients were stable for various specifications, including bivariate probit with the correlation constrained to be zero. Second-order parameters in limited and discrete dependent-variable models are difficult to estimate precisely, and the small standard error in this case could well be misleading.

[23] The Berndt, Hall, Hall, and Hausman (BHHH) algorithm in the GAUSS software package was used to obtain parameter estimates.

column in this table are parameter estimates from a Tobit model that ignores the presence of the CCTC and uses the predicted gross wage minus the predicted cost of child care and observed nonwage income as regressors.

Column 2 presents estimates from an instrumental-variables (IV) estimator of the nonlinear budget set. This method involves estimating a first-stage Tobit using the predicted gross wage, predicted cost of child care, and observed nonwage income as regressors.[24] Hours of work are then predicted using the parameter estimates from the first-stage tobit. These predicted hours are used to determine the appropriate net wage and virtual income associated with the predicted hours, which then become regressors in a second stage. The IV parameter estimates, while solving the problem of the endogenous effective wage, do not allow us to model the kinks in the budget set. Therefore, these parameter estimates cannot be used for simulations as they do not incorporate the full structure of the budget set.

The third column of table 5 presents the full structural model using the dual-error term methodology outlined earlier. These are the preferred parameter estimates in that they incorporate the structure of the CCTC and can be used to simulate changes in the CCTC.

In contrast to most other labor supply studies, we use a measure of the wage net of child care costs and the subsidy to child care. The expression for the effective wage in equation (2) implicitly makes the assumption that wages and child care costs are fungible, i.e., that an individual would react the same way to a dollar increase in wage as to a dollar decrease in child care costs. It has been suggested, however, that women's labor supply might depend more strongly on wages than on the cost of child care. For example, if husbands and wives share child care responsibilities, the wife may act as if she bears only part of the cost of child care per hour worked. Similarly, wages may carry more weight than child care costs because of the observed positive correlation between wage levels and future wage growth. An increase in wages may be associated with jobs that have higher human capital accumulation and higher future earnings. To examine this possibility, we reparameterize the effective wage in the dual-error term model as follows:

$$w^* = w(1 - t_b) - \tau(1 - s_b)p_f \tag{14}$$

where τ is a new parameter, which measures the extent to which the price of child care is included in the labor supply decision.[25] If individuals put a lower weight on child care costs, τ should be less than 1. We estimated τ along with the remaining parameters of the model and tested the null hypothesis H_0: $\tau = 1$ vs. H_1: $\tau < 1$. Since the point estimate of τ was greater than 1 (2.02, with a standard error of 0.32), the null hypothesis could not be rejected. Therefore the model was reestimated with τ constrained to 1, and those estimates are reported in table 5.

Since the effective wage is a function of the market wage and the cost of child care (both endogenous variables), each method of estimation employs a predicted market wage and a predicted cost of child care. The definition of the effective wage (equation (2)) constrains how these two variables appear in the labor supply equation, technically requiring but a single instrument.[26] Our specification is overidentified, as there are numerous exclusions. With respect to the price of child care, the indicator variables for the number of children are excluded from the labor supply equation on the assumption that, while the presence and age of the youngest child affect both the labor supply directly (through the productivity of home time) and the cost of child care, the number of children affects only the cost of child care. With respect to the market wage, the labor market experience variables are excluded from the labor supply equation. Mroz (1987) has found that the null hypothesis of exogeneity of experience in women's labor supply could not be rejected when sample selection had been properly accounted for, as it is here. The labor supply elasticity estimate is robust in the sense that, in addition to the results reported in table 5, we tried other variable exclusions (i.e., including SMSA and the regional variables in the cost of child care function and excluding them from the labor supply equation) with very minor differences in estimates.

Comparing parameter estimates across specifications reveals that the wage parameter estimates have the theoretically expected signs and are all statistically different from zero. The income parameter estimates vary across specifications. For the Tobit model the income parameter is negative and statistically significant, whereas for the instrumental-variables and dual-error term models, it is positive but small, and statistically different from zero. The effects of other control variables are similar to the results found in other labor supply analyses (see Killingsworth (1983)). In all variants of the models the presence of children ages six to twelve yields a significant and positive impact on their mother's labor supply relative to the omitted category of having only younger children. The older the youngest child in the family, the more hours the mother works. The magnitude of the mother's years of education varies across specifications, although its influence is always negative and significant. This result suggests that after controlling for the effect of education on market productivity, additional years of schooling also increase the productivity of the time spent in maternal child care. Older women tend to work fewer hours, and the effect is significant for all specifications.

In table 6 we report the wage and income elasticities. The total income elasticities for the three models are all very small. The uncompensated wage elasticities for all three

[24] As Moffitt (1990) notes, it is acceptable to use the observed gross wage and virtual income as regressors in the first stage because they are exogenous.

[25] Rosen (1976) first proposed this kind of reparameterization to test whether labor supply decisions were made on the basis of the gross wage or on the wage net of income taxes.

[26] The respecification (equation (14)) introduces the additional parameter τ, which modifies only the price variable. In that specification an identifying variable is needed for both the wage and the price of child care.

TABLE 6.—WAGE AND INCOME ELASTICITIES

	Uncompensated Wage Elasticity	Compensated Wage Elasticity	Total Income Elasticity
Tobit model[a]	1.29	1.33	−0.05
	(0.10)	(0.10)	(0.01)
Instrumental-variables model[a]	1.05	1.04	0.01
	(0.06)	(0.06)	(0.01)
Dual-error term structural model[a]	1.63	1.59	0.04
	(0.14)	(0.14)	(0.01)

Note: Standard errors of estimated elasticities are in parentheses.
[a] Elasticities are calculated using the sample means of working women. For the tobit model the mean effective ($w - p_f$) wage of \$4.59 and observed hours worked of 1447 are used for the elasticities. For the IV and dual-error term models the observed effective wage of \$3.17 for working women and the same observed hours worked are used to calculate elasticities. The following formula, from the Slutsky equation, is used for the wage elasticities:

$$(dH/dW)(W/H) = (W/H)(dH/dW)\big|_{\text{comp}} + W(dH/dV).$$

TABLE 7.—RESULTS FROM POLICY SIMULATIONS

	Mean Predicted Hours	Percent Change from Predicted
Current tax credit	1065.92	
No tax credit	928.69	−14.78
Higher subsidy rates[a]	1396.24	23.65
Using cutoffs specified by Robins (1990)[b]	1103.76	3.42
Making tax credit refundable	1066.23	0.02

[a] This variant of the CCTC keeps the number of kink points and the current expenditure limits unchanged, but the subsidy rate begins at 80% of annual expenditures (at adjusted gross incomes less than \$10,000) and is reduced by 1% for each \$2000 of additional adjusted gross income until it reaches 70% for all taxpayers.
[b] This variant of the CCTC keeps the current structure of the credit but changes the end points so that families can claim expenditures up to \$4800 for one child and \$7200 for two or more children.

models are positive and greater than 1, indicating that labor supply is elastic with respect to changes in the effective wage rate and that any policy that increases the effective wage rate, such as increasing the CCTC, will have a positive impact on hours of labor supplied. The magnitudes of the wage elasticities, however, are somewhat different. The elasticity obtained from the dual-error model is the largest of the three estimates.

Using the estimates from the dual-error term model, we calculate an elasticity of labor supply with respect to the cost of formal child care that equals −0.78.[27] This elasticity is somewhat higher than the estimates from other studies. For example, Connelly (1992) reports an elasticity of the labor force participation with respect to the cost of child care equal to −0.2; Blau and Robins (1988) report an average employment/child care cost elasticity of −0.38; Ribar (1992) reports an elasticity of −0.74; Michalopoulos et al. (1992) find an elasticity of the hours worked with respect to child care subsidies close to zero; and Hotz and Kilburn (1991) also report an elasticity near zero.

V. Policy Simulations

Of interest to policymakers are not only the direct costs of modifying the child care tax credit, but also the behavioral implications that result from such modifications. Women may respond to increased child care subsidization by increasing their labor supply and demanding more child care. This response implies that the total cost of increased subsidization may be much higher than the direct costs of subsidizing child care.[28]

Estimated wage and cost of child care elasticities greater than 1 suggest that the behavioral response may be large. To determine the magnitude of changes in the CCTC on the annual hours worked by the women in our sample, we simulate several different programs: (1) the current credit; (2) an elimination of the credit; (3) making the current CCTC refundable; (4) increasing the subsidy rates; and (5) increasing the amount of expenses eligible for the credit. The current lack of refundability is an issue that has been debated by policy analysts, primarily because it results in an unequal distribution of benefits across the population. According to Robins (1990) only 5% of the benefits accrue to the bottom third of the income distribution. The other modifications we simulate are based loosely on Robins' (1990) proposed changes in the CCTC. The expenditure limits are likely to be important because in our sample, at chosen hours of work, nearly one-third of the sample meets or exceeds the current expenditure limits. In addition, we nearly triple the subsidy rates, which can lead to a substantial increase in the value of the credit for a family. The purpose of the simulations is to provide policymakers with an idea of which features of the CCTC are most important in terms of stimulating labor supply.

The nonlinearity of the response to a change in the CCTC requires the use of a weighted average in the predicted hours worked. We follow Moffitt (1984) in using the following equation for the simulation:

$$\begin{aligned} E(h) = \sum_{b=1}^{j} &\text{Prob}\,(h^*_{b-1} - Seg_b < \epsilon_h \le h^*_b - Seg_b) \\ &\times [Seg_b + E(\epsilon_h | h^*_{b-1} - Seg_b < \epsilon_h \le h^*_b - Seg_b)] \\ &+ \sum_{b=1}^{j-1} \text{Prob}\,(h^*_b - Seg_b < \epsilon_h \le h^*_b - Seg_{b+1}) h_b \end{aligned} \tag{15}$$

where $E(h)$ is a weighted average of the kink values and the conditional means of the truncated distributions on each budget segment.

[27] To calculate this elasticity, we employed the definition of the effective wage: $w^* = w(1 - t_b) - (1 - s_b)p_f$. Taking the partial derivative of the hours equation with respect to p_f yields $-\beta(1 - s_b)$. Thus the elasticity of the hours worked with respect to child care costs is $-\beta(1 - s_b)(p_f/h)$ and is evaluated using the means of the data ($p_f = \$1.95$, $h = 1447$, and $s = 0.22$).
[28] Of course these costs may be offset by increased tax revenues from these women.

The results reported in table 7 use the parameter estimates from the dual-error term model. The first row simulates the current CCTC. The dual-error term model predicts hours fairly well. The difference between actual mean hours and predicted mean hours is only 3.5%. Eliminating the subsidy (line 2) would result in a 5% drop in hours worked. An increase in the initial subsidy rate from 30% to 80% would increase average hours worked by 24% (line 3), whereas keeping the current subsidy rates, but doubling expenditure limits, would increase hours by only 3% (line 4). The latter suggests that the annual expenditure limits of the subsidy are not as important to the labor supply decision as the percentage of expenditures that are subsidized. Finally, making the CCTC refundable results in an increase of 0.02% in hours worked.

VI. Conclusions

This paper explores the effects of child care costs and the federal child care tax credit on the labor supply decisions of married women with young children. We explicitly incorporate the piecewise linear nature of the budget set resulting from the tax credit in the estimation of a labor supply equation for mothers. This is the first study to do so explicitly. By treating the child care tax credit directly and using the nonlinear budget estimation methodology, we are able to simulate the effects of changes in the parameters of the tax credit program.

The empirical results from our estimation indicate that women's labor supply responds to the effective wage (i.e., the wage net of child care costs and the subsidy) rather than to the gross wage. The elasticity of labor supply with respect to child care costs is close to 1. Our policy simulations show that this government subsidy to child care substantially increases labor supply. An increase in the value of the subsidy (i.e., percent of expenditures-subsidized) has a much larger effect on women's labor supply than does an increase in the annual expenditure limits of the subsidy.

APPENDIX A

An alternative measure of child care costs used in the literature is dollars paid per hour worked. This is equivalent to assuming that the shadow price of informal care is zero. Given this assumption, and following equation (1) in the text, the effective wage is defined as follows:

$$w^* = w(1 - t_b) - (1 - s_b)p_f(h_f/h). \quad (A.1)$$

How might we expect our results to differ when using this measure as opposed to the effective wage defined in equation (2) in the text? Using the chain rule, the effect of the child care subsidy on hours is

$$\partial h/\partial s = (\partial h/\partial w^*)(\partial w^*/\partial s) \quad (A.2)$$

Assuming that the wage effect on hours is the same for both definitions of child care costs, the difference in the subsidy effect is a result of the second term in equation (A.2). If the shadow price of informal care is assumed to be zero, then

$$\partial w^*/\partial s = p_f(h_f/h). \quad (A.3)$$

Alternatively, if at the margin the shadow price of informal care is equal to the price of formal care (the assumption used for the empirical work presented in the main part of the paper), then

$$\partial w^*/\partial s = p_f. \quad (A.4)$$

TABLE A.1.—RESULTS FOR COST OF CHILD CARE EQUATION AND DUAL-ERROR TERM MODEL WHEN CHILD CARE COST IS DEFINED AS COST PER HOUR WORKED

	Linear Regression, Cost of Child Care	Dual-Error Model, Hours Worked
Constant	0.351	5754.11[a]
	(0.353)	(770.01)
Effective wage	—	585.22[a]
		(49.59)
Two children	0.282[a]	—
	(0.092)	
Three or more children	0.509[a]	—
	(0.155)	
North Central	—	98.79
		(150.90)
West	—	−31.80
		(152.46)
South	—	−81.23
		(135.37)
Black	—	62.24
		(129.01)
Hispanic	—	20.05
		(128.12)
SMSA	—	−131.61[b]
		(96.92)
Nonearned income ($1000)	0.007[a]	9.15[a]
	(0.003)	(3.18)
Education	0.026	−119.55[a]
	(0.031)	(33.39)
Other relative in household	—	−55.12
		(139.64)
Any children ages 6–12	−0.313[a]	—
	(0.116)	
Age of youngest child	—	100.25[a]
		(31.43)
Mother's age	—	−232.15[a]
		(28.78)
σ_h	—	1042.06[a]
		(53.51)
σ_r	—	234.03[a]
		(69.77)
R^2	0.14	—
Log likelihood	–	−818.9[c]

Note: Standard errors are in parentheses.
[a] Statistically significant at the 1% level.
[b] Statistically significant at the 10% level.
[c] Dependent variable was divided by 100 when maximizing function; the log-likelihood function reflect this.

TABLE A.2.—RESULTS FROM POLICY SIMULATIONS

	Mean Predicted Hours	Percent Change from Predicted
Current tax credit	1072.79	
No tax credit	985.78	−8.83
More progressive tax credit[a]	1239.51	13.45
Using cutoffs specified by Robins (1990)[b]	1067.45	−0.50
Making tax credit refundable	1076.28	0.32

[a] This variant of the CCTC keeps the number of kink points and the current expenditure limits unchanged, but the subsidy rate now begins at 80% of annual expenditures (at adjusted gross incomes less than $10,000) and is reduced by 1% for each $2000 of additional adjusted gross income unit it reaches 70% for all taxpayers.
[b] This variant of the CCTC keeps the current structure of the credit but changes the end points so that families can claim expenditures up to $4800 for one child and $7200 for two or more children.

The difference in the effects of the subsidy is simply the ratio of formal care to total working hours.

In Tables A.1 and A.2 we present the results of the child care cost estimates, the dual-error labor supply estimates, and the policy simulations using the alternative measure of child care costs. The size of the wage effect and the effect of variations in the CCTC on hours in the policy simulations are 40% to 60% smaller when using the alternative definition of child care costs. Consistent with these smaller effects of utilizing the alternative definition of child care costs, in our data the mean of h_f/h is 59%.

We prefer the estimates reported in the main body of the text for three reasons. First, in order for the price of informal care to be zero, informal care must be inelastically supplied for those who choose both formal and informal care. That is, if informal care is indeed free, women who use any formal care must have exhausted any available informal care. Therefore, as hours increase (perhaps due to a change in the subsidy rate), the demand for formal care should increase one for one. Thus, for those who are constrained by the supply of informal care, the marginal cost of child care per hour worked is the hourly cost of formal child care. Instead, using expenditures per hour worked is a measure of the *average* cost of child care. Second, as discussed in the text, we believe that informal care *is* costly. Third, in addition the measure using expenditures per hour worked depends on the mix of formal versus informal care, which is endogenous, because the CCTC subsidizes formal care and this subsidy could increase the demand for formal care.

APPENDIX B

Dual-Error Model Likelihood Function

The contribution to the likelihood function for each observations with observed hours of work greater than zero is the density of hours written as

$$
\begin{aligned}
f(h) = {} & \Bigg\{ \sum_{b=1}^{j} \left[\int_{h_{b-1}^*-SEG_b}^{h_b^*-SEG_b} \left(\frac{1}{\sigma_r}\right) \varphi\left\{\left[\frac{h-(SEG_b+\epsilon_h)}{\sigma_r}\right]\middle|\,\epsilon_h\right\} \right.\\
& \left. \times \left(\frac{1}{\sigma_h}\right)\varphi\left(\frac{\epsilon_h}{\sigma_h}\right) d\epsilon_h \right] + \sum_{b=1}^{j-1} \\
& \times \left[\Phi\left(\frac{h_b^*-SEG_{b+1}}{\sigma_h}\right) - \Phi\left(\frac{h_b^*-SEG_b}{\sigma_h}\right)\right]\left[\left(\frac{1}{\sigma_r}\right)\varphi\left(\frac{h-h_b^*}{\sigma_r}\right)\right] \\
& + \left[1-\Phi\left(\frac{h_L^*-SEG_L}{\sigma_h}\right)\right]\left(\frac{1}{\sigma_r}\right)\varphi\left(\frac{h-h_L^*}{\sigma_r}\right)\Bigg\} d_i \\
& + \Bigg\{ \int_{-SEG_1}^{m(1,2)-SEG_1} \left[\left(\frac{1}{\sigma_r}\right)\varphi\left\{\left[\frac{h-(SEG_1+\epsilon_h)}{\sigma_r}\right]\middle|\,\epsilon_h\right\}\left(\frac{1}{\sigma_h}\right)\varphi\left(\frac{\epsilon_h}{\sigma_h}\right) d\epsilon_h\right] \qquad \text{(B.1)} \\
& + \int_{m(1,2)}^{h_2^*} \left[\left(\frac{1}{\sigma_r}\right)\varphi\left\{\left[\frac{h-(SEG_2+\epsilon_h)}{\sigma_r}\right]\middle|\,\epsilon_h\right\}\left(\frac{1}{\sigma_h}\right)\varphi\left(\frac{\epsilon_h}{\sigma_h}\right) d\epsilon_h\right] \\
& + \sum_{b=3}^{j}\left[\int_{h_{b-1}^*-SEG_b}^{h_b^*-SEG_b}\left(\frac{1}{\sigma_r}\right)\varphi\left\{\left[\frac{h-(SEG_b+\epsilon_h)}{\sigma_r}\right]\middle|\,\epsilon_h\right\}\left(\frac{1}{\sigma_h}\right)\varphi\left(\frac{\epsilon_h}{\sigma_h}\right) d\epsilon_h\right] \\
& + \sum_{b=2}^{j-1}\left[\Phi\left(\frac{h_b^*-SEG_{b+1}}{\sigma_h}\right) - \Phi\left(\frac{h_b^*-SEG_b}{\sigma_h}\right)\right]\left[\left(\frac{1}{\sigma_r}\right)\varphi\left(\frac{h-h_b^*}{\sigma_r}\right)\right] \\
& + \left[1-\Phi\left(\frac{h_L^*-SEG_L}{\sigma_h}\right)\right]\left(\frac{1}{\sigma_r}\right)\varphi\left(\frac{h-h_L^*}{\sigma_r}\right)\Bigg\}(1-d_i)
\end{aligned}
$$

where SEG_L and h_L^* represent SEG and h^* on the last budget segment and kink; j is the total number of budget segments faced by a given individual; $d_i = 1$ if the individual does not face the initial nonconvex portion of the budget set; $d_i = 0$ if the individual does face the initial nonconvex portion of the budget set; and $\varphi(\cdot)$ and $\Phi(\cdot)$ are the density and cumulative distribution functions for a standard normal random variable, respectively. The first term for each group is the joint density of desired hours being in the interior of one of the segments of the budget set and observed hours equal to h. The second term is the joint density of desired hours being at one of the kink points and observed hours equal to h.

The contribution to the likelihood function for the nonworking women is the probability that $h = 0$, given by

$$
\begin{aligned}
F(h=0) = {} & \int_{-\infty}^{-SEG_1}\left(\frac{1}{\sigma_h}\right)\varphi\left(\frac{\epsilon_h}{\sigma_h}\right)d\epsilon_h + \Bigg\{\sum_{b=1}^{j}\left[\int_{h_{b-1}^*-SEG_b}^{h_b^*-SEG_b}\int_{-\infty}^{-(SEG_b+\epsilon_h)}\left(\frac{1}{\sigma_r}\right)\varphi\left(\frac{\epsilon_r}{\sigma_r}\right)\right. \\
& \left.\times\left(\frac{1}{\sigma_h}\right)\varphi\left(\frac{\epsilon_h}{\sigma_h}\right)d\epsilon_r\,d\epsilon_h\right] + \sum_{b=1}^{j-1}\left[\Phi\left(\frac{h_b^*-SEG_{b+1}}{\sigma_h}\right)-\Phi\left(\frac{h_b^*-SEG_b}{\sigma_h}\right)\right] \\
& \times\Phi\left(\frac{-h_b^*}{\sigma_r}\right) + \left[1-\Phi\left(\frac{h_L^*-SEG_L}{\sigma_h}\right)\right]\Phi\left(\frac{-h_L^*}{\sigma_r}\right)\Bigg\}d_i \\
& + \Bigg\{\int_{-SEG_1}^{m(1,2)-SEG_1}\left[\left(\frac{1}{\sigma_r}\right)\varphi\left\{\left[\frac{-(SEG_1+\epsilon_h)}{\sigma_r}\right]\middle|\,\epsilon_h\right\}\right. \\
& \left.\times\left(\frac{1}{\sigma_h}\right)\varphi\left(\frac{\epsilon_h}{\sigma_h}\right)\right]d\epsilon_h + \int_{m(1,2)}^{h_2^*}\left[\left(\frac{1}{\sigma_r}\right)\varphi\left\{\left[\frac{-(SEG_2+\epsilon_h)}{\sigma_r}\right]\middle|\,\epsilon_h\right\}\right. \qquad \text{(B.2)} \\
& \left.\times\left(\frac{1}{\sigma_h}\right)\varphi\left(\frac{\epsilon_h}{\sigma_h}\right)\right]d\epsilon_h + \sum_{b=3}^{j}\left[\int_{h_{b-1}^*-SEG_b}^{h_b^*-SEG_b}\int_{-\infty}^{-(SEG_b+\epsilon_h)}\left(\frac{1}{\sigma_r}\right)\varphi\left(\frac{\epsilon_r}{\sigma_r}\right)\right. \\
& \left.\times\left(\frac{1}{\sigma_h}\right)\varphi\left(\frac{\epsilon_h}{\sigma_h}\right)d\epsilon_r\,d\epsilon_h\right] + \sum_{b=2}^{j-1}\left[\Phi\left(\frac{h_b^*-SEG_{b+1}}{\sigma_h}\right)-\Phi\left(\frac{h_b^*-SEG_b}{\sigma_h}\right)\right] \\
& \times\Phi\left(\frac{-h_b^*}{\sigma_r}\right) + \left[1-\Phi\left(\frac{h_L^*-SEG_L}{\sigma_h}\right)\right]\times\Phi\left(\frac{-h_L^*}{\sigma_r}\right)\Bigg\}(1-d_i).
\end{aligned}
$$

APPENDIX C—WAGE EQUATION ESTIMATES

	Probit Estimates of Labor Force Participation	OLS Wage Regression
Constant	−2.071	−23.816
	(7.668)	(41.360)
Labor market experience	0.433[b]	1.026[d]
	(0.081)	(0.567)
Experience squared	−0.009	−0.038
	(0.008)	(0.044)
SMSA[a]	0.037	0.147
	(0.128)	(0.640)
Black[a]	0.234	0.817
	(0.175)	(0.822)
Hispanic[a]	−0.112	0.286
	(0.157)	(0.833)
Mother's age	0.119	1.313
	(0.609)	(3.268)
Age squared	−0.006	−0.023
	(0.012)	(0.064)
Number of children	0.210[b]	—
	(0.079)	
Education	0.134[b]	0.555[b]
	(0.035)	(0.166)
Nonearned income ($1000)	−0.017[b]	—
	(0.004)	
Other relatives in household[a]	−0.082	—
	(0.190)	
Age of youngest child	0.212[b]	—
	(0.042)	
South[a]	0.089	0.276
	(0.171)	(0.845)
West[a]	0.016	−0.115
	(0.190)	(0.967)
North Central[a]	0.240	0.095
	(0.190)	(0.927)
λ	—	2.625
		(1.672)
Log likelihood	−344.90	—
R^2	—	0.09
F-statistic	—	4.37[c]
Sample size	749	533

Note: The dependent variable in the wage regression is measured as the actual wage rather than the more standard log wage. Standard errors are in parentheses.
[a] Dichotomous variable equal to 1 if the observation has the given characteristic, equal to 0 otherwise.
[b] Statistically significant at the 1% level.
[c] Statistically significant at the 5% level.
[d] Statistically significant at the 10% level.

The first term is the probability that desired hours of work are zero. The remaining three terms represent the probability that observed hours are zero, but desired hours are greater than zero.

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