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A STRUCTURAL MODEL OF LABOR SUPPLY AND CHILD CARE DEMAND

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Abstract

In recent years, child care has become an important public policy issue, owing primarily to the significant increase in the labor force participation of women with young children. Consequently, a number of bills containing provisions to subsidize child care have been introduced into Congress. As a first step in considering possible behavioral responses to proposed child care subsidies, this paper presents estimates of a structural model in which a mother simultaneously chooses her labor status, whether or not to purchase market child care, and the quality of care purchased. The authors find that among mothers who work and purchase child care, an increase in wages does not result in a proportional increase in child care expenditures, and that a mother will not change the number of hours she works at her job, regardless of any child care subsidies or an increase in wages.

Estimation results are also used to simulate the effects of two proposed changes in the federal child care tax credit. The simulation results indicate that the primary effect of a more generous credit is to allow working mothers who use free care to purchase higher quality market care.

A Structural Model of Labor Supply and Child Care Demand

Introduction

In recent years, child care has become an important public policy issue, owing primarily to the significant increase in the labor force participation of women with young children.[1] As a consequence, a large number of bills containing provisions to subsidize child care have been introduced into Congress.[2] Barnes (1988) estimated federal expenditures under several congressional proposals that would subsidize child care through the federal tax code, as well as additional proposals offered by social scientists. Using microsimulation analysis, she estimated that these new proposals would increase current federal spending on child care by as much as three billion dollars per year. Her analysis assumed that there would be no behavioral response to any of the new subsidies; economic theory, however, holds that family decisions regarding labor supply, child care arrangements, birthrates, and other relevant factors would be affected by such subsidies.

As a first step in considering possible behavioral responses to child care subsidies, this paper presents estimates of a structural model in which a mother jointly chooses her labor status and her children's care arrangement. A structural model contains a direct relationship between policy parameters and individual behavior. Therefore, the estimates of the structural model presented in this paper can be used to simulate both the indirect costs resulting from behavioral changes as well as the direct costs resulting from changes in child care policy.

Concurrent with increasing congressional interest in child care issues has been an increase in the number of studies of child care performed by economists. These studies have attempted to estimate the effects of economic and demographic variables on women's labor supply, choices regarding child care, and fertility rates. For example, Blau and Robins (1988a) and Connelly (1989) found that increased child care costs reduced both women's labor supply and the use of market-provided child care. Blau and Robins (1988b) found further evidence of a correlation between employment status and child care arrangements. Using a retrospective questionnaire from the National Longitudinal Survey of Youth (NLSY), they found that changes in child care arrangements frequently occurred with changes in employment status but not with changes in the number of young children or marital status.

In the spirit of these previous studies, the purpose of this paper is to estimate the impact of changes in child care costs on women's labor supply. Unlike the other researchers we employ a structural model in which the decision to purchase market care--and the quality purchased--is made simultaneously with the employment decision of the mother. In this way, we are able to estimate directly the effect of a change either in wage rates or child care tax subsidies on child care expenditures and mothers' labor supply. By hypothesizing a structural relationship between exogenous variables and behavior, we can predict the effect of policy changes on future behavior in a method consistent with economic theory.

The remainder of the paper is organized as follows. Section I presents a formal model of the joint labor supply and child care decisions. Section II contains a discussion of estimation strategies. Section III describes the data used in the empirical analysis. Section IV presents estimates of the theoretical model. Section V presents simulated impacts of two proposed changes in the federal child care tax credit. Finally, a brief conclusion summarizes the results and suggests directions for future research.

I. The Model

Our analysis centers on a utility maximization model in which a mother chooses consumption, market time, and average quality of child care.[3] The maximization problem implies a direct relationship between consumer demand for consumption, leisure, and child care quality on the one hand, and the consumer's preferences, opportunity costs, and economic resources on the other. Estimation of the resulting system of demand equations provides a means of inferring behavioral response to policy changes.

We make the model tractable through a number of simplifying assumptions. First, we assume that the actions of other members of the household are exogenous to the decisions of the mother, implying that the utility of other family members does not enter into the decision-making process and that the mother considers the earnings of all other members of the household as her own nonlabor income. This assumption is valid if family labor supply decisions are made sequentially, with the family first determining the work status of the father and other household members, and the mother's market behavior representing a response to that decision. (It is likely that many families will consider adjusting the father's work schedule to accommodate a working mother, and much work has been done regarding utility functions for families.[4] Mroz [1987], however, provides some evidence that other income--primarily from the husband--is exogenous to the wife's labor supply, but this is a subject for further investigation.)

A second set of simplifying assumptions regards home care of children. In particular, we assume that all of the mother's leisure time is spent caring for her children at home, and that free care is available to a working mother for as many hours as she works. Although both assumptions are unrealistic to some degree, the assumption of universal availability of free care may be particularly so. Every working mother has the unattractive option of leaving her children to care for themselves during the work day, thus using perhaps the lowest quality free care. Although most mothers do not take such a drastic action, this example reminds us that the quality of available free care can vary from household to household. A major influence on the mother's labor supply decision is the availability of acceptable options other than paid care.

A third assumption is that parents derive current utility from higher quality child care. This utility may reflect the discounted value of expected improvement in their children from better care. The parents may also derive current utility from knowing that their children are in competent hands. We do not attempt to distinguish between these two motives, but lump both into one utility category.

The final set of assumptions pertains to market care. We assume that only one type of nonmother care is used and that its price is proportional to its quality.[5] If the supply of child care services is perfectly elastic, then the price of child care would be proportional to the inputs to production of care. Even in the case of perfect competition, there is not necessarily a linear relationship between inputs and a parent's opinion of the quality of the resulting care. Nevertheless, because the quality of commercial child care is unobserved, the assumption that its cost is proportional to its quality enables us to identify key parameters in our model.

In order to derive response functions for estimation, we assume that all mothers possess Stone-Geary utility functions. Although this utility function has limitations that have been well-documented (see, for example, Goldberger, 1987), it provides closed-form solutions for optimal quantities chosen. In particular, we assume the mother solves the following decision problem:

$$\max_{f,x,h,Q_c} \beta_1 \log(x-x_0) + \beta_2 \log(h_0-h) + \beta_3 \log(Q-Q_0) \tag{1}$$

$$s.t. \quad px + (1-f)\alpha Q_c h = wh + E$$

$$TQ = h\{(1-f)Q_c + fQ_f\} + (T-h)Q_h$$

where x = consumption of goods other than child care;

h = market time of the mother;

Q = average quality of child care;

p = unit price of the composite commodity x;

w = net wage rate of the mother;

E = effective nonlabor income (including earnings of other household members);

Q_c = quality of purchased care;

Q_h = quality of care provided by the mother;

Q_f = quality of free care available to the mother;

$f=1$ if free care is chosen, and 0 if care is purchased;

x_0, Q_0, and h_0 are subsistence levels of consumption, and child care quality, and maximum hours of market time, respectively;

T is total time available to the mother;

α=the price of purchased care per unit of quality; and β_1, β_2, β_3 are parameters such that $\sum_{i=1}^{3} \beta_i = 1$.

The first constraint in this problem is the familiar budget constraint. Expenditures on child care are represented by $(1-f)\alpha Q_c h$. In words, if the mother chooses to purchase care, the total price will be the product of the cost per hour per unit of quality, the quality chosen, and the number of hours of care purchased.

The second constraint defines the average quality of care. When the mother is home, the quality of care is Q_h, since she provides all the care. When the mother works, she can either avail herself of free care ($f=1$) at an exogenous quality of Q_f, or purchase care ($f=0$) at a chosen quality (Q_c). One consequence of the proportional relationship between quality of market (commercial) care and its price is that a mother will almost always choose either all market care or all free care.[6]

Because both quantity and quality of care are chosen, the first-order conditions for this problem differ slightly from the standard ones associated with the Stone-Geary utility function. Therefore, they warrant examination. After making the usual substitutions, the first-order necessary conditions of optimality for a mother who chooses both to work and purchase child care are

$$\frac{\beta_1 (w-\alpha Q_c)}{px - px_0} = \frac{\beta_2}{h_0-h} + \frac{\beta_3 (Q_h-Q_c)}{T(Q-Q_0)}$$

$$\frac{\beta_1 \alpha}{px-px_0} = \frac{\beta_3}{T(Q-Q_0)} \qquad (2)$$

$$px + \alpha Q_c h = wh + E$$

These three conditions define the optimum child care quality, consumption, and market time of an interior solution to the maximization problem. The third condition is simply the budget constraint. The second condition implies that, for any level of income, a consumer who purchases child care will distribute income so that the marginal utility of the latest dollars spent on consumption and child care will be equal. The first condition is slightly different from the standard first-order condition of a Stone-Geary utility maximization problem because child care quality is chosen by the mother rather than determined outside the model.

This first condition can be interpreted as follows. The term on the left-hand side is the additional utility from consumption due to an increase in earnings from an infinitesimal increase in hours worked. Notice that the value of market time is not the actual wage, but the wage minus hourly child care expenses ($w-\alpha Q_c$). The first term on the right is the direct marginal disutility from additional market time. In standard models, a condition for optimality is that the marginal disutility from labor exactly offset the added utility from consumption. In our model market time is also associated with additional use of nonmother care, perhaps of an inferior quality than mother care. Therefore, the mother must take into account the utility lost from not providing care for her children (or, if her care is of poor quality, the utility gained from other care). The second term on the right is the marginal (dis)utility in child care quality following a substitution of either purchased or free care for mother's care. Thus, the condition says that the marginal increase in utility from consumption must exactly offset the marginal decreases in utility from added labor and decreased child care quality.

In our model, the mother has three possibilities: work and purchase child care; work and use the available free care; and not work and provide home child care. To determine which option is optimal, we must compare utility under all three scenarios.

The easiest case to consider is the one in which the mother does not work. In this case, $px_1 = E$, $h_1 = 0$, and $Q_1 = Q_h$. Utility is given by

$$v_1 = u(E,0,Q_h) = \beta_1 \log(E-px_0) + \beta_2 \log(h_0) + \beta_3 \log(Q_h-Q_0) - \beta_1 \log p \qquad (3)$$

Next consider the case in which the mother works and purchases child care (the solution to the optimality conditions in [2]). The solution to the first-order maximization conditions of this problem is the demand system

$$x_2 = x_0 + \beta_1 \frac{I^*}{p} \qquad (4a)$$

$$h_2 = h_0 - \beta_2 \frac{I^*}{w^*} \qquad (4b)$$

$$Q_2 = Q_0 + \beta_3 \frac{I^*}{\alpha T} \qquad (4c)$$

where

$$I^* = E + w^* h_0 - px_0 + \alpha T(Q_h - Q_0) \quad \text{and}$$

$$w^* = w - \alpha Q_h$$

In this solution, I^* represents full income after adjusting for "subsistence" levels of consumption, child care quality, and maximum hours of market labor. The variable w^* represents the effective net wage after deducting the implicit price of home care. Substituting the optimal consumption bundle into the Stone-Geary utility function yields utility

$$v_2 = u(x_0 + \beta_1 I^*, h_0 - \beta_2 \frac{I^*}{w^*}, Q_0 + \beta_3 \frac{I^*}{\alpha T})$$

$$= log I^* + \sum_{i=1}^{3} \beta_i \log\beta_i - \beta_1 \log p - \beta_2 \log w^* - \beta_3 \log \alpha T \qquad (5)$$

The final possibility is for the mother to work and take advantage of free care. When free care is used, the mother chooses only her labor supply. Let h_3 denote the optimal hours of work when free care is used. Since Q_f and Q_h are considered exogenous, the average quality of care is $Q_3 = \{h_3Q_f + (T-h_3)Q_h\}/T$ and is determined by the choice of labor supply. In the same way, because child care is free, the budget constraint implies that consumption will be $px_3 = wh_3 + E$. The quantity h_3 will be chosen so that

$$\frac{\beta_1 w}{px_3 - px_0} = \frac{\beta_2}{h_0 - h_3} + \frac{\beta_3 (Q_h - Q_f)}{T(Q_3 - Q_0)} \qquad (6)$$

(Q_3 and px_3 are defined above). The equation is a quadratic expression in h_3. The solution is complicated and we choose not to present it.

Letting v_3 represent the maximum utility from choosing to work and use free care, the mother chooses not to work if v_1 is greater than both v_2 and v_3. Similarly, the mother chooses to work and purchase care if v_2 is the largest, and she chooses to work and use the available free care if v_3 is the largest.

The estimation strategy we chose focuses on mothers with interior solutions to the utility maximization problem, i.e., those who work and purchase child care. The equations in (4) represent the demand for consumption, leisure (hours of work), and quality of child care for this group. A more useful representation is a system of expenditures on consumption, child care, and earned income from market work.

In order to derive a system of expenditure equations, we need an expression for the quality of purchased care. The definitions of average child care quality and optimal child care quality given in equation (4c) imply that the quality of purchased care is

$$Q_{c2}=Q_h - \frac{1}{h}T(Q_h-Q_0) + \frac{\beta^3 I^*}{ha} \qquad (7)$$

According to this expression, the quality of purchased child care (Q_{c2}) increases as full income (I^*) and the minimum quality of care (Q_0) increase. The effect of the quality of mother's care (Q_h) on the quality of purchased care (Q_c) is ambiguous, however. At low values of β_3, families will spend only a small fraction of their full income to raise the quality of care above the minimum acceptable level. In this case, the higher the quality of mother's care, the lower the quality of purchased care. As β_3 increases, a family will spend more of its full income on child care. Since a higher quality of mother's care contributes to a higher full income, an increase in the former (Q_h) may allow for an increase in the quality of market care chosen if such a situation should ever arise.

Using equation (7) for Q_{c_2}, the expenditure system for women who purchase market care is

$$E_x = px_2 = px_0 + \beta_1 I^* \qquad (8a)$$

$$E_h = wh_2 = wh_0 - \beta_2 I^* \frac{w}{w^*} \qquad (8b)$$

$$E_q = \alpha h Q_{c_2} = \alpha\{h_0 Q_h - T(Q_h-Q_0)\} + \{\beta_3 - \beta_2 \frac{\alpha Q_h}{w^*}\} I^* \qquad (8c)$$

where the last expression is derived by substituting for the optimal labor supply. Similar expressions can be derived for the case in which the mother chooses to use free care.

II. Estimation

As discussed in the previous section, mothers can be divided into three groups: those who work and purchase child care; those who work but take advantage of available free care; and those who do not work. This division permits several ways of estimating the parameters of the utility function.

First, a multinomial discrete choice model could be estimated using the indirect utility functions presented in the previous section. A mother chooses option i if $v_i > v_j$ and $j = 1, 2,$ or 3. That is, a mother chooses the option which provides the greatest utility based on nonlabor income and prices.

The first-order conditions suggest a second method of estimating the parameters of the utility function. If child care is purchased, the mother will work only if $\frac{\partial u}{\partial h}\ (E, O, TQ_h) > O$. Letting U_2 be the utility that the mother would receive if she were to work and avail herself of free care, she then would work only if $\frac{\partial U_2}{\partial h}\ (E, O, TQ_h) > O$. These conditions permit the use of a nonlinear binary response model as a means of estimating the parameters of the utility function.

A third alternative is to estimate the expenditure system (8a) through (8c) using only the subsample of working mothers who purchase child care. The issue of self-selection, however, then becomes a problem. Women who work are more likely to be those with a preference for working, those with a preference for market work over caring for one's children at home, and those with poor alternatives to purchased care. Parameters estimated from this subsample are likely to be poor estimates of the same parameters for women who either choose not to work or choose to use free care. Appendix A presents one means, suggested by Maddala (1983), of adjusting for this potential selectivity bias. Because of computational ease, we opt for this third alternative.

The expenditure system (8) represents optimal expenditures and optimal earned income when the parameters β_1, β_2, β_3, px_0, h_0, Q_h and Q_0 are known with certainty. Since the parameters are not known to us and are likely to vary from family to family, we actually estimate the "mean" parameters for the population. Because the expenditure system is nonlinear, these mean parameters are not arithmetic means of the parameters of families in the sample, but values which imply mean zero differences between actual expenditures and earnings on the one hand, and predicted expenditures and earnings on the other.[7] In symbols, the system (8) can be rewritten as

$$E_x = px_0 + \beta_1 I^* + \epsilon_x \tag{9a}$$

$$E_h = wh_0 - \beta_2 I^* \frac{w}{w^*} + \epsilon_h \tag{9b}$$

$$E_q = \alpha(h_0 Q_h - T(Q_h - Q_0)) + (\beta_3 - \beta_2 \frac{\alpha Q_h}{w^*}) I^* + \epsilon_q \tag{9c}$$

where $\epsilon_x, \epsilon_h, \epsilon_q$ are mean zero error terms, and the parameters now represent values which give the errors zero mean.

In order to estimate (9a) through (9c), it would be sufficient to assume only that the ϵ's are mean zero, conditional on the exogenous variables. In order to use the correction for sample selection bias described in Appendix A, however, we must make the more restrictive assumption that the ϵ's are joint normally distributed. Further, we must assume that they are joint normally distributed with the error terms for the bivariate probit of the mother's work and child care decisions.

Once the sample selection bias is taken into account, the expenditure system can be rewritten as

$$E_x = px_0 + \beta_1 I^* + E(\epsilon_x | W=1, C=1) + \xi_x \tag{10a}$$

$$E_h = wh_0 - \beta_2 I^* \frac{w}{w^*} + E(\epsilon_h | W=1, C=1) + \xi_h \tag{10b}$$

$$E_q = \alpha(h_0 Q_h - T(Q_h - Q_0)) + (\beta_3 - \beta_2 \frac{\alpha Q_h}{w^*}) I^* + E(\epsilon_q | W=1, C=1) + \xi_q \tag{10c}$$

where W=1 if the mother works and C=1 if she uses market care. In this system, the ξ 's represent error terms which have zero means conditional on both the exogenous variables and the mother's decision to work and purchase child care. The assumption that the error terms are conditionally mean zero is sufficient to estimate the system using a method-of-moments type estimator. Therefore, we make no further assumptions regarding the distribution of the ξ terms.[8]

To estimate the parameters of the utility function, we employ an iterative nonlinear least squares technique using PROC SYSNLIN in SAS.[9]

The parameters of the expenditure system (8) can be estimated using equations (10b) and (10c), the expressions for earned income and child care expenditures, respectively. Therefore, we will estimate the parameters of the model using these two relationships.[10]

The expenditure system (10) allows us to identify all of the structural parameters except α, Q_f, and Q_0. Consider these in turn. Since quality is unobserved, we normalize α to 1, so that child care quality is measured in dollars per hour.

Next, consider Q_f. The model implies that, once the decision has been made to use market care, the quality of the available free care affects neither the quality of the market care chosen nor the number of hours given to the labor market. The first-order condition for mothers who work and purchase market care implies an expression for Q_f for this subgroup of workers. We do not pursue an estimation of Q_f in this paper, however.

Finally, consider Q_0. In the expenditure system (10), Q_0 appears only in the market value of the difference between quality of mother's care and minimum quality ($\alpha T(Q_h-Q_0)$). Although we estimate Q_h and a normalized α, T is not identified. T, however, represents the total time available to the mother. If we make the natural assumption that T is equal to the total number of hours in the period (e.g., 1,947 hours, or 16 hours per day for a four-month period), we can derive an estimate of Q_0.

The estimation of labor supply models is complicated by endogenous income tax rates owing to the progressivity of the federal and state tax codes. Federal and state child care income tax credits are additional sources of nonlinearity. In several versions of the estimated model, we incorporate the federal and state tax structures by adjusting nonlabor income so that the budget constraint is tangent to the actual, nonlinear budget constraint at actual hours worked and child care quality purchased. This procedure requires several adjustments.

First, we define the wage rate (w) to be net of the marginal tax rate at actual income. Second, we define the unit price of child care quality (α) to be net of the marginal subsidy at actual income and actual child care expenditures. In defining the effective marginal tax rate and marginal subsidy rate, there are several points to consider. First, the current federal child care tax credit has a maximum amount. If a family has reached this maximum, then the marginal subsidy will be zero, since additional spending on child care does not increase the credit amount. In addition, the federal tax credit is currently nonrefundable. That is, the credit cannot exceed the tax liability. If child care expenditures exceed this amount, then the marginal subsidy rate is again effectively zero. In this case, the marginal tax rate is also effectively zero. Additional taxable income will increase the tax liability, but it will also increase the credit by the same amount. As a consequence, at the margin, the net wage rate equals the gross wage rate, and net child care expenditures equal gross expenditures. Finally, when the child care credit is limited by neither the maximum credit nor the tax liability, the marginal tax and subsidy rates are defined according to the tax code.

These adjustments ensure that the nonlinear budget constraint and the linearized budget constraint have identical slopes at the chosen levels of labor supply and child care expenditures. To correct the height of the linearized budget constraint, we make several adjustments to nonlabor income. In particular, equivalent nonlabor income can be expressed as

$$\hat{E} = E + S + sE_q + \tau E_h - IT \qquad (11)$$

where s is the marginal subsidy rate, S is the total credit, τ is the marginal tax rate, and IT is total income tax.[11]

The adjustments to the wage rate and child care expenditures make these variables endogenous since they depend on both the choice of hours worked and the choice of child care expenditures. To eliminate the dependence of these rates on the work decision, we employed proxies for these two variables in two separate estimations. To obtain one set of proxies, we calculated the marginal tax rate and subsidy rate using earned income if the mother worked 40 hours per week. To obtain the second set of proxies, we regressed the tax and subsidy rates calculated at actual earnings and child care expenditures on demographic and state-level variables. The second set of proxies are predicted tax and subsidy rates from these regression estimates. Results of the least-squares estimates are presented in Appendix C.[12]

III. Data

To estimate the structural model, we used data from the 1984 panel of the Survey of Income and Program Participation (SIPP). The 1984 panel of SIPP consisted of nine interview periods called waves, each containing information on income sources, program participation, and other economic variables for the four months prior to the interview date. In the fifth wave of the 1984 panel, all families in which all custodial parents and guardians were usually employed and which had children under age 15 were asked for the primary and secondary sources of care for their three youngest children for the last week of the reference period (wave). These parents were also asked for total family expenditures on child care during that week. The availability of means-tested transfer programs introduces kinks into the budget constraint of an individual and complicated our estimations; however, we limited our sample to working mothers who purchased child care.

Among married women, the husband's earnings are almost always sufficient to prohibit participation in means-tested transfer programs. Among single mothers who work and purchase child care, only about 6 percent receive transfer payments in a month in which they received earned income.[13] This indicates that, for the most part, the decision to work is also a decision not to receive transfers.

In the SIPP data, child care arrangements are of twelve types: care by either the father, a sibling under age 15, a sibling over age 15, a grandparent, the mother at the place of work, the mother who works at home, the child him or herself, another relative, a nonrelative, or a day care center; attendance at a preschool or nursery school; and attendance in either kindergarten, elementary school, or secondary school.

Table 1 presents means for some demographic and economic variables among married and single mothers. All income is reported in annual dollars. Since SIPP is organized into four-month waves, we tripled wave-level incomes to arrive at annual figures. Statistics are presented for the sample of all families with children less than 18 years of age, as well as two subsamples: all families who were asked questions regarding child care ("Families in Child Care Module"), and all families who reported paying for child care. Recall that families were asked about child care arrangements only if all custodial parents and guardians were usually employed.

Several differences appear in the table. Families purchasing child care are more likely to have preschool children. It is not surprising, then, that mothers in these families tend to be the youngest. At the same time, these mothers have higher hourly wages than mothers in families which do not pay for child care. The number of years of education is also higher (albeit slightly) for mothers in families that purchase care. It is somewhat surprising that families in which the mother does not work have only slightly more preschool children on average than families in which the mother does work. Finally, note that few families in any part of the sample receive transfers. In fact, less than 1 percent of married mothers and only 10 percent of single mothers who purchase child care report receiving any means-tested transfer income during some month of the wave.

Our comparison of married mothers with single mothers indicates that, on average, married mothers are older and better educated, have larger incomes (except transfer incomes), earn higher wages, and have more children. Single mothers by and large work slightly more hours per week;

Table 1

Means of Demographic and Economic Variables

	Families with Nonworking Mothers and Children Under 18	Families with Working Mothers Using Unpaid Child Care	Families with Working Mothers Using Purchased Child Care
Married Mothers			
Age (years)	39.3	36.0	31.1
Education (years)	11.7	12.9	13.3
Completed high school	53.3%	61.3%	90.1%
Completed college	9.8%	20.2%	25.4%
Earned income			
of mother (yearly)	0	$9,435	$13,789
of others	$24,340	$23,283	$22,840
Property income	$1,164	$941	$520
Transfer income	$395	$58	$26
Receiving transfers	7.3%	2.4%	0.6%
Other income	$1,839	$1,194	$993
Hourly wage	0	$5.98	$7.58
Hours worked per week	0	31.04	33.28
Number of children			
Under age 6	0.71	0.51	1.09
6 to 10	0.41	0.59	0.48
11 to 15	0.44	0.71	0.20
16 and older	0.70	0.37	0.05
Distribution of work hours per week			
Did not work	100.0%	3.7%	0.0
20 hours or fewer	0.0	26.5%	17.0%
21-35 hours	0.0	13.4%	23.8%
36 hours or more	0.0	56.4%	59.2%
Sample size	1,763	2,315	618

(table continues)

Table 1, continued

Means of Demographic and Economic Variables

	Families with Nonworking Mothers and Children Under 18	Families with Working Mothers Using Unpaid Child Care	Families with Working Mothers Using Purchased Child Care
Single Mothers			
Age (years)	32.1	34.3	29.8
Education (years)	10.5	12.1	12.7
Completed high school	49.9%	66.0%	85.9%
Completed college	1.6%	9.0%	12.7%
Earned income			
of mother (yearly)	$1,037	$10,428	$11,988
of others	$474	$821	$140
Property income	$303	$146	$73
Transfer income	$2,724	$443	$236
Receiving transfers	67.1%	16.0%	10.0%
Other income	$1,862	$2,039	$1,749
Hourly wage	$0.59	$5.89	$6.34
Hours worked per week	3.6	34.2	33.9
Number of children			
Under age 6	0.57	0.26	.68
6 to 10	0.48	0.51	0.44
11 to 15	0.55	0.72	0.20
16 and older	0.31	0.40	0.10
Distribution of work hours per week			
Did not work	89.3%	1.0%	0.0
20 hours or fewer	1.9%	16.0%	14.5%
21-35 hours	1.9%	19.0%	25.0%
36 hours or more	6.8%	64.0%	60.5%
Sample size	674	498	228

Source: 1984 panel of the Survey of Income and Program Participation.

however, among families purchasing child care, married and single mothers work virtually the same number of hours. Among all unmarried workers, single mothers have slightly higher earnings, while among workers who purchase child care, married mothers earn considerably more on average.

Several calculations were made in obtaining the quantities needed to estimate the expenditure system (Table 2). SIPP provides expenditures on child care only for the week prior to the interview month. To obtain expenditures for an entire wave, we multiplied the reported weekly expenditures by the number of weeks (17.3) in an average four-month period. SIPP also provides earned income and other types of income for each month in the wave. We calculated wave-level income as the sum of the monthly incomes.

The variables in Table 2 include hourly wages, nonlabor income, and tax and subsidy rates. For the base cases, nonlabor income was set equal to the difference between total income (earned income plus nonlabor income) and the mother's earned income. For the cases in which taxes and subsidies were accounted for, nonlabor income was adjusted to produce a linear budget constraint. Although means-tested transfer income should be treated differently than other income, fewer than 1 percent of married mothers who purchased child care received transfers. Among single mothers, only about 6 percent of those who worked received transfer payments in the same month (information not derived from table).

SIPP data include hourly wages for about 60 percent of our sample of mothers; however, wages are not reported for some women, and other women have several different wages for different jobs. For women with no reported wage, we calculated hourly wage as total earned income in the wave divided by the product of weeks worked and typical hours worked per week. For women with more than one reported wage, we calculated their average hourly wage as the average wage, weighted by hours worked at each job.

Table 2
Descriptive Statistics for Variables used in Estimation

	Mean	Standard Deviation	Minimum	Maximum
Married Mothers (N=618)				
Earned income				
Gross (E_h)	$13,789.96	$8,598.30	$438.00	$69,600.00
Net ($E_h(1-t)$)	8,035.02	4,074.33	328.50	23,802.57
Child care expenditures				
Gross (E_q)	$2,128.50	$1,161.10	$52.00	$5,200.00
Net ($E_q(1-s)$)	1,736.90	1,098.10	41.10	5,200.00
Child care tax credit				
Federal	$437.60	$225.10	$0.0	$1,248.00
State	44.00	87.30	0.0	936.00
Total	481.60	262.50	0.0	1,872.00
40 hour week	471.60	267.50	0.0	1,872.00
Income tax				
Federal	$6,413.20	$6,805.40	$0.0	$61,437.00
State	1,628.00	2,290.50	0.0	23,618.00
Total (IT)	8,041.20	10,920.60	0.0	78,467.30
Hourly wage rate				
Gross (w)	$7.58	$3.77	$1.74	$38.99
Net (w(1-t))	4.48	1.70	1.30	13.78
40 hour week	4.38	1.61	1.22	11.89
Instrum. var.	5.09	2.12	1.31	17.72
Nonlabor income				
Total (E)	$24,381.60	$16,172.10	$0.0	$120,162.00
Adjusted (E)	21,266.90	11,029.20	75.00	75,926.30
40 hour week	21,217.30	11,023.20	307.00	76,570.50
Instrum. var.	21,219.00	10,922.60	-856.40	74,058.30
Child care tax subsidy rate				
Federal	0.179	0.093	0.00	0.30
State	0.024	0.036	0.00	0.25
Total (s)	0.208	0.096	0.00	0.50
40 hour week	0.235	0.059	0.00	0.46
Instrum. var.	0.208	0.023	0.14	0.33
Marginal income tax rate				
Federal	0.259	0.093	0.00	0.49
State	0.050	0.039	0.00	0.14
Total (t)	0.308	0.108	0.00	0.63
40 hour week	0.316	0.108	0.00	0.63
Instrum. var.	0.308	0.092	0.09	0.55

(table continues)

Table 2, continued
Descriptive Statistics for Variables used in Estimation

	Mean	Standard Deviation	Minimum	Maximum
Single Mothers (N=228)				
Earned income				
Gross (E_h)	$11,826.24	$7,344.51	$210.00	$57,348.00
Net $(E_h(1-t))$	8,690.73	4,182.48	195.30	22,939.20
Child care expenditures				
Gross (E_q)	$1,848.50	$1,066.41	$104.00	$5,200.00
Net $(E_q(1-s))$	1,577.34	1,049.40	104.00	5,200.00
Child care tax credit				
Federal	$344.43	$283.62	$0.00	$1,206.39
State	49.83	107.46	0.00	717.60
Total (S)	394.26	322.00	0.00	1,458.00
40 hour week	465.75	442.08	0.00	1,560.00
Income tax				
Federal	$1,142.10	$1,609.60	$0.00	$14,388.80
State	354.40	547.00	0.00	4,153.90
Total (IT)	1,496.50	2,019.50	0.00	18,542.70
Hourly rate				
Gross (w)	$6.34	$2.807	$0.84	$17.07
Net (w(1-t))	4.77	1.575	0.78	10.23
40 hour week	4.65	1.498	0.78	8.84
Instrum. var.	5.31	2.060	0.83	14.06
Nonlabor income				
Gross (E)	$2,188.41	$3,006.94	$ 0.00	$17,754.00
Adjusted (E)	3,162.48	3,288.70	0.00	17,756.76
40 hour week	3,274.53	3,238.87	-162.40	17,850.36
Instrum. var.	3,190.32	3,028.23	402.89	17,586.42
Child care tax subsidy rate				
Federal	0.139	0.140	0.000	0.300
State	0.025	0.054	0.000	0.300
Total (s)	0.164	0.155	0.000	0.600
40 hour week	0.198	0.148	0.000	0.600
Instrum. var.	0.164	0.066	-0.018	0.320
Marginal income tax rate				
Federal	0.107	0.098	0.000	0.420
State	0.032	0.032	0.000	0.123
Total (t)	0.139	0.114	0.000	0.530
40 hour week	0.158	0.110	0.000	0.430
Instrum. var.	0.139	0.075	-0.026	0.330

Taxes and child care tax subsidies were calculated using federal and state tax codes, assuming that families would receive standard deductions and couples would file joint returns.[14] In addition to calculating taxes and subsidies using actual child care expenditures and earnings, we calculated taxes and subsidies using earnings if the mother had worked 40 hours per week at her reported wage. The actual taxes and subsidies were also used, along with adjusted nonlabor income, as dependent variables in least squares regressions.[15] These regression results provided a means of predicting "exogenous" levels of tax and subsidy rates and nonlabor income.

Table 2 presents descriptive statistics for variables used in estimation of the Stone-Geary expenditure system. For families with married mothers, approximately one-third of their gross income on average comes from the mother's earnings, with the bulk of the remainder coming from the earnings of other household members. About 5.6 percent of the household's total income (earned income plus nonlabor income) was spent on market child care. Weekly child care expenditures ranged from one dollar to one hundred dollars.

The earned income of single mothers represents nearly 85 percent of their family's total income on average. Approximately 13 percent of their gross income was spent on child care.

The maximum child care expenditures reflect one shortcoming of the SIPP data: the maximum recorded weekly expenditure on child care was artificially set at 100 dollars. Only about 5 percent of families purchasing care reported spending this amount. The average estimated annual child care subsidy from federal income taxes is 405 dollars for married mothers and 344 dollars for single mothers.[16] Because the subsidy is nonrefundable, the poorest families receive no subsidy. In addition, we estimate an average state credit of about 50 dollars for married mothers and 43 dollars for single mothers.

Table 2 also contains comparisons of actual taxes, subsidies, net wages, and nonlabor income, all calculated assuming a 40 hour work week and obtained from the instrumental variables regressions.

Since the average work week in the estimation sample is between 33 and 34 hours, tax and subsidy rates are slightly higher when a 40 hour work week is assumed. The instrumental variables approach produces means that are equal to those calculated using the tax code, but produces lower dispersions of subsidy rates and tax rates and equal variance of nonlabor income.

The next section of the paper presents estimates of the Stone-Geary parameters using the data described above.

IV. Results

Table 3 presents estimated parameters of the Stone-Geary utility function for married mothers and for single mothers.[17] Results are presented for four cases: a base case; a base case with sample selection correction terms; and two cases which account for taxes and subsidies.

First, consider married mothers. Column 1 presents the base case, with no adjustments for taxes or child care subsidies, and no correction for sample selection bias. Since our data are for one SIPP wave, parameter estimates for minimum consumption, px_0, maximum labor market time, h_0, and total difference between qualities of home care and minimum care, $T(Q_h-Q_0)$, reflect values for a four-month period. Note that the parameter $T(Q_h-Q_0)$ is equal to the hourly difference between quality of home child care, Q_h, and minimum acceptable level of child care, Q_0, multiplied by T, the total available hours for market and nonmarket activities. If we assume a value for T (the total number of possible work hours in a four-month wave [1,947, or 16 hours per day]), then we can infer a value for Q_0.

The estimates in column 1 appear reasonable. The taste parameters β_1, β_2, and β_3 are all between 0 and 1, although β_1 is very close to 1.0. The interpretation of these estimates is that, of

Table 3

Structural Estimates of Stone-Geary Utility Function

	Base case	With bias correction	Adjusted for Taxes & Subsidies 40 hour work week	 Instrum. variable
Married Mothers				
β_1	0.9621 (0.0052)	0.9667 (0.0050)	0.9777 (0.0089)	0.9635 (0.0046)
β_2	0.0177 (0.0036)	0.0148 (0.0034)	0.00013 (0.00024)	0.0088 (0.0017)
β_3	0.0201 (0.0036)	0.0183 (0.0025)	0.0222 (0.0037)	0.0277 (0.0037)
Q_h	$2.1395 (0.0471)	$2.1345 (0.0535)	$1.8868 (0.0320)	$2.1414 (0.0381)
$\alpha T(Q_h-Q_0)$	$709.14 (38.74)	$532.13 (64.45)	$724.66 (304.26)	$312.12 (62.33)
h_0	625.99 hrs. (9.35)	632.16 (15.46)	647.55 (14.80)	521.12 (12.56)
px_0	$5,926.96 (728.45)	$5,955.25 (804.46)	-$8,512.10 (9,641.70)	$4,425.93 (682.73)
τ_{11}		214.47 (156.73)	78.70 (78.84)	157.52 (81.48)
τ_{12}		-422.74 (220.10)	-326.98 (14.37)	-127.43 (115.10)
τ_{21}		-290.87 (34.26)	-265.06 (32.18)	-248.41 (31.64)
τ_{22}		138.25 (53.42)	84.78 (51.67)	118.18 (49.97)
Q_0 (1,947)	1.7753	1.8613	1.5545	1.9811
Q_c (median)	1.2270	1.4764	1.5195	1.8306
Pct. $px<px_0$	10.26	10.42	0.00	6.32
Pct. $h>h_0$	59.40	57.03	13.27	69.51
Pct. $Q<Q_0$	9.47	10.42	14.69	2.84

(table continues)

Table 3, continued

Structural Estimates of Stone-Geary Utility Function

	Base case	With bias correction	Adjusted for Taxes & Subsidies: 40 hour work week	Adjusted for Taxes & Subsidies: Instrum. variable
Single Mothers				
β_1	0.9144	0.8914	0.8890	0.9673
	(0.0133)	(0.0298)	(0.0282)	(0.0373)
β_2	0.0343	0.0513	0.0544	-0.0284
	(0.0259)	(0.0277)	(0.0240)	(0.0344)
β_3	0.0514	0.0573	0.0567	0.0611
	(0.0093)	(0.0098)	(0.0109)	(0.0140)
Q_h	2.0701	2.0801	1.9820	2.0340
	(0.0721)	(0.0627)	(0.0851)	(0.0672)
$\alpha T(Q_h-Q_0)$	913.44	994.065	828.064	721.291
	(68.10)	(87.170)	(94.215)	(143.610)
h_0	676.24	736.536	757.052	536.508
	(25.85)	(31.878)	(32.065)	(28.508)
px_0	762.41	965.574	720.518	372.544
	(329.96)	(200.103)	(271.584)	(1,070.24)
τ_{11}		104.74	58.37	43.26
		(59.72)	(36.80)	(38.77)
τ_{12}		-532.61	-414.45	-194.23
		(161.16)	(107.41)	(111.22)
τ_{21}		71.71	-12.39	-19.51
		(59.64)	(18.47)	(19.48)
τ_{22}		-516.56	-70.08	9.97
		(156.35)	(64.80)	(70.12)
Q_0 (1,947)	1.6009	1.5696	1.5567	1.6632
Q_c (median)	0.9290	0.8518	1.0512	1.2445
Pct. $px<px_0$	4.38	6.14	4.39	3.07
Pct. $h>h_0$	44.30	15.35	13.16	71.93
Pct. $Q<Q_0$	0.00	0.00	0.88	0.43

Note: Uncorrected asymptotic standard errors in parentheses.

each dollar of full income, about 96 cents is used for consumption and about 2 cents is used to purchase leisure and child care. Our estimate of β_2 is lower than the corresponding estimate from Johnson and Pencavel's work (1984) with the Stone-Geary utility function. In the model estimated by Johnson and Pencavel, the alternative to market work was leisure; in our model, the alternative to market work is providing child care, an activity with its share of disutility. Since β_2 represents the portion of full income spent on leisure (nonmarket) time, and since nonmarket time is less valuable in our model, it is not surprising that our estimate of β_2 is lower than that of Johnson and Pencavel.

The parameter Q_h can be interpreted as the shadow value of an hour of mother's care. The estimate in the first column implies that mother's care (Q_h) is worth about 75 percent more than that of the average purchased care (Q_c). The estimated subsistence levels px_0, h_0, and Q_0 are closer to average levels than to either minimum or maximum levels. Although the estimate for h_0 (625.99) is about 25 hours greater than the average hours worked in a wave by the mothers in the sample, the estimate is still lower than the number of hours worked in a four-month wave by a full-time worker (640). As Table 1 indicates, about 60 percent of mothers purchasing child care reported working more than 35 hours per week. As a result, nearly 60 percent of the mothers in the sample worked more than this supposed maximum. In addition, slightly more than 10 percent of families consumed less than the estimated subsistence level of consumption.

The parameterization presented in column 2 differs from that in column 1 only in the correction for potential bias caused by limiting the estimation sample to mothers who both work and purchase care. Parameters τ_{11}, τ_{12}, τ_{21}, *and* τ_{22} represent estimates of the covariance of the error terms in the consumption and earnings equations with the error terms in the bivariate probit of the choice to work and to purchase child care. Note that the addition of these estimated variables requires an adjustment in the calculation of the standard errors. We have not made this correction; therefore inferences should be made with caution.

In general, the addition of the correction terms has little effect on the parameter estimates. The difference between mother's quality care and minimum quality care decreased slightly, implying a higher value of minimum quality care.

The last two columns of Table 3 present estimates in which earnings, child care expenditures, wages, and unit quality price of market care are net of taxes and child care tax subsidies. In column 3, taxes and subsidies were calculated assuming a 40 hour work week. In column 4, taxes, subsidies, and adjusted nonlabor income were predicted using separate least squares regressions. Since net income is lower than gross income, we expect subsistence income to decrease when taxes are deducted from income and wages. The effect of adjusting for taxes and subsidies on other parameters is less pronounced.

By far, the most striking difference between column 3 and the base case is in the estimate of subsistence consumption (px_0), which decreased in column 3 to -8512.10. The estimates of β_2 and Q_h decreased only slightly. As in many nonlinear estimations, the final results depend on the initial values of the parameters. There is probably a different set of starting values which would yield estimates closer to those in the base cases.

On the other hand, the instrumental variables approach (column 4) produces an estimation of subsistence consumption (px_0) that is closer to the base case.[18] The estimated difference, however, between home care quality and minimum quality of care is lower by about a half. Also, estimated subsistence consumption decreased by about 25 percent compared to the base cases

$$\left(\frac{5{,}926-4{,}425}{5{,}926}\right).$$

The estimates for single women indicate higher shares of full income for leisure (β_2) and child care (β_3) in all columns except column 4, where β_2 is negative, although insignificantly so. As expected, minimum consumption (px_0) is much lower (except in column 3), since both family size and nonlabor income are smaller for single mothers. The value of home quality (Q_h) is similar for both marital statuses, although the difference between mother's care and minimum acceptable quality (Q_0) is greater for single mothers. In addition, maximum labor market time (h_0) is greater for single mothers.

Table 3 also contains estimates of Q_0 and Q_c based on the parameter estimates. Minimum quality of care is about thirty to forty cents lower than the quality of mother's care for married mothers, and about fifty cents lower than mother's care for single mothers. The median predicted purchased quality is lower than the minimum quality in all cases; however, our model implies that average quality--not purchased quality--should be at least as high as minimum quality. According to our estimates nearly all families purchase sufficiently good care to obtain an average quality higher than their minimum standards (pct. $Q < Q_0$).

Uncompensated elasticities of hours worked (h), quality of purchased child care (Q_c), and expenditures on child care ($Q_c h$) were estimated with respect to hourly wage and nonlabor income for each mother in the sample. Table 4 presents median values of these estimated elasticities, which indicate responses conditional on working and purchasing child care. They do not reflect the effect of subsidies on the decision to work or purchase child care. Our model allows us to separate changes in child care quality from changes in total expenditures. If a change in the wage rate induces an increase in market work, then the quality of child care will increase at a lower rate than expenditures.

Several points stand out in Table 4. Child care quality responds more than labor supply to changes in wage rates or nonlabor income. While the elasticity of labor supply with respect to wages is less than .04 in all cases, the elasticity of child care expenditures with respect to wages varies from approximately .12 to over .56. Single mothers increase child care expenditures and quality in response to wage changes at a rate between two and four times greater than that of married mothers; however, married mothers have higher average responses to changes in nonlabor income.

Table 4

Median Uncompensated Elasticities of Hours Worked, Child Care Quality, and Child Care Expenditures, with Respect to Wage, Nonlabor Income, and Subsidy Rate

	Base case	Base case with correction	Adjusted for Taxes & Subsidies: 40 hour work week	Adjusted for Taxes & Subsidies: Instrum. variable
Married Mothers				
Hours worked				
Wage	0.0116	0.0086	0.0019	0.0178
Nonlabor income	-0.0417	-0.0350	-0.0005	-0.0355
Subsidy rate			0.0001	0.0015
Child care quality				
Wage	0.1544	0.1174	0.1380	0.1441
Nonlabor income	0.1488	0.1891	0.2780	0.3003
Subsidy rate			0.2466	0.0670
Child care expenditures				
Wage	0.1710	0.1260	0.1448	0.1732
Nonlabor income	0.1071	0.1541	0.2777	0.2460
Subsidy rate			0.2467	0.0965
Single Mothers				
Hours worked				
Wage	0.0137	0.0141	0.0321	-0.0263
Nonlabor income	-0.0039	-0.0067	-0.0191	0.0101
Subsidy rate			0.0019	-0.0012
Child care quality				
Wage	0.3772	0.4151	0.4877	0.2962
Nonlabor income	0.0330	0.0233	0.0728	0.1126
Subsidy rate			0.1289	0.0866
Child care expenditures				
Wage	0.3909	0.4295	0.5621	0.2485
Nonlabor income	0.0291	0.0166	0.0456	0.1445
Subsidy rate			0.1406	0.0724

The estimations which include subsidy rates provide a means of estimating elasticities of hours worked, child care expenditures, and quality with respect to the subsidy rates. The results presented in Table 4 indicate that subsidies have little effect on hours worked for mothers who already work and purchase child care. The effect on child care quality and expenditures, however, is greater for this group. Married mothers would increase expenditures by between .0965 and .2467 percent in return for a 1 percent change in subsidies. Single mothers show less of a response, with estimated elasticities of expenditures of .0724 and .1406. As with the response to wage and nonlabor income increases, the bulk of the response to subsidies represents an increase in child care quality rather than hours worked.

V. Simulated Response to Changes in Tax Subsidies

The elasticities presented in the previous section represent the response of market care users to marginal changes in subsidy rates, wage rates, and nonlabor income, conditional on using market care. These elasticities cannot capture behavioral changes for those who use free care or do not work, nor do they indicate responses to large changes in subsidy rates, etc., for market care users. This section attempts to generalize the results to the entire population using the technique of microsimulation. The microsimulation analysis estimates the responses of market care users, free care users, and nonworkers to proposed changes in the federal child care tax credit.

The federal child care tax credit is the largest program subsidizing the child care expenditures of families with working parents. The current credit is structured as follows. For family incomes below $10,000, a 30 percent credit is allowed. For incomes between $10,000 and $28,000, the credit is gradually reduced to 20 percent, where it remains even if incomes increase. There is an expenditure ceiling of $2,400 for one child and $4,800 for two or more children. The credit is nonrefundable, meaning that it can only offset positive tax liability amounts; if a family pays no income tax, it cannot receive a child care tax credit.

The nonrefundability of the child care tax credit has been severely criticized by many policy analysts, primarily because it results in an inequitable distribution of benefits. As pointed out by Robins (1990b), only about 3 percent of the benefits go to the lower 30 percent of the income distribution, while nearly 50 percent of the benefits go to the upper 30 percent of the income distribution. Therefore, several recent proposals in Congress have called for a refundable child care tax credit.

As an illustration of how our results can be used to analyze the effects of policy changes, we estimate the behavioral responses to two proposed changes in the tax credit. The first proposed change makes the current credit refundable. The second simulated change is a more progressive tax credit suggested by Robins (1990b). In addition to refundability, the Robins proposal makes the credit schedule more generous for low-income families and less generous for high-income families. Specifically, the Robins proposal would allow families with incomes below $10,000 to receive a credit equal to 80 percent of their child care expenditures. This rate would be gradually reduced to 20 percent for families with annual incomes of $40,000 and would be phased out entirely for families with annual incomes exceeding $60,000.

This represents an extension of the analysis by Barnes (1988), who examined the direct effects (holding labor supply and child care constant) of a refundable credit. It is important to note that we (as well as Barnes) assume that a family receives the full benefits to which it is entitled. Critics of refundability have argued that many low-income families will not benefit from a refundable tax credit because they do not file income tax returns (see Robins, 1990b). Thus, our estimates may be thought of as representing an upper bound on the expected behavioral response to a refundable credit.

Our simulation of a family's response consists of two stages. In the first stage, we remove discrepancies between observed choices and those implied by the estimated utility function. In the second stage, we estimate responses to the proposed changes. If all parameters needed to determine utility are known, then the new subsidy schedule can be substituted into the appropriate formulas and the simulated response can be calculated. In principle, the estimates of the previous section provide all parameters of the model with the exception of Q_f, the quality of free care. The estimated utility function will not be consistent, however, with observed behavior. For example, predicted and observed labor supply and child care expenditures will differ. To rectify such differences between observed and predicted behavior, we simulate heterogeneity across families in four parameters: px_0, h_0, Q_0, and Q_f.

Consider users of market care. Conditional on the decision to use market care, the predicted levels of hours worked, child care expenditures, and consumption will differ from the observed choices. These discrepancies can be eliminated by allowing heterogeneity in any two of the three subsistence parameters.[19] Suppose that px_0 and h_0 are allowed to vary across mothers. Although this heterogeneity ensures that predicted and observed values are equivalent as long as market care is used, it does not guarantee that the use of market care is the best alternative. For example, if the quality of free care is high enough, the use of free care will be optimal. Heterogeneity in Q_f provides a means of guaranteeing that market care is optimal relative to free care. In our model, however, the quality of free care does not affect the utility of a nonworking mother. Therefore, one additional source of heterogeneity is needed to ensure that market care is preferred to not working. For symmetry, we allow the third subsistence parameter, Q_0, to vary across mothers. In practice, random values are drawn for u_q and Q_f. For any chosen value of u_q, values of u_h and u_x can be determined which will exactly yield the observed child care and work choices, conditional on working and using market care. Once these random parameters are drawn, optimal utility is calculated for the three alternatives. If it is optimal to work and use market care, the simulation is performed for that mother. Otherwise, new values are chosen for u_q and Q_f.

The procedure is similar for workers who use free care and for nonworkers. Since there are fewer observed choices for these mothers than for users of market care, fewer heterogeneous parameters are necessary to justify their observed actions. For consistency, however, the same four parameters are allowed to vary across families. For nonworkers, the four parameters are randomly drawn until they produce a utility function in which not working is the optimal choice. For workers who use free care, the observed labor supply choice allows us to identify Q_f once all other parameters are known. Random draws are made for u_x, u_h, and u_Q, and Q_f is calculated given the mother's observed labor supply and the random values. For mothers in the other groups, if working and using free care is optimal given these random values, then the simulation is performed for that mother. Otherwise, new values are drawn and the process repeated.

Tables 5 through 8 present results of the simulated responses to the two proposed federal child care tax credits. Results are presented by marital status of the mother. Five simulations were performed for each family, using parameter estimates of the portion of full income spent on child care (variable β_3, Table 3, for married and single mothers). Separate distributions were used for the random parameters u_x, u_h, u_Q, and Q_f by marital status.[20] Future work includes testing the sensitivity of our projections to the assumed distribution as well as the estimates of the parameters of the utility function.

Table 5 presents the number of mothers in the sample who work and use market care, work and use free care, and do not work. The response to the refundable credit is small. About 3.3 percent (weighted) of single mothers and 1.9 percent of married mothers who used free care switch to market care. Even fewer nonworkers switch to market care. In contrast, under the progressive credit, more than 40 percent of single mothers and 30 percent of married mothers who use free care would switch

Table 5

Distribution of Families by Work and Child Care Decisions:
Current Tax Credit and Simulated Credits

	Current Credit	Refundable Credit		Progressive Credit	
		Simulation	Pct. Change	Simulation	Pct. Change
Single Mothers					
Unweighted					
Market care	181	197	8.84	392	116.57
Free care	492	480	-2.44	281	- 42.89
Nonworkers	650	649	-0.15	646	- 0.62
Weighted (thousands of families)					
Market care	938	1,032	10.02	2,094	122.37
Free care	2,632	2,546	- 3.27	1,490	- 43.39
Nonworkers	3,200	3,195	- 0.16	3,181	- 0.59
Married Mothers					
Unweighted					
Market care	117	123	5.13	215	83.76
Free care	315	309	- 1.91	219	- 30.48
Nonworkers	442	442	0.00	442	0.00
Weighted (thousands of families)					
Market care	3,496	3,661	4.72	5,851	67.36
Free care	7,663	7,498	- 2.16	5,354	- 30.13
Nonworkers	9,071	9,071	0.00	9,071	0.00

to market care. Even with the large incentives of the progressive credit, we project that few nonworkers will decide to work.

Table 5 shows large movements toward market care under the progressive tax credit; Table 6 summarizes the simulated aggregate effects of the proposed tax credit on labor supply, child care expenditures, and child care quality. Again, the effects of the progressive credit are more pronounced than the effects of the refundable credit. Among single mothers, the refundable credit produces a 1.5 percent increase in hours worked, a 38 percent increase in child care expenditures, and a doubling of subsidies. Married mothers show a lower response, increasing child care expenditures by 10.5 percent and subsidies by 16 percent. Despite these increases in child care expenditures and subsidies, the quality of care used while the mother works increases only slightly.

The progressive credit produces greater changes. Single mothers show a 6.8 percent increase in hours worked, a 330 percent increase in child care expenditures, a fifteenfold increase in subsidies for single mothers, and an 8 percent increase in the quality of care while the mother works. Among married mothers there is a 1 percent increase in hours worked, a tripling of child care expenditures, a sixfold increase in subsidies, and a 19 percent increase in the quality of care while the mother works.

According to Table 6, most of the simulated increases in child care subsidies stem from behavioral responses, rather than increased subsidies to mothers already purchasing child care. In the absence of behavioral changes, subsidies would increase by only about 11 percent under the refundable credit and 128 percent under the progressive credit. These results are similar to the changes simulated by Barnes. They explain, however, only about one-third of the total simulated increases in subsidies under the refundable credit and less than 20 percent of the increases under the progressive credit.

Table 7 compares the per capita simulated responses of those who originally chose market care and those who originally used free care.[21] In this table, average child care expenditures and

Table 6

Simulated Changes in Labor Supply and Child Care Spending
Induced by Tax Credit Changes
(Weighted to national population; hours and dollars in millions)

	Current Credit	Refundable Credit		Progressive Credit	
		Simulation	Pct. Change	Simulation	Pct. Change
Single Mothers					
Hours worked	6,285	6,384	1.54	6,690	6.79
Child care expenditures	$1,812	$2,502	38.12	$7,800	330.48
Subsidy					
Total	$363	$750	107.41	$5,580	1,437.17
With no change in behavior	$363	$561	55.20	$1,464	306.21
Quality of care during work	1.74	1.78	2.13	1.89	7.94
Married Mothers					
Hours worked	19,339	19,387	0.24	19,538	1.03
Child care expenditures	$7,883	$8,715	10.56	$22,700	188.00
Subsidy					
Total	$1,671	$1,940	16.10	$11,292	575.78
With no change in behavior	$1,671	$1,696	1.54	$3,173	89.90
Quality of care during work	1.65	1.66	0.88	1.95	18.90
Total					
Hours worked	25,624	75,771	0.57	26,228	2.36
Child care expenditures	$9,695	$11,217	15.70	$30,500	214.60
Subsidy					
Total	$2,034	$2,690	32.25	$16,872	729.50
With no change in behavior	$2,034	$2,257	10.96	$4,637	127.97
Quality of care during work	1.67	1.69	1.20	1.93	15.57

Table 7

Per Capita Responses to Changes in Child Care Tax Credit
(Weighted to national population; hours and dollars in millions)

	Current Credit	Refundable Credit		Progressive Credit	
		Simulation	Pct. Change	Simulation	Pct. Change
Single Mothers					
Hours worked					
Market care	1,786	1,822	2.02	1,834	2.69
Free care	1,757	1,771	0.80	1,888	7.46
Child care expenditures					
Market care	$1,946	$2,290	17.68	$3,360	72.66
Free care	0	$3,714		$3,997	
Subsidy					
Market care	$390	$694	77.95	$2,611	569.49
Free care	0	$1,078		$2,704	
Quality of care (total)					
Market care	1.71	1.76	0.36	1.94	13.14
Free care	3.29	3.29	0.14	3.31	3.42
Married Mothers					
Hours worked					
Market care	1,894	1,894	0.00	1,904	0.10
Free care	1,659	1,665	0.40	1,681	1.32
Child care expenditures					
Market care	$2,255	$2,285	1.32	$2,955	31.04
Free care	0	$4,415		$5,417	
Subsidy					
Market care	$478	$488	2.20	$1,382	189.21
Free care	0	$1,407		$2,797	
Quality of care (total)					
Market care	1.10	1.12	1.88	1.55	40.9
Free care	1.89	1.90	0.71	2.12	12.2

subsidies for free care users are calculated using mothers who switch from free care to market care. Although annual hours worked are similar across the two groups, free care users who decide to purchase care spend quite a bit more on child care. The average quality of care is much higher for free care users and does not change greatly in response to the more generous subsidies. To maintain a high average level of care, those who decide to purchase care choose a high quality of market care.

As indicated earlier, a refundable credit has been favored by some because it promotes an equitable distribution of benefits. A refundable tax credit would have the greatest impact on those who were constrained by their lack of an income tax liability (e. g., low-income workers). Table 8 presents estimates of the effects of the proposed subsidies by income group.[22] As expected, workers in the lower income categories are projected to have the greatest increases in subsidies. For example, the percentage of subsidies going to single mothers with earnings below $12,000 increases from 23.6 percent under the current credit to 53.5 percent under the refundable credit and 46.4 percent under the progressive credit. The effect on poor married mothers is not so pronounced. The share of subsidies, however, going to married mothers in the highest income category decreases from 71.4 percent under the current credit to 60.2 percent under the refundable credit and 21.1 percent under the progressive credit.

VI. Conclusion

This paper has presented estimates of a structural model of labor supply and child care demand. We find several novel results. First, we estimate that the market value of a mother's care is approximately $1.90 to $2.15 per hour. This is 15 to 75 percent higher than the average hourly expenditure on child care for married mothers in our sample and 67 to over 100 percent higher than average hourly expenditures by single mothers. We also estimate the short-run responses of labor

Table 8

Percentage Distribution of Child Care Subsidies
under the Current Credit and Proposed Credits
(Weighted to national population)

	Subsidies under Current Credit	Subsidies under Refundable Credit	Subsidies under Progressive Credit
Single mothers			
Annual income			
0 - $12,000	23.6%	53.5%	46.4%
$12,001-20,700	52.9	35.2	40.6
$20,701-32,050	16.9	8.1	11.4
$32,051 +	6.6	3.2	1.5
Total subsidy (millions)	$363	$751	$5,544
Married Mothers			
Annual income			
0 - $12,000	1.7%	14.0%	9.2%
$12,001-20,700	10.6	12.1	20.9
$20,701-32,050	16.4	13.8	48.7
$32,051 +	71.4	60.2	21.1
Total subsidy (millions)	$1,671	$1,940	$11,292
Total			
Annual income			
0 - $12,000	5.6%	25.0%	21.5%
$12,001-20,700	18.1	18.5	27.4
$20,701-32,050	16.5	12.2	36.4
$32,051 +	59.8	44.3	14.7
Total subsidy (millions)	$2,035	$2,691	$16,835

supply, child care expenditures, and child care quality to changes in the wage rate, nonlabor income, and child-care income tax subsidies of mothers who work and purchase child care. We find that a 1 percent increase in the wage rate produces as much as a .56 percent increase in child care expenditures by single women. The elasticity for married women, who spend a substantially smaller portion of income on child care, is much smaller. Among women who purchase child care, nearly all of the change in child care expenditures is attributed to changes in child care quality, rather than changes in the hours of market care use. The response of labor supply is quite a bit smaller than the response of child care expenditures.

The structural model results were used to simulate the effects of a refundable child care tax credit. The simulations indicate that a refundable tax credit would increase equity by increasing the shares of subsidies received by low-income women and would induce a considerable increase in expenditures on market child care. Labor supply also increases, but considerably less so than child care expenditures. A surprising result is that, despite large increases in child care expenditures, the overall quality of child care does not change very much. The primary benefit of more generous subsidies is that they allow users of high-quality free care to purchase slightly higher-quality market care. Overall, a refundable credit is estimated to cost an additional $655 million more than the current credit (in 1985 dollars). This represents a 38 percent increase over the current credit. A more progressive tax credit is estimated to increase subsidies by $14.8 billion, or more than 700 percent, over the current credit. Most of the increased cost ($433 million for the refundable credit and $12.2 billion for the more progressive credit) is due to behavioral responses in the form of increased hours of work and increased expenditures on child care.

Appendix A

Method of Correcting for Bivariate Sample Selection

This appendix presents a method, suggested by Maddala (1983), to adjust for potential selectivity bias when the subsample is selected based on two choices. Suppose that consumption and earned income are imperfectly observed so that

$$E_h = E_h^* + \epsilon_h \quad \text{and}$$
$$E_x = E_x^* + \epsilon_x \quad \text{(A-1)}$$

Suppose, further, that there are latent variables

$$y_1^* = X_1\tau_1 + u_1 \quad \text{and}$$
$$y_2^* = X_2\tau_2 + u_2 \quad \text{(A-2)}$$

such that a woman works if and only if $y_1^* \geq 0$, and purchases child care if she works and $y_2^* \geq 0$. If

$$\binom{\epsilon}{u} \sim \left(\binom{0}{0}, \begin{pmatrix} \Sigma_{11} & \Sigma_{12} \\ \Sigma_{21} & \Sigma_{22} \end{pmatrix} \right)$$

It is well established that $E(\epsilon|u=c)=(\Sigma_{11})^{-1}\Sigma_{12}c$ (see, for example, Maddala 1983, p. 368).

Therefore, $E(\epsilon|u>c)= (\Sigma_{11})^{-1}\Sigma_{12}E(u|u>c)$ where

$$F(c_1, c_2)E(x_1|x>c) = \phi(c_i)\{1 - \Phi(c_j^*)\} + r\phi f(c_j)\{1 - \Phi(c_i^*)\} \quad \text{(A-3)}$$

where $c_i^* = (c_i - rc_j)/(1-r^2)^{1/2}$, $\quad i = 1,2, j \neq i$

r is the correlation between x_1 and x_2, c_i equals $X_i\tau_i$,

ϕ and Φ are the standard normal density and distribution functions, and

F is the bivariate normal distribution function.

The parameters τ_1, τ_2, and Σ_{12} can be estimated up to scale using a bivariate probit with sample selection (since only working mothers are observed to purchase child care). The elements of Σ_{11} can then be estimated by adding terms of the form of expression (A-3) to the estimation of the system (8).

APPENDIX B

Bivariate Probit Results

This appendix presents results of the bivariate probit for the decisions to work and purchase market care. Table B-1 provides definitions of variables used in the analysis. Tables B-2 and B-3 provide means and standard deviations for each of these variables for each equation for married mothers. Table B-5 presents descriptive statistics for single mothers. For married mothers, the analysis was performed separately for black and nonblack mothers. Because of the small sample of single mothers, a binary variable was included to capture racial differences among single mothers. Table B-4 presents results of the bivariate probit estimation for married mothers, Table B-6 for single mothers.

Table B-1

Definition of Variables in Bivariate Probit Equations

Variable	Definition
PRES01	Presence of children less than 2 years old
PRES13	Presence of children 2 to 3 years old
PRES35	Presence of children 4 to 5 years old
PRES610	Presence of children 6 to 10 years old
PRES1115	Presence of children 11 to 15 years old
PRES16P	Presence of children older than 15
P01XNL6	PRES01 x No. of children less than 6 years old
P13XNL6	PRES13 x No. of children less than 6 years old
P35XNL6	PRES35 x No. of children less than 6 years old
P13XNG6	PRES13 x No. of children older than 6 years
P35XNG6	PRES35 x No. of children older than 6 years
HIGHSC	High school graduate, but not college graduate
COLLEGE	College graduate
NOEAST	Resides in Northeast region of United States
MIDWEST	Resides in Midwest
SOUTH	Resides in South
METRO	Resides in an SMSA
DISABLED	Reports some disability
EDUC	Years of schooling
EDUCSQ	Years of schooling, squared
AGE	Age (in months)
AGESQ	Age (in months), squared
OTHINCA	Other income
BLACK	Race reported as black
TITLEXX	Per capita Title XX expenditures, by state
STAND	AFDC plus food stamp maximum
RECTRANS	Received transfers during wave
UNEMP	State unemployment rate
RHO(1,2)	Covariance between errors of probit equations

Table B-2

Descriptive Statistics for Labor Supply Equation

Variable	Nonblack Mean	Nonblack Standard Deviation	Black Mean	Black Standard Deviation
PRES01	0.10551	0.30724	0.95775E-01	0.29470
PRES13	0.19949	0.39967	0.18873	0.39185
PRES35	0.28358	0.45079	0.29014	0.45447
PRES610	0.39346	0.48857	0.43099	0.49591
PRES1115	0.40659	0.49125	0.43662	0.49667
PRES16P	0.28404	0.45101	0.31268	0.46424
P01XNL6	0.16770	0.54093	0.14366	0.49195
P13XNL6	0.31767	0.70856	0.29859	0.69369
P35XNL6	0.42916	0.76644	0.40282	0.72369
P13XNG6	0.10481	0.49171	0.16338	0.60255
P35XNG6	0.24833	0.70061	0.34085	0.79858
HIGHSC	0.64593	0.47828	0.62254	0.48544
COLLEGE	0.17323	0.37849	0.13803	0.34542
UNEMP	701.40	167.65	690.63	167.18
NOEAST	0.23750	0.42560	0.25915	0.43879
MIDWEST	0.25432	0.43553	0.18028	0.38496
SOUTH	0.33264	0.47121	0.49014	0.50061
METRO	1.2771	0.44763	1.1803	0.38496
DISABLED	0.47685E-01	0.21312	0.84507E-01	0.27854
EDUC	12.506	2.8497	12.296	2.5311
EDUCSQ	164.52	66.505	157.57	62.328
AGE	35.792	8.2590	36.727	10.150
AGESQ	1349.3	628.88	1451.6	853.02
OTHINCA	9.0275	6.3048	5.9421	4.2144
Sample size	4,341		355	

Table B-3

Descriptive Statistics for Market Care Equation

	Nonblack		Black	
Variable	Mean	Standard Deviation	Mean	Standard Deviation
PRES01	0.87231E-01	0.28223	0.66946E-01	0.25045
PRES13	0.16778	0.37374	0.17992	0.38492
PRES35	0.26058	0.43903	0.30126	0.45977
PRES610	0.37639	0.48457	0.43515	0.49682
PRES1115	0.42279	0.49409	0.45607	0.49911
PRES16P	0.28953	0.45363	0.28033	0.45011
P01XNL6	0.12584	0.44377	0.96234E-01	0.40369
P13XNL6	0.24944	0.60521	0.25105	0.59032
P35XNL6	0.36823	0.68040	0.37238	0.63464
P13XNG6	0.70156E-01	0.37847	0.16318	0.63721
P35XNG6	0.20564	0.60695	0.32218	0.75089
HIGHSC	0.66592	0.47175	0.62762	0.48445
COLLEGE	0.19896	0.39929	0.17573	0.38139
NOEAST	0.23014	0.42100	0.26360	0.44151
MIDWEST	0.26058	0.43903	0.17992	0.38492
SOUTH	0.34076	0.47405	0.48954	0.50094
METRO	1.2762	0.44718	1.1632	0.37031
DISABLED	0.32665E-01	0.17779	0.37657E-01	0.19076
EDUC	12.882	2.5836	12.615	2.5026
EDUCSQ	172.63	65.511	165.38	64.141
AGE	35.830	7.7709	35.588	8.4768
AGESQ	1344.1	583.30	1338.0	671.53
OTHINCA	8.9125	5.9521	6.1645	4.2866
Sample size	2,694		239	

Table B-4

Bivariate Probit Estimates for Market Care Equation
(Married Mothers)

	Nonblack		Black	
Variable	Coeff.	Standard Error	Coeff.	Standard Error
CONSTANT	-2.48357	1.057	-11.3689	12.22
PRES01	0.923770	0.2621	4.18026	4.503
PRES13	1.77047	0.2281	2.97537	1.407
PRES35	1.45288	0.2231	2.28382	1.628
PRES610	0.172245	0.1032	-0.147410	0.5296
PRES1115	-0.378441	0.1012	0.407661	0.5847
PRES16P	-0.639984	0.1450	-0.250473	0.7867
P01XNL6	-0.160699	0.1465	-1.34602	1.875
P13XNL6	-0.597395	0.1314	-0.635696	0.6559
P35XNL6	-0.326175	0.1265	-0.237698	1.376
P13XNG6	0.447394E-02	0.7992E-01	-0.438060	0.5771
P35XNG6	-0.825680E-01	0.6754E-01	-0.472739	0.3673
HIGHSC	-0.103074E-02	0.1499	0.354693	1.294
COLLEGE	0.159250	0.2671	0.455028	1.812
NOEAST	0.315708E-02	0.9575E-01	0.232099	0.6140
MIDWEST	0.106846	0.9514E-01	0.365775	0.6235
SOUTH	0.171860	0.9431E-01	0.408593	0.5426
METRO	-0.144545E-01	0.7255E-01	-0.271771	0.5120
DISABLED	-0.405360	0.2784	0.352320	1.684
EDUC	-0.566051E-01	0.7572E-01	0.320031	1.847
EDUCSQ	0.206146E-02	0.3369E-02	-0.827463E-02	.6768E-01
AGE	0.107996	0.4838E-01	0.424256	0.3355
AGESQ	-0.164372E-02	0.7188E-03	-0.669178E-02	.5106E-02
OTHINC	0.117713E-01	0.7435E-02	0.268252E-02	.4090E-01

(Continued on next page)

Table B-4 (Cont.)

Bivariate Probit Estimates for Labor Supply Equation
(Married Mothers)

	Nonblack		Black	
Variable	Coeff.	Standard Error	Coeff.	Standard Error
CONSTANT	0.470735E-01	0.4535	-1.54150	1.799
PRES01	-0.519627	0.1882	-1.64404	0.8035
PRES13	-0.578523	0.1604	-0.181102	0.8165
PRES35	0.309198E-01	0.1480	1.18460	0.7188
PRES610	-0.276244	0.5341E-01	-0.181412	0.1959
PRES1115	-0.217390E-01	0.5295E-01	0.127404	0.2096
PRES16P	0.284350E-01	0.6269E-01	-0.241485	0.2319
P01XNL6	-0.256614E-02	0.1053	0.605976	0.4871
P13XNL6	0.588272E-01	0.9097E-01	-0.116002E-01	0.5194
P35XNL6	-0.175857	0.8560E-01	-0.845612	0.4821
P13XNG6	0.457808E-01	0.5324E-01	0.237577	0.3258
P35XNG6	-0.525616E-01	0.4407E-01	-0.206631	0.1579
HIGHSC	0.211746	0.7915E-01	0.519981E-01	0.2891
COLLEGE	0.184920	0.1672	1.05409	0.7143
UNEMP	-0.822330E-03	0.1284E-03	-0.232304E-03	.5890E-03
NOEAST	-0.140161	0.6391E-01	0.105368	0.3668
MIDWEST	0.910668E-01	0.6309E-01	-0.120899	0.3979
SOUTH	0.239628E-01	0.5998E-01	0.779323E-02	0.3631
METRO	-0.241424E-01	0.4535E-01	-0.938469E-01	0.2458
DISABLED	-0.503285	0.9330E-01	-0.965746	0.3257
EDUC	0.289454E-01	0.3906E-01	0.193145	0.2147
EDUCSQ	0.176499E-02	0.1977E-02	-0.833062E-02	.1043E-01
AGE	0.518218E-01	0.2023E-01	0.886184E-01	.6294E-01
AGESQ	-0.908276E-03	0.2563E-03	-0.136765E-02	.6894E-03
OTHINC	-0.223129E-01	0.3297E-02	0.219272E-01	.2051E-01
RHO(1,2)	-0.331044	0.3546	0.167852	3.146
Sample size	4,341		355	
Log likelihood	-3,741.4		-264.54	

Table B-5

Descriptive Statistics for Single Mothers

	Labor Supply Equation		Market Care Equation	
	Mean	Standard Deviation	Mean	Standard Deviation
PRES01	0.07732	0.26719	0.04595	0.20950
PRES13	0.17739	0.38212	0.12035	0.32555
PRES35	0.27810	0.44821	0.22976	0.42091
PRES610	0.35802	0.47958	0.33917	0.47369
PRES1115	0.38077	0.48573	0.42013	0.49385
PRES16P	0.27680	0.44756	0.31291	0.46393
HIGHSC	0.59454	0.49114	0.67724	0.46779
COLLEGE	0.06952	0.25443	0.10722	0.30956
NOEAST	0.23912	0.42668	0.24617	0.43101
MIDWEST	0.24626	0.43097	0.22429	0.41734
SOUTH	0.34438	0.47532	0.35011	0.47727
METRO	1.2151	0.41101	1.2079	0.40601
DISABLE	0.10071	0.30105	0.05251	0.22319
EDUC	11.500	2.7618	12.246	2.4024
EDUCSQ	139.86	57.270	155.73	56.568
AGE	33.798	10.014	34.889	8.7319
AGESQ	1242.5	772.65	1293.4	653.51
OTHINC	1.0026	2.0789	1.1863	2.2233
BLACK	0.35543	0.47880	0.30963	0.46259
STAND	507.54	194.81	506.33	184.33
TITLEXX			1.9179	2.4032

Table B-6

Bivariate Probit Results for Single Mothers

	Labor Supply Equation		Market Care Equation	
	Estimate	Standard Error	Estimate	Standard Error
ONE	-2.99742	0.7115	0.425039	4.023
PRES01	-0.483792	0.1513	0.077148	0.4644
PRES13	-0.504987	0.1155	0.837797	0.2399
PRES35	-0.494744	0.0963	1.09528	0.1708
PRES610	-0.385847	0.0890	0.436166	0.2278
PRES1115	-0.194428	0.0992	-0.358139	0.2756
PRES16P	-0.070059	0.1120	-0.438974	0.2397
HIGHSC	0.195634	0.1270	0.228761	0.3326
COLLEGE	0.279164	0.3574	-0.082492	0.4662
NOEAST	-0.033619	0.1151	-0.068460	0.2018
MIDWEST	-0.163011	0.1153	0.172924	0.2041
SOUTH	0.135966	0.1254	0.016105	0.2365
METRO	-0.132435	0.0947	0.092086	0.1521
DISABLED	-0.945503	0.1131	0.397939	0.7873
EDUC	0.058889	0.0691	-0.084566	0.1664
EDUCSQ	0.002908	0.0040	0.005286	0.0062
AGE	0.164692	0.0328	-0.054236	0.1308
AGESQ	-0.002013	0.0004	0.000460	0.0016
OTHINCA	-0.011047	0.0182	-0.026481	0.0621
BLACK	-0.248681	0.0835	-0.081814	0.2508
STAND	-0.000297	0.0002	-0.000304	0.0005
TITLEXX			0.031554	0.0232
RECTRANS			-0.241702	0.1658
RHO(1,2)	-0.313593	1.294		
Sample size	1,539		914	
Log likelihood	-1203.8			

Appendix C

Instrumental Variable Results

This appendix contains results of the ordinary least squares regressions of adjusted nonlabor income, marginal tax rates, and marginal child care tax subsidy rates. The results of these regressions were used to obtain predicted values of the right-hand-side variables in the Stone-Geary demand system.

Tables C-1 and C-2 contain descriptive statistics for all variables used in this set of regressions. Table C-1 contains statistics for married mothers, Table C-2 for single mothers. Regressors fall into four categories: demographic variables, income variables, state-level variables, and sample selection correction terms (lambdas). Among demographic variables are age, age squared, years of schooling (education), education squared, and whether the mother completed high school and college. Income variables include nonwage taxable income and nonwage income squared. The mother's nonwage income includes earnings of her partner. Two state variables were used: the maximum AFDC plus food stamp amount for a family of two, and per capita Title XX expenditures. These variables were designed to capture social spending, which in turn is expected to reflect tax and subsidy levels.

Table C-1

Descriptive Statistics for Married Mothers

Variable	Mean	Standard Deviation
Age*	373.539	64.674
Age squared*	143,707.173	50,454.434
Education	13.291	2.565
Educ. squared	183.227	68.176
Completed HS	0.901	0.299
Completed college	0.254	0.436
Other income**	8.119	5.399
Oth. inc. squared**	95.012	168.896
AFDC standard**	0.410	0.107
Title XX exp.***	1.770	1.632
Lambda a	0.981	0.440
Lambda b	0.736	0.281
Subsidy rate	0.208	0.096
Marginal tax rate	0.308	0.108
Adj. nonlab. inc.	7,072.988	3,684.045

* Age reported in months.
** In thousands of dollars.
*** Per capita state expenditures.

Table C-2

Descriptive Statistics for Single Mothers

Variable	Mean	Standard Deviation
Age*	358.06	77.135
Age squared*	134,131.72	59,868.431
Education	12.67	2.095
Educ. squared	164.93	53.994
Completed HS	0.86	0.348
Completed college	0.13	0.334
Other income**	0.62	1.004
Oth. inc. squared**	1.39	3.983
AFDC standard**	0.41	0.111
Title XX exp.***	2.36	3.166
Lambda a	1.63	2.087
Lambda b	0.96	0.618
Subsidy rate	1,054.16	1,096.234
Marginal tax rate	0.16	0.155
Adj. nonlab. inc.	0.14	0.114

* Age reported in months.
** In thousands of dollars.
*** Per capita state expenditures.

Table C-3

Instrumental Variable Regressions
(Married Mothers)

Variable	Adjusted Nonlabor Income	Marginal Tax Rate	Subsidy Rate
Intercept	874.5279	0.1106	0.2760
	(744.0843)	(0.0757)	(0.1233)
Age	-0.0570	-0.0004	-0.0004
	(3.2285)	(0.0003)	(0.0005)
Age squared	0.0014	7.1254E-07	6.2577E-07
	(0.0042)	(4.2413E-07)	(6.9075E-07)
Education	-64.9105	-0.0010	0.0088
	(64.3986)	(0.0066)	(0.0107)
Education squared	5.4253	0.0003	-0.0006
	(2.6753)	(0.0003)	(0.0004)
Completed HS	-102.3070	-0.0149	-0.0043
	(113.6393)	(0.0116)	(0.0188)
Completed college	-301.7860	-0.0242	0.0180
	(128.1805)	(0.0130)	(0.0212)
Other income	853.0918	0.0282	-0.0049
	(11.8743)	(0.0012)	(0.0020)
Oth. inc. squared	-6.6112	-0.0005	0.00009
	(0.3695)	(0.00004)	(0.00006)
AFDC standard	-595.9710	0.2613	-0.0336
	(222.4284)	(0.0226)	(0.0368)
Title XX exp.	-69.3631	0.0017	0.0055
	(14.2130)	(0.0014)	(0.0024)
Lambda a	-37.6820	-0.0170	0.0113
	(65.2523)	(0.0066)	(0.0108)
Lambda b	217.9885	-0.0486	-0.0012
	(106.3037)	(0.0108)	(0.0176)
R-SQUARE	0.9767	0.7193	0.0570

Note: Standard errors are presented in parentheses.

Table C-4

Instrumental Variable Regressions
(Single Mothers)

Variable	Adjusted Nonlabor Income	Marginal Tax Rate	Subsidy Rate
Intercept	-997.1390	-0.2249	0.0504
	(956.2829)	(0.1783)	(0.2942)
Age	3.3816	0.0019	0.0009
	(3.1212)	(0.0006)	(0.0010)
Age squared	-0.0024	-2.21701E-06	-8.3605E-07
	(0.0039)	(7.25681E-07)	(1.1973E-06)
Education	16.9696	-0.0121	-0.0135
	(105.8541)	(0.0197)	(0.0326)
Education squared	0.4039	0.0004	0.0001
	(4.5507)	(0.0008)	(0.0014)
Completed HS	-71.5097	0.0092	0.0003
	(129.9317)	(0.0242)	(0.0400)
Completed college	152.7599	0.0349	-0.0228
	(202.9611)	(0.0378)	(0.0624)
Other income	985.4902	0.0548	0.0544
	(83.5098)	(0.0156)	(0.0257)
Oth. inc. squared	-12.9012	-0.0043	-0.0100
	(19.6373)	(0.0037)	(0.0060)
AFDC standard	435.7111	0.1343	0.1776
	(298.5659)	(0.0557)	(0.0919)
Title XX exp.	13.8462	0.0028	0.0042
	(12.0034)	(0.0022)	(0.0037)
Lambda a	1.8826	0.0201	0.0250
	(33.4275)	(0.0062)	(0.0103)
Lambda b	132.5168	-0.0661	-0.1052
	(127.4417)	(0.0238)	(0.0392)
R-SQUARE	0.8288	0.4375	0.1786

Note: Standard errors are presented in parentheses.

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Notes

1. Between 1970 and 1985, the labor force participation rate of married women with children under six years of age grew from 30 percent to 54 percent (Hayghe, 1986).

2. For a description of many of these bills, see Robins (1990b).

3. Either parent could remain unemployed and care for his or her children. Since most parents who provide home care in the United States are mothers, we focus attention on their behaviors.

4. For an example of the use of family utility functions in the estimation of child care responses, see Blau and Robins (1988a).

5. By quality, we mean the subjective assessment of their children's well-being in care. An alternative concept of quality which has received much discussion is the notion that the product of different providers can be objectively compared using observable characteristics such as the education of the provider and the number of children per child care worker.

6. To see that the mother will choose either all free care or all market care, suppose that she could choose f to be the proportion of time during which she would use free care. The first-order condition with respect to f is

$$\frac{\beta_1 \alpha Q_c h}{px-px_0} + \frac{(Q_f-Q_c)\beta_3 h}{Q-Q_0} \quad \left\{ \; = \begin{array}{l} <0 \text{ if } f*=0 \\ 0 \text{ if } 1>f*>0 \\ >0 \text{ if } f*=1 \end{array} \right.$$

where f* is the optimal proportion of free care. Substituting from the other first-order conditions yields the equivalent relationship

$$\frac{\alpha Q_f}{px-px_0} \quad \left\{ \; = \begin{array}{l} <0 \text{ if } f*=0 \\ 0 \text{ if } 1>f*>0 \\ >0 \text{ if } f*=1 \end{array} \right.$$

That is, a mother will choose all free care if $Q_f>0$, use market care exclusively if $Q_f<0$, and choose an indeterminate amount of free care if $Q_f=0$.

This result stems from the proportional relationship between quality of care and its price. Suppose that the price of an hour of market care of quality Q_c were $P(Q_c)$, with $P'(Q_c)>0$ and $P''(Q_c)>0$. The budget constraint would be $E + (w-P(Q_c))h = px$. The resulting first-order condition with respect to f ensures a unique value for f* between 0 and 1.

7. There is a natural interpretation of the Stone-Geary parameters which produces the system (9a) through (9c). In particular, suppose that each of the subsistence parameters had a random, mean zero component unobserved by us. That is, suppose $px_o = px_o*+u_x$, $h_o = h_o*+u_h$, and $Q_o = Q_o*+u_q$. The resulting expenditure system would have the form of (9a) through (9c).

8. An alternative would be to assume an explicit distribution on the ξ's. In this case, maximum likelihood would be an efficient estimation technique. However, nonlinear least squares, in addition to being computationally easier, avoids the consequences of incorrectly choosing a distributional family for ξ.

9. The ITSUR (Iterative Seemingly Unrelated Regression) option was used in PROC SYSNLIN to perform the estimations. The iterations provide successive estimates of the covariance of the error terms. This estimated covariance is used to form a weighting matrix to improve the efficiency of the estimates.

10. As in the linear expenditure system, parameter estimates for this model will be asymptotically identical regardless of which two equations are used in the estimation. We verified this by estimating the system once using equations (10b) and (10c) and again using equations (10a) and (10b).

11. The formula for effective nonlabor income is derived from the equivalence of the budget constraint evaluated both at proportional rates (equal to the marginal rates) and using the progressive tax schedule. Under proportional rates, the budget constraint implies

$$\hat{\mathbf{E}} + (1-\tau)\,wh = \alpha Q_c h\ (1-s) + E_x$$

where $\hat{\mathbf{E}}$ is effective non-labor income. Under the progressive tax code, the budget constraint is

$$\mathbf{E} + (wh-IT) = (\alpha Q_c h-S) + \mathbf{E}_x$$

Solving for $\hat{\mathbf{E}}$ yields equation (11).

12. The nonlinear nature of the estimated demand system removes the usual justification for this two-stage approach. We are currently estimating the demand system using a more appropriate instrumental variables approach.

13. Table 1a indicates that 10 percent of the single mothers who purchased child care also received transfer payments during the wave. However, a wave is a four-month period. Some mothers received transfer payments in a month in which they did not work, but did not receive transfer payments in a month in which they did work. Six percent of the sample of single mothers who purchased child care received transfers during the fourth month of the wave.

14. We would like to thank David Blau for providing state tax and subsidy schedules. For a description of variation of subsidies across states, see Robins (1990).

15. We use "actual" to refer to taxes and subsidies which were calculated using reported income and child care expenditures.

16. According to the Internal Revenue Service, the national average federal child care subsidy in 1984 was $351 (U.S. Department of the Treasury, 1985).

17. Results of the bivariate probit for the work and market care decisions are presented in Appendix B.

18. Since several variables are estimated, the standard errors for this estimation must be adjusted. Standard errors reported in column 4 of Table 3 have not been corrected.

19. Suppose that $px_{0i} = px_0 + u_\xi$, $h_{0i} = h_0 + u_{hi}$, and $Q_{0i} = Q_0 + u_{qi}$ where i indicates the value for an individual. Then the error terms of the demand system, equations (9a) through (9c), are additive. Additivity of the errors is a necessary condition for consistency of the estimation technique used.

20. In particular, the subsistence parameters were chosen from a trivariate normal distribution implied by the covariance matrices of the estimated parameters. The parameter Q_f was chosen from a normal distribution with a mean equal to Q_h and a variance equal to 1.0.

21. Since few nonworkers switch to market care, we exclude estimates for this group.

22. The four income groups are the same as those used by Barnes (1988). According to Barnes, 20 percent of families are in the lowest income group, 30 percent are in the second group, 30 percent are in the third group, and 20 percent are in the highest income group.