Maternal Employment, Fertility, Child Care Use, and Cognitive Outcomes of Children: Evidence from a Norwegian Reform

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February 2014
Incomplete draft. Please do not circulate.

Abstract

In 1998, Norway implemented the cash-for-care reform (kontant stoette), which provided cash to families with young children who did not use government-subsidized child care facilities. The reform resulted in a sizable exogenous change in the relative price of child care facilities, which interacted with pre-existing regional variations in the child care system. Using administrative data from 1995 to 2010, we examine the effects of the reform by estimating a dynamic structural model of maternal employment, fertility, and child care use for multiple children. We investigate the effects of such behavioral changes on the long-run cognitive outcomes of children, by estimating a cognitive ability production function with data on national test scores. Numerical results from several counterfactual exercises, including budget analysis, are presented. In particular, we compare the effects of existing and alternative child care polices with the effects of the maternity leave system.

1 Introduction

The most important output of a household is the quantity and the quality of children it produces. In the seminal static model of fertility introduced by Becker and Lewis (1973), an additional child may decrease the average expenditure the household spent on previous children, thereby creating a trade-off between the quantity and quality of children in household choices.

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In recent years, an important literature has used a production technology to characterize the development of the quality of children over time. The production of child quality, usually measured by cognitive outcomes, depends on the initial endowment of the child at birth and subsequent parental investments and formal schooling (Cunha and Heckman, 2007). Studies have shown that parental investment made in early childhood is the most important determinant of labor market outcomes in adult life. For young children, parental investment can be made either in terms of parental time inputs and/or purchased child care. This creates another trade-off in the household choice, as parental time investments are usually associated with a reduction of labor supply of the mother.

In this paper, we construct and estimate a dynamic structural model of maternal employment, fertility, and child care use for multiple children, using data from the Norwegian Register Data. Our first contribution is to extend the literature of estimating the cognitive production function to multiple children within the same household.\(^1\) We take the birth of each child in the household as endogenous and explicitly formulate household’s fertility decisions jointly with parental investment choice in a dynamic model. By the same argument as Becker and Lewis (1973), estimation of the production function of the quality of children would be biased without modeling the quantity of children. We also show that the timing of fertility is an important element to understand the effects of parental investment. The decisions on both the timing of fertility and parental investment in the quality of children are determined by the preferences and the budget constraint facing the household.

Our second contribution is to make use of a sizable exogenous policy change in the relative price of child care to parental time investments in estimating the structural model. In 1998, Norway implemented the cash-for-care reform (kontant stoette), which provided cash to families with young children who did not use government-subsidized child care facilities. The reform resulted in a sizable exogenous change in the relative price of child care facilities, which interacted with pre-existing regional variations in the child care system. Different birth cohorts have different exposure under the program, varying from zero month to 24 months of eligibility. We formalize the policy change as a potential shift to the household’s budget constraint, and use it to identify and estimate the structural model. We investigate the effects of behavioral changes on the long-run cognitive outcomes of children and estimate a cognitive ability production function with data on national test scores.

\(^1\)Closely related to our work, Bernal (2008) and Del Boca, Flinn, and Wiswall (2010) present structural estimation of the production function jointly with household choices, taking the number of children as exogenous. Both studies do not rely on exogenous policy changes for model estimation.
We construct a discrete choice dynamic programming model in which the female makes decisions on her labor supply, pregnancy, and child care usage for each of her child (if she is a mother). The female exhibits heterogeneous and state-dependent preferences in all major choice dimensions. The budget constraint is highly piecewise linear, as it includes the price schedule of child care, cash-for-care benefits, maternity leave benefits, income tax, and the deduction schedule of child-care-related expenses. The stepwise implementation of the cash for care reform generates a notable difference in life-cycle exposure to benefits across women cohorts. We exploit this source of variation to separately identify the effect of the reform on fertility and child care use. Municipality-level data is used to construct the price schedule and the level of local coverage of child care facilities.

The wage equation and the cognitive production function of each child are estimated jointly with the model. The cognitive production function is estimated using data from national test scores on mathematics and reading in early childhood. Unobserved child ability is potentially correlated with the unobserved characteristics of the mother. Cognitive ability evolves dynamically, and is a function of a number of factors including the child’s exposure to child care use, parental time with the child, income, existence of siblings, and the age gap between siblings. The set of state variables that evolve over time includes lagged employment, lagged child care use for each child, prior pregnancy status, the stock of children, work experience, and the age of each child. The utility function specification and the policy structure in the budget constraint potentially allow for the mother to practice birth spacing as part of the optimization problem. Its effects on child cognitive outcomes are investigated.

The paper is organized as follows. Section 2 provides background of the reform. Section 3 contains a brief overview of the data. Section 4 presents the dynamic model which we are currently in the process of estimating.

2 Institutional Background and the Cash-for-care Reform

The Norwegian welfare state offers generous support to families with children. Two pillars of the family welfare are the parental leave program and subsidized child care. The parental leave program provides financial support and job protection to parents in the first year after child birth. From 1993 (which is the period we study), all working parents in Norway have been entitled to 52 weeks leave with income replacement rate of 80%, or 42 weeks’ leave with 100% replacement (four weeks of the leave have to be
taken by the father). The parental leave benefits are tied to previous employment. Such a system gives young women incentives to start their labour market career before giving birth and starting a family. This, in turn, may give them a stronger attachment to the labour market and a specific job, and ease their later reentry into the labour market.

The other pillar of the family welfare policy is the subsidized child care. When the child turns to one, the family has the option to use child care centers at a price that is heavily subsidized relative to the cost. The child care center may be owned by local public authorities, private organizations, firms, or individuals. In the year 2000, 62% of children aged one to five attend child care centers. The coverage rate is higher for children aged 3-5. All child care centers are subject to strict regulations concerning group size, child to staff ratio, staff qualifications, facilities etc. In addition, nearly all receive operating funds from the public, mainly trough either the central government or the municipality. The costs of a day-care centre are shared between the state, the municipality and the parents. In 1998, the average parental payment was approximately 3500 Norwegian kroner (NOK - approximately 430 Euros) per month in private centres and slightly less in public centres (Schöne, 2004). In the model we do not make a distinction between public and private child care centers, given that they are relatively homogeneous, both in terms of observed characteristics and price.

Besides the option of subsidized child care centers, Norwegian families may also choose to have non-parental care provided by either nannies (paid care) or close family (e.g. grandma). Neither types of non-parental care are eligible for public financial support. Another main difference from child care centers is that there are no special public arrangements regulating these types of care in Norway. Nanny use is much less common: it was estimated to be 12 % in 1992 (Blix and Guldbransen 1993). Unpaid child care is the least common, as it requires able and motivated grandparents living close to their children.

The cash-for-care reform was introduced in 1998. There were three main purposes of this reform: give more freedom of choice to parents of form of care, provide parents more time to be with their children and to redistribute to families that do not benefit from public funded daycare (Kontantstttteloven 1 1998). From August 1st 1998 the Cash-for-Care benefit was available for one-year-old children, and from January 1st 1999 it was expanded to also apply for two-year old. All parents with children in this age group who do not use publicly subsidised daycare are entitled to the subsidy. To receive the
full subsidy, the child must not attend a publicly funded day-care centre at all. Parents of children that attend publicly funded daycare on a part-time basis may receive a share of the full benefit (80, 60, 40, or 20%) depending on weekly attendance. The right to the CFC-subsidy also for part-time users was important to ensure flexibility in the parents work and child care arrangements. In addition, for eligible parents, there is no obligation for parents who claim the benefit to stay at home and care for the children themselves. The subsidy is a flat, tax-free payment, paid out monthly from the month after the child is one year old (from month 13), until the month the child is maximum three years old (36 months). The subsidy was set to 3000 NOK per month (approximately 370 Euros) in 1998.\footnote{The subsidy was reduced to 2263 NOK per month in 1999, before adjusted up to 3000 NOK per month from 2000 and then to 3657 NOK per month from August 2003} The subsidy is approximately equivalent to the state subsidy for a place in a day-care centre. Since the reform is implemented at one time with age limits, different cohorts of children are exposed to different length of treatment. Figure 1 plots the total potential months of treatment against cohort of the child. It can be shown that all children born after Aug 1997 can receive full treatment. For children born in Aug 1997, they turn age 1 in August 1998, and turn age 1.5 in Jan 1999. For children born in Jan 1997, they only receive 18 months of treatment. They turn age 1.5 in August 1998, and turn age 2 in Jan 1999. They cannot receive cash-for-case between age 1 and age 1.5. For children born in Aug 1996, they only receive 6 months of treatment. They turn age 2 in August 1998, and turn age 2.5 in Jan 1999. They cannot receive cash-for-case between age 1 and age 2.5. For children born in Jan 1996, they receive no treatment. They turn age 2.5 in August 1998, and turn age 3 in Jan 1999.

### 3 Data

We use data from several Norwegian registry data covering the entire population. Our final data contains detailed information about the child, including initial conditions at birth from the birth register such as birth weight and APGAR scores, national standardized test scores in grade 5 and grade 8, and detailed information on cash-for-care benefits take up such as number of months receiving benefits and average hours per week in kindergarten. We also obtain demographic and employment information on the mother and father of the child, including city of residence, education, marital status, labor supply, job starting and end date, and earnings. Each child can be linked with birth-mother and father through
unique IDs. Therefore, we are able to obtain complete fertility history for each adult individual.

4 Model

Utility function

\[
\bar{u}_{it} = y_{it}(d_{hit}, d_{hit}^{ft}, d_{cl1it}, d_{c2it}) + \alpha_{hit}d_{hit} + \alpha_{hit}^{ft}d_{hit}^{ft}
\]
\[
+ \alpha_{c1it}d_{c1it} + \alpha_{he1it}d_{hit}d_{c1it} + \alpha_{hc1}^{ft}d_{hit}d_{c1it}
\]
\[
+ \alpha_{c2it}d_{c2it} + \alpha_{he2it}d_{hit}d_{c2it} + \alpha_{hc2}^{ft}d_{hit}d_{c2it}
\]
\[
+ \alpha_{c12}(1 - d_{c1it})d_{c2it} + \alpha_{hc12}d_{hit}(1 - d_{c1it})d_{c2it} + \alpha_{hc12}^{ft}d_{hit}(1 - d_{c1it})d_{c2it}
\]
\[
+ \alpha_{p1}d_{pit} + \alpha_{hp}d_{hit}d_{pit} + \alpha_{c1p}(1 - d_{c1it})d_{pit} + \alpha_{c2p}(1 - d_{c2it})d_{pit}
\]
\[
+ \alpha_{n1it}n_{it} + \alpha_{n2it}^2 + \alpha_{hn}d_{hit}n_{it} + \alpha_{hn2}d_{hit}n_{it}^2
\]
\[
+ \gamma_{hit}d_{hi,t-1} + \gamma_{c1}d_{c1it}d_{c1i,t-1} + \gamma_{c2}d_{c2it}d_{c2i,t-1} + \gamma_{p1}d_{pit}d_{pi,t-1}
\]

If the individual has no children, she chooses her work hours (no work, part time, full time) and whether to become pregnant. There are 6 choices in total. Work status is denoted by \(d_{hit} \in \{0, 1\}\), full-time work status is denoted by \(d_{hit}^{ft} \in \{0, 1\}\), and pregnancy status is denoted by \(d_{pit} \in \{0, 1\}\).

If the individual has one child whose age is between 1 and 5, she faces a decision of whether to put the child in formal child care. There are \(6 \times 2 = 12\) choices in total. Child 1’s formal care usage is denoted by \(d_{c1it} \in \{0, 1\}\).

If the individual has two children whose ages are both between 1 and 5, she also faces a decision of whether to put the younger child (i.e., child 2) in formal child care. There are \(6 \times 2 \times 2 = 24\) choices in total. Child 2’s formal care usage is denoted by \(d_{c2it} \in \{0, 1\}\).

Utility depends on income \((y_{it})\), the individuals work hours, the children’s formal care use, pregnancy status, and the stock of children \((n_{it})\). The tastes for work, formal care use, and pregnancy status exhibit first-order state dependence.
Preference equations

\[
\begin{align*}
\alpha_{ht} & = \beta_{ht} + \mu_{hi} \\
\alpha_{c1it} & = \beta_{c1}a_{1it} + \beta_{c1x}X_{c_{it}} + \mu_{c1i} \\
\alpha_{c2it} & = \beta_{c2}a_{2it} + \beta_{c2x}X_{c_{it}} + \mu_{c2i} \\
\alpha_{hc1it} & = \beta_{hc1}a_{1it} + \beta_{hc1x}X_{hc_{it}} + \mu_{hc1i} \\
\alpha_{hc2it} & = \beta_{hc2}a_{2it} + \beta_{hc2x}X_{hc_{it}} + \mu_{hc2i} \\
\alpha_{pit} & = \beta_{pt} + \mu_{pi} \\
\alpha_{nit} & = \beta_{n1}a_{1it} + \beta_{n2}a_{2it} + \beta_{n12}a_{1it}a_{2it} + \mu_{ni}
\end{align*}
\]

The taste for work depends on mother’s age \((t)\); the taste for formal care depends on the child’s age \((a_{1it}, a_{2it})\) as well as the coverage of child care facilities in the local municipality \((X_{c_{it}})\); the interactive taste for work and formal care depends on the child’s age and physical distance from grandparents \((X_{hc_{it}})\); the taste for pregnancy depends on mother’s age; the taste for the stock of children depends on each child’s age and their interaction. There are unobserved permanent components in the above preference equations, and they are denoted by \(\mu\).

For simplicity, the alternatives in the choice set are indexed by \(k\), so \(k = 1, 2, \ldots, 24\). The utility of alternative \(k\) is the sum of the alternative-specific utility \(\bar{u}_{ikt}\) and a preference shock \(\epsilon_{cikt}\):

\[
\begin{align*}
 u_{ikt} & = \bar{u}_{ikt} + \epsilon_{cikt}
\end{align*}
\]

The preference shocks are assumed to follow an extreme value distribution.

**Wages and Budget Constraints**

The log wage equation is given as follows:

\[
\ln w_{it} = \beta_{wt} + \beta_{we}\epsilon_{it} + \beta_{we2}\epsilon_{it}^2 + \beta_{wu}X_{u_{it}} + \mu_{wi} + \epsilon_{wit}
\]

The wage depends on mother’s age, work experience (\(\epsilon_{it}\)), local unemployment rate (\(X_{u_{it}}\)), and an unobserved permanent component \(\mu_{wi}\). The log wage is subject to a normally distributed shock \(\epsilon_{wit}\).
Gross earnings ($E_{it}$) is the product of wage and work hours:

$$E_{it} = w_{it}(d_{hit} + d_{hit}^{ft})$$

Income is determined by the following budget constraint:

$$y_{it} = E_{it} - T(E_{it}, P_{cit}, Z_{Tt}) - P_{c}(d_{c1it}, d_{c2it}, Z_{pit}) + \sum_{j=1}^{2}(1 - d_{cjit})B_{c}(a_{jit}, Z_{Bc,t}) + B_{m}(E_{i,t-1}, Z_{Bm,t})d_{pi,t-1} + y_{it}^{o}$$

The tax formula $T(.)$ includes income tax on earnings net of deductions related to formal child care expenses. As of year 2000, the maximum child care deduction 25,000 NOK for families with one child, and 30,000 NOK for families with more than one child. The total cost of formal care is determined by formula $P_{c}(.)$ (with the total amount denoted by $P_{cit}$). The formula varies by municipalities, and in most municipalities the cost for the second child is 50% less if the first child is in formal care. The cash for care benefit is denoted by $B_{c}(.)$. Benefits are given if the child is not in formal care and is in an eligible age range. Between August 1998 and December 1998, each child of age 1 can receive 36,000 NOK annually. From January 1999, each child of age 1 or 2 can receive 36,000 NOK annually.

If the individual was pregnant last period, she receives fully paid maternity leave this period. The formula for maternity leave is denoted by $B_{m}(.)$. The variables $Z_{Tt}, Z_{Bm,t}, Z_{pit}, Z_{Bc,t}$ denote formula rules. The husband’s income is denoted by $y_{it}^{o}$.

**Cognitive production function**

Cognitive production function (type of test score $g \in \{m, r\}$; child index $j, j' \in \{1, 2\}$ such that
\(j + j' = 3\):

\[
\begin{align*}
A_{jit}^g &= \bar{A}_{jit}^g + \mu_{Aji}^g + \epsilon_{Ajit}^g \\
\bar{A}_{jit,t+1}^g &= \gamma_{A} \bar{A}_{jit}^g + \beta_{Ac}^g \tilde{d}_{cjit} \\
&\quad + \beta_{Ap1}^g (1 - \tilde{d}_{cjit}) \tilde{d}_{cj't} (1 - \tilde{d}_{hit}) + \beta_{Ap2}^g (1 - \tilde{d}_{cjit}) \tilde{d}_{cj't} (1 - \tilde{d}_{hit}) \\
&\quad + \beta_{Ap3}^g (1 - \tilde{d}_{cjit}) (1 - \tilde{d}_{cj't}) (1 - \tilde{d}_{hit}) + \beta_{Ap4}^g (1 - \tilde{d}_{cjit}) (1 - \tilde{d}_{cj't}) (1 - \tilde{d}_{hit}) \\
&\quad + \beta_{Ay}^g \tilde{y}_{it} + \beta_{Ayn}^g \tilde{y}_{it} (n_{it} - 1) \\
&\quad + \beta_{An}^g (n_{it} - 1) + \beta_{Aa0}^g (t - a_{jit}) \\
&\quad + \beta_{Aa1}^g (a_{1it} - a_{2it}) (n_{it} - 1) 1\{j = 1\} + \beta_{Aa2}^g (a_{1it} - a_{2it}) (n_{it} - 1) 1\{j = 2\} \\
&\quad + \beta_{As}^g \tilde{X}_{Aat} 1\{a_{jit} \geq 6\}
\end{align*}
\]

For child \(j\), there are two types of observed test scores: math (m) and reading (r). The observed score for test type \(g \in \{m, r\}\) is the sum of the cognitive ability \(\bar{A}_{jit}^g\), unobserved permanent component \(\mu_{Aji}^g\), and an error term \(\epsilon_{Ajit}^g\). Cognitive ability evolves dynamically as a first order autoregressive process. The stock of cognitive ability next period also depends on the following states in the current period: child’s usage of formal child care, parental time with the child during daytime, income, existence of a sibling, the age of the mother at which the child is born, the age gap between the child and the sibling, and the quality of the primary school (if the child is past age 6). There are \(13*2 = 26\) parameters to be estimated in the cognitive ability evolution equation.

The state variables that evolve over time are \(d_{hit,t-1}, d_{c1it,t-1}, d_{c2it,t-1}, d_{pit,t-1}, n_{it}, a_{1it}, a_{2it}, E_{it}\). The error space consists of \(\epsilon_{cit}, \epsilon_{wit}, \epsilon_{A1it}^m, \epsilon_{A1it}^r, \epsilon_{A2it}^m, \epsilon_{A2it}^r\).

References


Figure 1: Total Potential Length of Treatment, by Children’s Cohort