Catalogue no. 89-594-XIE
ISBN: 0-662-35196-7

Research Paper

Parental work, child-care use and young children's cognitive outcomes

by Lynda G. Gagné

Research Data Centres Program
1710 Main Building, Ottawa, K1A 0T6

Telephone: 1 800 263-1136

Statistics Canada Statistique Canada

Canada

Parental work, child-care use and young children's cognitive outcomes

By

Lynda G. Gagné*

Catalogue No. 89-594-XIE
ISBN: 0-662-35196-7

*School of Public Administration
University of Victoria
Victoria, British Columbia

Research Data Centres Program
1710 Main Building
Statistics Canada
Ottawa, ON K1A 0T6

How to obtain more information :
National inquiries line: 1 800 263-1136
E-Mail inquiries: infostats@statcan.ca

October 2003

Aussi disponible en français

The analysis for this paper was conducted at the British Columbia Inter-university Research Data Centre, at University of British Columbia. The Research Data Centres (RDC) program is part of an initiative by Statistics Canada, the Social Sciences and Humanities Research Council and university consortia to help strengthen Canada's social research capacity and to support the policy research community.

RDCs provide researchers with access, in a secure university setting, to micro-data from population and household surveys. The centres are staffed by Statistics Canada employees. They are operated under the provisions of the Statistics Act in accordance with all its confidentiality rules and are accessible only to researchers with approved projects who have been sworn in under the Statistics Act as 'deemed employees.'

The centre at University of British Columbia is one of nine RDCs currently operating at various universities across the country.

Additional information about the RDC program is available at the Statistics Canada website (www.statcan.ca); click on “Studies by Statistics Canada, located on the lower left-hand side of the opening page of Statistics Canada’s web site; select “Research Opportunities” on the left-hand side of this page and click on “Research Data Centres.”

For more information, or to enquire about the concepts, methods or data quality of this release, contact Lynda G. Gagné (250-721-8063), University of Victoria, Victoria, B. C. For more information about the Research Data Centre program, contact Gustave Goldmann (613-951-1472), Manager, Research Data Centre program, Statistics Canada.

Published by authority of the Minister responsible for Statistics Canada

Table of Contents

Abstract

This paper uses three cycles of the National Longitudinal Survey of Children and Youth (NLSCY) to examine whether parental labour market participation and the use of substitute child-care influence the cognitive development (i.e., school readiness) of pre-school children. The analysis in this paper is based on the arguments that parent/child interaction fosters the development of the skills that pre-school children need to start school successfully, and that full-time labour market participation among by lone parents (in one-parent families) and by both parents (in dual-parent families) often results in comparatively less time for parent/child interaction than in families with a stay-at-home parent. Therefore, the purpose of this study is to determine whether reductions in parental time spent with children – due to parental labour market participation and the use of substitute child care – impact upon the intellectual development of young children.

The study indicates that parental labour market participation has little effect on the school readiness scores of most pre-school children. However, children's school readiness scores do appear to be influenced by parental labour market participation if the parents exhibit above-average parenting skills and levels of parental education. Children of mothers who display above-average parenting skills and higher levels of education tend to benefit slightly when their mothers do not work outside the home. Likewise, children of fathers with above-average education exhibit slightly higher cognitive outcomes if their fathers work part-time.

Though the author finds that there is no association between school readiness and the number of hours that the majority of pre-school children spend in child-care, the study did observe that children from higher income families in substitute care exhibit better cognitive outcomes than children from lower income families. This finding may be attributable to the possibility that children in higher income families are exposed to a higher quality of substitute care, or it may be attributed simply to the advantages of growing up in a family with greater resources.

1. Introduction

According to the 1995 General Social Survey, a number of Canadians are concerned about the effect that maternal labour supply has on children. Zukewich Ghalam (1997) reports that while the majority of Canadian men (59 percent) and women (67 percent) agreed or strongly agreed that an employed mother can establish just as warm and secure a relationship with her children, over half of the men (59 percent) and women (51 percent) also agreed or strongly agreed that a pre-school child is likely to suffer if both parents are employed.[1]

Parental labour supply can adversely affect young children if substitute care is of lower quality than parental care and/or if parental care deteriorates because of work outside the home. Income spent on child-care services is not available for other potentially beneficial uses. On the other hand, working parents who do not use substitute care are putting in a double shift and may have less time to devote exclusively to their children. Finally, the additional family income that is available to working parents as well as a possible increase in parental self-esteem can offset potentially adverse effects of reduced parental time or lower quality substitute care.

In this paper, I use data from cycle 1 (1994), cycle 2 (1996) and cycle 3 (1998) of the National Longitudinal Survey of Children and Youth (NLSCY) master files to estimate labour supply and child-care use impacts on pre-school children cognitive skills. The dependent variable is the Peabody Picture Vocabulary Test – Revised (PPVT-R) for children three and a half to five years old.[2]

For the NLSCY, the PPVT-R was used as a measure of school readiness. The test was administered to the child in the home. The child looked at pictures on an easel and identified the picture that matched the word the interviewer read out. A total raw score was calculated for each child who completed the PPVT-R by computing the number of correct responses. A standardized score was also assigned to each child to allow for comparisons of scores to be made across age groups. Individuals in the norm sample were assigned standard scores so the mean of

[1] Zukewich Ghalam (1997), p. 16
[2] From now on, the test is just referred to as PPVT.

the standard scores was 100 and the standard deviation was 15 for all age groupings. This standardization was done for each two-month age group. [3]

One of the difficulties that arises in estimating the relationship between employment, income, child-care use and child outcomes is that the employment, income and child-care use variables may be correlated with unobserved child, family or neighbourhood characteristics that also affect child outcomes. Parents who stay at home with their children may be more skilled at child-care or parents who work for pay may have abilities that non-workers do not have and that would not be fully captured by parental education variables. A comprehensive set of explanatory variables, including child health and parenting skills, is used to address this issue. However, parental cognitive ability is likely not fully proxied by education and parenting skills. To address the issue of unobserved parental ability and neighbourhood characteristics, I use data on siblings to estimate family fixed-effects models.[4]

Endogeneity can also be a problem if parental (maternal) labour supply is affected by child outcomes. For example, a mother might decide not to work because her child has poor outcomes. To test for endogeneity I use an instrumental variables estimator.

For this analysis, I pool data from cycle 1, cycle 2 and cycle 3 of the NLSCY to a construct large cross-sectional sample. To allow parental employment to have differential effects for parents with different skill levels, education and parenting skills variables are interacted with measures of parental employment.

2. Literature survey

While there is a considerable body of literature on the effects of maternal employment and/or child-care on child outcomes using US data, findings are mixed. The Canadian literature on these issues

[3] http://www.ucalgary.ca/~landru/adc/kids/k96-9b.htm#9.21, June 17, 2002

[4] It is reasonable to assume that child-care choice depends on family and neighbourhood characteristics: child-care is selected from what is locally available to meet parents' needs for substitute care. While the choice of care is likely dependent on the child's age, this variable is observed.

is just emerging as data from the NLSCY become available. To my knowledge, this is the only Canadian study that uses all three cycles of the NLSCY to examine the impact of both parental labour supply and child-care use on outcomes of pre-school children or tests for endogeneity of maternal labour supply.

Hanushek (1992) uses four-year data on low-income blacks (1971-1975) from the Gary Income Maintenance Experiment and estimates achievement growth models for school children and preschool achievement for pre-school children. The achievement variables are the results of the Iowa reading comprehension and vocabulary tests. Hanushek investigates the trade-offs between number of children and their scholastic performance and finds that being early in the birth order is an advantage presumably because of the longer time spent in a small family. He finds no apparent impact of market work by mothers on test scores of either school children or preschoolers.

Blau and Grossberg (1992) use a sample of three- and four-year old children from the 1986 NLSY to investigate the effect of maternal employment on children's PPVT scores. Independent variables include a measure of mother's verbal ability in 1979 as well as parental education at the time of the child's birth. They use a Hausman test for the heterogeneity of working versus non-working mothers, and find no evidence of heterogeneity.[5] Their main findings are that maternal employment has a negative impact on scores when it occurs in the first year of a child's life with a potentially offsetting positive effect when it occurs during the second and subsequent years.

O'Brien Caughy, DiPietro, and Strobino (1994) use a sample of five- and six-year old children from the 1986 NLSY to examine the impact of day-care participation during the first 3 years of life on the cognitive functioning of school-aged children. They compare day-care participation variables with family income variables, and find that initiation of day-care before the first birthday is associated with higher reading recognition scores for children from impoverished home environments and with lower scores for children from more optimal environments.

Ruhm (2000) uses a sample of three- to six-year old children from multiple years of the NLSY to investigate the effect of parental employment on PPVT scores of three- and four-year old children,

[5] Maternal labour supply coefficients are very imprecisely estimated in the IV equation.

and on the reading and math achievements of five- and six-year old children. To control for potential unobserved heterogeneity between working and non-working mothers, Rhum uses maternal employment prior to and after the birth of the child, as well as a variety of observed family characteristics, including child-care use. He also estimates fixed-effects siblings' models. Findings suggest that maternal and paternal employment during the first three years of life has a small negative effect on the verbal ability of three- and four-year olds, and a substantial negative impact on the older children's reading and math achievement.

Greenstein (1993) examines the impact of maternal employment on children's PPVT scores using children born to mothers who participated in the 1979 NLSY and were between the ages of 14 and 21 at the time. The children were between 48 and 83 months of age at either the 1986, 1988, or 1990 NLSY interview. Greenstein's primary concern is to determine whether there are any differential effects of maternal employment on child cognitive outcomes for families differing in resource level. The hypothesis is tested using interaction variables for family income and maternal labour supply in OLS regression models. Separate regressions are estimated for Hispanics, blacks and others. No evidence is found for differential effects.

Hill and O'Neill (1994) use 1986 and 1988 NLSY data to examine the impact of family endowments on children's PPVT scores. They find that mothers' labour supply and welfare participation both have significant negative effects on the score. Selection models are used to account for potential unobserved heterogeneity with respect to fertility,[6] labour supply and welfare participation.

Baydar and Brooks-Gunn (1991) use 1986 NLSY data to examine the effect of maternal employment and child-care arrangements on preschool children's cognitive outcomes. They find that maternal employment in the first year has detrimental effects on cognitive scores and that grandmother care is the most beneficial arrangement for the cognitive development of children in poverty.

Lefebvre and Merrigan (1998) use data on four- to eleven-year old children from cycle 1 of the NLSCY in various OLS specifications to examine the effect of income, maternal employment and family background on child development outcomes. The dependent variables include the PPVT scores for four- and five-year old children. They find that with an all-inclusive specification, maternal work in the previous year has a weak negative impact on PPVT scores.

Lefebvre and Merrigan (2000) use cycle 1 of the NLSCY to examine the effect of child-care arrangements on children's development outcomes. The dependent variables are PPVT scores for four- and five-year old children, and Motor and Social Development (MSD) scores for children aged 0-47 months. A mother fixed-effects model is estimated to control for unobserved family characteristics, along with various OLS specifications. They find that when family and child characteristics are controlled for, infant-toddler non-parental arrangements have insignificant impacts on PPVT and MSD scores.

Lipps and Yiptong-Avila (1999) use cycles 1 and 2 of the NLSCY to examine the effect of non-parental care on four and five year old children's subsequent school achievements. They find children who were in non-parental care arrangements two years earlier, are more likely to have top scores in mathematics than children who were not.[7]

After a review of the literature on the effect of child-care on children outcomes, Burchinal (1999) reaches the following weak conclusion: "After 30 years of research into the relation between child-care experiences and child development, it appears that some aspects of child-care experiences are related to some developmental outcomes for at least some children." Burchinal also states that "studies of early intervention for children from families living in poverty suggest that high-quality child-care, beginning in infancy, can have large long-term effects on cognitive development." Finally, Burchinal also finds that "there is some evidence that extensive care may be modestly

[6] In the NLSY, the base unit of analysis is the mother; mothers with higher AFQT test scores are less likely to have children early in life, so that the children included in the sample are more likely to come from mothers with lower AFQT scores.

[7] It is not clear from the report whether appropriate controls were used in the estimation method. Since child-care use is highly correlated with income, labour supply, and education, the lack of controls can result in an overestimate of the benefits of non-parental care.

negatively related to social outcomes and that center care may be modestly positively related to cognitive outcomes."[8]

3. Model and estimation issues

The analysis is done in the context of Becker's model of household utility maximization, where utility is derived from the consumption of activities that require market and time inputs. One such activity includes rearing children. Utility is increasing in child quantity and quality, where quality may be evaluated on the basis of a variety of child outcomes, including verbal and mathematical ability as well as behaviour. Parents select their labour supply and consumption of goods and services, including child quantity and quality subject to child outcomes production functions and a time constraint. Children's cognitive test scores represent one aspect of child quality and depend on a variety of parental inputs and on other factors that affect parental inputs.

Parents can affect child quality by investing time and market goods in their children. A stay-at-home parent will invest her own time in teaching children a variety of skills. In families where all parents work, parental schedules may be staggered, or child-care services may be purchased. Beneficial goods may include books and educational toys, as well as the provision of a generally healthy and pleasant living environment. Since highly skilled parents can transmit more skills and wealthier parents can purchase more goods, parental education, parenting skills,[9] and money income are all expected to contribute favourably to child quality. Parental education is expected to be strongly associated with cognitive outcomes. The amount of time a parent spends reading to/with her child is a time investment that will also likely have a strong impact on cognitive outcomes.

[8] P. 89.

[9] While it has been argued elsewhere that parenting behaviour is an endogenous variable in a child behaviour equation (child behaviour affects parental behaviour), this position is not taken here for two reasons. First, the correlation between children's cognitive skills and parental behaviour is much lower than that between child behaviour and parental behaviour. Second, the underlying assumption here is that parents are responsible for their children's behaviour and that children are not responsible for their parents' behaviour. Parents have access to parenting literature and classes, but children do not. Parents can and do successfully discipline children and maintain order in the household, and parents with good parenting skills do devise appropriate responses to a variety of problematic child behaviours. Finally, if genetics are also a factor, they are passed on from parents to children.

Since more children are competing for resources in larger families, the number of children is expected to adversely affect cognitive outcomes. Similarly, since the older children in a family tend to have lived in a smaller family longer than the younger children in the same family, being higher in the birth order is expected to result in poorer cognitive outcomes.

Today's families are relatively small. A pre-school child who stays at home with a parent is therefore likely to receive more one-on-one attention from the parent than she would receive in a child-care setting: child/staff ratios for children aged two to six years of age in Canadian full-day centres range from 4 to1 for two year olds to 15 to 1 for 6 year olds.[10] Hence, just from the adult/child ratio perspective, assuming that parents are as good teachers as child-care providers, children in parental care should have better cognitive outcomes than children in substitute care, ceteris paribus.[11] On the other hand, working parents contribute additional income, which may compensate for the loss of parental time.

Some working parents stagger their work schedules to avoid using substitute care. This may benefit the child if the parents are able to provide more positive attention to their children than the children would receive in a child-care setting. However, this may be detrimental to the child if the parents are overworked and have little quality time left to offer their children. It is therefore an empirical question whether children of working parents are better or worse off if their parents use substitute care.

If child-care has a negative impact on outcomes, omitting child-care variables may result in larger negative estimates for labour supply coefficients as most working parents of preschoolers use child-care.[12] When measures of labour supply, hours in care, and household income are included, the labour supply variable should pick up the effect of parental time, the hours in care variable should pick up the substitute care effect net of parental time savings and pecuniary costs, and the household income effect should pick up the effect of income, before child-care costs and taxes.

[10] Childcare Resource and Research Unit (2000).
[11] There could be offsetting beneficial spillover effects among children in care, however.
[12] Tabulations for the PPVT sample show that 73 percent of children in families where parents work full-time are in some form of substitute care and that 45 percent of children in dual-parent families where the mother works outside the home part-time are in substitute care; the corresponding percentage for children in single-parent families is 53 percent.

If children benefit from being taken care of by parents because of the additional adult-intensive time they can enjoy, the importance of this effect could depend on parental education and parenting skills. To investigate this possibility, I test for interactions between parental time, and education and parenting skills.

Another question of interest is the existence and extent of variability in child-care quality. While the quantity (hours) of child-care used is available in the data, no measures of child-care quality are available. To investigate this issue, I test for interactions between household income and hours in care.

To illustrate the model, consider the following linear outcome function:

$$(1) \qquad C_{ikt} = \alpha_0 + \alpha_1 C_{ikt-1} + \boldsymbol{\alpha_2 X_k} + \boldsymbol{\alpha_3 K_{ik}} + \boldsymbol{\alpha_4 W_{ikt}}$$

where:

C_{ikt} = child i's score in family k at time t,

$\boldsymbol{X_k}$ = a vector of (relatively) fixed family demographic variables and endowments such as region, parental education and parenting skills,

$\boldsymbol{K_{ik}}$ = a vector of fixed child demographic variables such as gender and parental age at birth, and

$\boldsymbol{W_{ikt}}$ = a vector of family k investments in child i (flow variables) such as parental time and income, and other period-specific variables at time t.[13]

In equation (1), the child's score in period t is a function of the child's score in the prior period, of current parental investments and other period-specific variables, and of fixed demographic variables and endowments. The coefficient on the lagged child quality variable (α_1) captures the effect of prior parental time investments and other period-specific variables, coefficients on fixed variables such as education and parenting skills and child gender ($\boldsymbol{\alpha_2}$ and $\boldsymbol{\alpha_3}$) capture the current or short-term effect of these variables, and coefficients on current flow variables such as parental time and income

[13] Note that while some of these investments may be child-specific (reading time), other investments such as income and time (labour supply) are family-specific.

(α_4) capture the effect of current investments.[14] In the absence of prior score information, equation (1) can be solved recursively, yielding the following function of current and lagged period-specific explanatory variables and fixed demographic variables in a three period model:[15]

$$(2) \quad C_{ikt} = (\alpha_0 + \alpha_0\alpha_1 + \alpha_0\alpha_1^2) + (\alpha_2 + \alpha_2\alpha_1 + \alpha_2\alpha_1^2)X_k + (\alpha_3 + \alpha_3\alpha_1 + \alpha_3\alpha_1^2)K_{ik} + \alpha_4\alpha_1^2 W_{ikt-2} + \alpha_4\alpha_1 W_{ikt-1} + \alpha_4 W_{ikt}$$

An econometric specification for (2) in the context of the classical linear regression model would be as follows:

$$(2)' \quad C_{ikt} = (\alpha_0 + \alpha_0\alpha_1 + \alpha_0\alpha_1^2) + (\alpha_2 + \alpha_2\alpha_1 + \alpha_2\alpha_1^2)X_k + (\alpha_3 + \alpha_3\alpha_1 + \alpha_3\alpha_1^2)K_{ik} + \alpha_4\alpha_1^2 W_{ikt-2} + \alpha_4\alpha_1 W_{ikt-1} + \alpha_4 W_{ikt} + \varepsilon_{ikt}$$

Assuming that the error term $\varepsilon_{ikt} \sim N(0,\sigma^2)$ and ε_{ikt} is homoscedastic and not correlated with any of the regressors, and that except for possible correlations between error terms from the same family, the error terms are not correlated with each other, OLS with robust variance estimation on (2) will yield unbiased and efficient estimates.[16]

In (2), coefficients on period-specific variables capture current and prior investment effects on current outcomes, while coefficients on fixed variables capture the long-term effect of these variables. The intercept is also larger in the absence of a lagged outcome.

When working with purely cross-sectional data, prior information on child quality and lagged period-specific variables is not available. Coefficients on fixed variables capture the long-term effects of fixed variables if fixed variables are not correlated with lagged period-specific variables and additional effects if fixed variables are correlated with past values of period-specific variables.

[14] Hanushek (1992) uses this framework.
[15] Ruhm (2000) and Blau and Grossberg (1992) use this framework.
[16] In the OLS estimations, robust variance estimation is used. The procedure further allows error terms for observations from the same family to be correlated, while error terms for observations from different families are not. This procedure does not affect coefficient estimates. For a discussion of the Huber-White robust variance estimator and the relaxation of error term independence for certain groups of observations, see Stata User's Guide Release 7, pp. 254-258. All estimations are weighted using cross-sectional weights.

Coefficients on current period-specific variables capture only current effects if current period-specific variables are not correlated with their past values, but also capture past effects if current and past values are correlated. In particular, if current and past labour supply are positively correlated, the coefficient on current labour supply will be larger (in absolute terms) than it would have been in the presence of past labour supply.[17]

A possible concern here is one of unobserved heterogeneity between workers and non-workers. For example, non-workers may be relatively more skilled at childcare than at market work, and/or non-workers may be staying home because of a poor health or a child's poor health.[18] With a simple OLS regression, unobserved skill differences between workers and non-workers give rise to omitted variable bias.

Another concern that arises is that maternal labour supply may be endogenous. For example, mothers of children with poor cognitive outcomes may decide to quit work and spend more time with their children.

To address potential omitted variable bias and endogeneity issues, I follow a three-step approach. The inclusion of a comprehensive set of explanatory variables such as child health, a variety of measures of parental investments such as reading time, parenting skills and family functioning, which are arguably excellent proxies for more general social skills, is likely to capture a substantial portion of heterogeneity and is the first of these steps.

To allow for the possibility that heterogeneity is not fully captured by the comprehensive set of explanatory variables, but that heterogeneity is parent-related rather than child-related, and that child outcomes do not directly affect parental labour supply, I estimate a family fixed-effects estimator. Rewriting equation (2)' for siblings i and j, and subtracting j's equation from i's equation yields:

[17] While the use of a full longitudinal set of variables appears warranted, the longitudinal sample size is small and the number of potential additional explanatory variables is large. Furthermore, the survey is conducted every two years so that even with longitudinal data, half of the lagged variables are not available. As with the OLS results that use the cross-sectional data and are presented in the next section, estimates using OLS and the small longitudinal sample did not yield significant labour supply and child-care effects.

[18] A variable indicating if the child is in poor health is included in the analysis.

$$(3) \quad C_{ikt} - C_{jkt} = + (\alpha_3 + \alpha_3\alpha_1 + \alpha_3\alpha_1^2)(K_{ik} - K_{jk}) + \alpha_4\alpha_1^2(W_{ik\ t-2} - W_{jkt-2}) + \alpha_4\alpha_1(W_{ikt-1} - W_{jkt-1}) + \alpha_4(W_{ikt} - W_{jkt}) + (\varepsilon_{ikt} - \varepsilon_{jkt})$$

Assuming the error term $(\varepsilon_{ikt} - \varepsilon_{jkt}) \sim N(0,2(\sigma^2 - C(\varepsilon_{ikt},\varepsilon_{jkt}))$ and is homoscedastic and not correlated with itself or any of the regressors, OLS on (3) will yield unbiased and efficient estimates. The error variance follows from the error term correlation assumptions made in (2) regarding observations from the same family.

In equation (3), all family fixed elements disappear, leaving only period-specific differences and child differences.[19] As long as the unobserved heterogeneity is a family fixed-effect and child outcomes do not directly affect parental (maternal) labour supply, estimating (3) with OLS will yield unbiased coefficient estimates. If the unobserved heterogeneity is child-related, that is if the missing variables are part of the **K** vector of variables rather than part of the **X** vector of variables, their effect will be included in $(\varepsilon_{ikt} - \varepsilon_{jkt})$ and the fixed-effects estimator will also suffer from omitted variables bias, as long as the missing variables are correlated with other regressors.[20] If parental (maternal) labour supply is partially and directly determined by child outcomes, the simultaneity is not resolved in (3) and the endogenous labour supply will be contemporaneously correlated with the error term. In a purely cross-sectional estimation, labour supply effects will likely capture prior labour supply effects as current and past labour supply are probably correlated.

Now suppose that a child outcome directly affects maternal labour supply.[21] As discussed previously, the mother of a child with poor outcomes may choose to reduce her labour supply. If this is the case, negative effects of maternal labour supply will be underestimated, or alternatively, its positive effects will be overestimated. To illustrate, consider the following modification of (2)' into a simultaneous equations model:

[19] Although in equation (3) dummy explanatory variables can take on three values (1,0, -1), coefficients retain the same interpretation in equation (3) as they have in equation (2): coefficient estimates can be used with the vector of explanatory variables in (2) to arrive at a prediction for the dependent variable.

[20] If the missing variables are orthogonal to the regressors, coefficient estimates will not be biased, but variance estimates will still be. See Greene (1993), 246-47, for a discussion of omitted variables bias.

[21] Alternatively, there may be unobserved heterogeneity at the child level, that affects child outcomes and is correlated with maternal labour supply.

(4) $$C^q_{ikt} = \beta_0 + \beta_1 C^q_{ikt-1} + \boldsymbol{\beta_2 X_k} + \boldsymbol{\beta_3 K_{ik}} + \boldsymbol{\beta_4 Z_{ikt}} + \beta_5 H_{kt} + \varepsilon_{ikt}$$

(5) $$H_{kt} = \varphi_0 + \boldsymbol{\varphi_1 R_k} + \boldsymbol{\varphi_2 S_{ik}} + \varphi_3 C^q_{ikt} + \mu_{kt}$$ [22]

where:

$\boldsymbol{Z_{ikt}}$ = a vector of family k investments in child i (flow variables) such as income, and other period-specific variables at time t,

H_{kt} = maternal hours of work in family k a time t,

$\boldsymbol{R_k}$ = a vector of (relatively) fixed family demographic variables and endowments such as region, parental education and parenting skills, and

$\boldsymbol{S_{ik}}$ = a vector of fixed child demographic variables such as gender.

Assume the error term $\varepsilon_{ikt} \sim N(0,\sigma_\varepsilon^2)$ and ε_{ikt} is homoscedastic and not correlated with any of the regressors, and except for possible correlations between error terms from the same family, the error terms are not correlated with each other. Also assume the error term $\mu_{kt} \sim N(0,\sigma_\mu^2)$ and μ_{kt} is homoscedastic and not correlated with any of the regressors and except for possible correlations between error terms from the same family, the error terms are not correlated with each other. That is, parental labour supply at time t is correlated with parental labour supply at other times.[23] Furthermore, also assume that $E(\varepsilon_{ikt}\mu_{kt}) = E(\varepsilon_{ikt}\mu_{kt}) = \rho$. Finally, assume that H_{kt} is censored, that is, $H_{kt} = \max(0, H_{kt}^*)$. Here H_{kt} is a censored endogenous explanatory variable. The variable H_{kt} is contemporaneously correlated with the error term ε_{ikt} and OLS on (4) yields biased estimates. This is a variant of the model due to Nelson and Olsen (1978), which is described in Maddala (1983) chapter 8.8 and in Greene (1993) section 28.4.[24,25] If a suitable instrument can be found for H_{kt}, an instrumental variables estimator can be used to estimate (4). A suitable instrument will be

[22] Note that the direct parental time investment in the child is not observed. Parental hours of work are observed and are necessarily the same for each child in the family.

[23] The IV estimator for PPVT scores uses the cross-sectional data. Hence, parental hours of work are for one period only.

[24] Except for the possible correlation between error terms from the same family, the model is identical to Nelson and Olsen's model.

[25] The procedure for the Nelson-Olsen estimator is described in the next section.

contemporaneously uncorrelated with ε_{ikt}, and should be highly correlated with maternal labour supply. In other words, a good instrument would explain labour supply but not child outcomes.

The basic equation that is estimated is as follows:

$$(6) \quad C^q_t = \alpha + \varphi C^q_{t-1} + \beta_1 LFP_m + \beta_2 LFP_f + \beta_3 ED_m + \beta_4 ED_f + \beta_5 PS + \beta_6 ED_m * LFP_m + \beta_7 ED_f * LFP_f + \beta_8 PS * LFP_{PMK} + \beta_9 Y + \beta_{10} Y * THCC + \beta_{11} THCC + \boldsymbol{\delta X} + \varepsilon,$$

where:

C^q_t = child outcome q at time t,

LFP_m= mother's labour supply, represented by dummy variables or hours of work [26]

LFP_f= father's labour supply, represented by dummy variables or hours of work

LFP_{pmk} = person-most-knowledgeable labour supply [27]

ED_m= mother's education,

ED_f= father's education,

PS = parenting skills,

Y = family income,

$\boldsymbol{X}$ = a vector of child and family characteristics

$THCC$ = total hours in care, and

$\varepsilon \sim N(0,\sigma^2)$ and ε is homoscedastic and not correlated with any of the regressors, and except for possible correlations between error terms from the same family, the error terms are not correlated with each other.

In specification I, β_5, β_6, β_7, β_8, and β_{10} are restricted to be equal to zero. This is a basic equation, where parenting skills and reading activities are assumed to have no effect on the score, and where no interactions between parental labour supply and education are allowed. In addition, no

[26] Hours of work are only used in equations that test whether labour supply is endogenous.

[27] PMK labour supply is interacted with parenting skills because only the parenting skills of the PMK are available. For the great majority of children, the PMK is the mother.

interaction between hours in child-care and household income is allowed. Finally, φ is also restricted to be equal to zero since no prior scores are available.

In specification II, β_6, β_7, β_8, and β_{10} are restricted to be equal to zero. This is an enhanced basic equation, where no interactions between parental labour supply, and education and parenting skills are allowed. In addition, no interaction between hours in child-care and household income is allowed. Finally, φ is also restricted to be equal to zero when strictly cross-sectional data are used. However, parental skills effects are allowed as well as the effect of reading to/with the child.

In specification III there are fewer restrictions. Here, only β_{10} is restricted to be equal to zero. Hence, no interaction between hours in child-care and household income is allowed. The cross-sectional data restriction is also imposed.

Specification IV has no restrictions, except for the cross-sectional restriction. Hence, interactions are allowed for labour supply with education and parenting skills, and for hours in care and household income.

4. Data and preliminary statistics

The data consists of pooled cross-sectional observations from the first three cycles of the NLSCY (1994, 1996, and 1998). All observations on all children with a PPVT score who are between the ages of three and a half and five, and who are not in grade school are used. [28] The PPVT score is a standardized score ranging from 40-160.

[28] While some explanatory variables are missing for some observations, the observations were kept, but dummy variables were included in the regressions to identify these observations. A special dummy variable is created for each explanatory variable with missing observations. The dummy is coded as a one if the related explanatory variable is missing, and as a zero otherwise. The related explanatory variable maintains its value if the value is not missing, and is coded as a zero if the value is missing. This allows the special dummy variable coefficient to pick up the average full effect of the missing explanatory variable for observations with missing information. I chose this methodology rather than dropping the observations or substituting means of non-missing explanatory variables because I found that mothers for whom education was missing worked almost twice as many hours as other mothers, and because omitting an unrepresentative category of people (such as 'overworked' mothers too busy to complete the survey for example), makes it more difficult to infer from the sample to the general population without qualification. I also found that the child-care hours coefficient was sensitive to the deletion of these observations.

Table 1 shows the weighted means, ranges and standard deviations of PPVT scores and explanatory variables for the observations.[29] These are divided into two subgroups, one for children in dual parent families (dp) and one for children in single-parent families (sp). Many of the reported means are for dummy variables, in which case the range column is left blank. The household income for observations from cycle 1 and cycle 2 is adjusted to 1997 levels using the consumer price index.

PPVT scores are lower for children in single-parent families (95.9) than for children in two-parent families (99.7). Employment dummy variables combine work and study. For example, a full-time student is treated as fully employed. A part-time student who stays at home is treated as employed part-time, and a part-time student who also works outside the home part-time is treated as employed full-time.[30] In addition, a full-time worker has worked an estimated 30 hours per week or more in the last year, and a part-time worker has worked some hours but an average of less than 30 hours per week in the last year.

Most children live in families where the mother or single parent works outside the home or studies. However, children of single parents are more likely to have a stay-at-home parent (37 percent) than children of married mothers (29 percent) are likely to have a stay-at-home mother. Those who work outside the home are more educated than those who do not and married mothers are more educated than single parents.

There are two measures of family relationship health used: the consistency and family dysfunction scores.[31] Consistency basically covers discipline: does the parent set and follow-up on limits? Family dysfunction is based on questions that assess the degree of cohesiveness, positive communication, and support in the family. These scores are the average results of four to seven questions asked of the PMK. The means for these measures are shown under 'Child and Family

---

An alternative procedure to the missing variable problem is available in Stata (regmsng downloadable command) where missing variables are imputed.

[29] Means and regression estimates are weighted using the cross-sectional weights.

[30] The variable attempts to measure average annual labour supply but does so imperfectly: current hours of work are multiplied with work weeks in the last 12 months to arrive at average hours of work in the last 12 months; furthermore, the school participation variables are also current variables.

[31] The data contains other parenting skills scores. These other scores have considerable explanatory power for child behaviour, but not for the PPVT test scores.

Characteristics' in Table 1. Single parents tend to have slightly worse consistency and family dysfunction scores than dual parents. Table 1 also shows the means of the consistency variable by PMK labour supply. This is the interacted parenting skills dummy variable used in the majority of specifications. It is constructed by multiplying PMK labour supply dummy variables with PMK consistency scores. The means for these dummy variables indicate that children of PMKs who work outside the home fare slightly better in terms parental consistency than children of PMKs who do not. [32]

The PMK depression score, also shown under 'Child and Family Characteristics' in Table 1, is also used as an explanatory variable, and is based on questions of the PMK about her appetite, moods, happiness, concentration, energy, sleep and perceived acceptance by others.

Other variables of interest include the child's age, gender, language ability, parental immigrant status, child's health [33], whether the child is in kindergarden, mother's age at birth, the number of children less than 17, the number of older children, and reading frequency.

Children of immigrants are more likely to be in two-parent families. Immigrant and language status variables are included in the estimation equations as children with these characteristics are not likely to perform as well on official language tests, although some immigrants may come from other English or French speaking countries.

Child-care hours show that children of single parents tend to spend more hours in child-care even though their mother is less likely to work. Of course, with no spouse to care for children, single parent are more likely to rely on substitute care.

[32] While family dysfunction has been interacted with labour supply in one of the fixed effects specifications, the consistency score takes on that role in all other specifications with an interacted 'parenting skills' variable.
[33] The variable poor health is coded as a 1 if the PMK responded "poor" to the question "In general, would you say the child's health is: 1) excellent, 2) very good, 3) good, 4) fair, 5) poor ?"

Table 1

Means, Ranges and Standard Deviations of Variables

	Dual Parents	Single Parents	Range	Standard Deviation
N	*11,254*	*1,981*	blank=dummy	blank=dummy
Standard PPVT Score	99.72	95.91	40-160	15.32/14.89
Employment and Education				
Mother/PMK did not work	0.29	0.37		
Mother/PMK worked part-time	0.32	0.23		
Mother/PMK worked full-time	0.39	0.40		
Father did not work	0.05			
Father worked part-time	0.09			
Father worked full-time	0.86			
Mother/PMK years of education				
Did not work	12.27	11.01	0-20	2.22/2.00
Worked part-time	13.01	12.09	0-20	2.15/2.14
Worked full-time	13.17	12.24	0-20	2.14/1.73
Father years of education				
Did not work	10.92		0-20	2.63
Worked part-time	12.03		0-20	2.56
Worked full-time	13.06		0-20	2.46
Conditional/Interacted Consistency				
Mother/PMK did not work	14.60	13.58	0-20	3.34/3.84
Mother/PMK worked part-time	15.13	14.56	0-20	3.12/3.52
Mother/PMK worked full-time	14.85	14.13	0-20	3.30/3.49
Child and Family Characteristics				
Age in months/five/three years old	59.75	60.01		
Boy	0.50	0.53		
Speaks no English or French	0.02	0.02		
Immigrant parents	0.10	0.04		
Poor health	0.03	0.04		
In kindergarden	0.62	0.60		
Mother (parent) age at birth	29.30	26.93	1 +	5.63/5.99
Number of children < 17	2.38	1.96	1 +	0.98/1.07
Number of older children	0.84	0.66	0 +	0.96/1.00
Reads or is read to daily	0.58	0.50		
" " several times a day	0.09	0.06		
PMK depression score	4.07	7.46	0-35	4.65/6.78
Consistency score	14.87	14.02	0-20	3.26/3.65
Family dysfunction score	7.63	9.62	0-36	5.09/5.59
Child Care Hours				
Total hours	11.41	13.82	0-168	16.89/19.37
Average hours for those in care	25.32	31.86	0-168	16.78/17.04

continued

Table 1 (continued)				
Means, Ranges and Standard Deviations of Variables				
	Dual Parents	**Single Parents**	**Range**	**Standard Deviation**
Family Income				
Less than $20,000	0.05	0.58		
$20,000 - $29,999	0.09	0.19		
$30,000 - $39,999	0.13	0.12		
$40,000 - $49,999	0.15	0.05		
$50,000 - $59,999	0.14	0.03		
$60,000 - $69,999	0.11	0.01		
$70,000 - $79,999	0.10	0.01		
$80,000 +	0.22	0.01		
Location				
Newfoundland	0.02	0.02		
Prince Edward Island	0.00	0.00		
Nova Scotia	0.03	0.04		
New-Brunswick	0.03	0.02		
Quebec	0.25	0.22		
Ontario	0.39	0.38		
Manitoba	0.04	0.04		
Saskatchewan	0.04	0.03		
Alberta	0.10	0.07		
British Columbia	0.11	0.17		
Urban - 500,000 +	0.45	0.47		
Urban - 100,000 - 499,000	0.18	0.19		
Urban < 100,000	0.21	0.24		

Family income dummy variable means show that around 58 percent of the children of single parents lived in a family with an income of less than $20,000 in the prior year.[34] Conversely, 22 percent of children in two-parent families lived in a family with an income in excess of $80,000. I experimented with both a quadratic income specification and the income categories shown in Table 1. The fit is marginally better with the income categories and indicates that the relationship is not quite monotonic.

Provinces and urban location dummy variables have been included as explanatory variables because regional differences may contribute to outcomes. Approximately 60-64 percent of the children in

[34] Family income is for the calendar year preceding the survey and has been restated in 1997 dollars.

the samples live in Ontario and Quebec, while 63-66 percent live in cities with more than 100,000 people.

5. Estimation results and discussion

Specifications I, II, III and IV are reported for two-parent families and single parents in table 2. Specifications II and III modified for the fixed-effects estimator are reported for two-parent families in table 3. Results of specification IV estimations for two-parent families are presented in table 4. The dependent variable has been standardized around its standard deviation so that:

Dependent variable = (standard PPVT score –100)/15

a.) OLS estimates

Table 2 shows OLS estimates for the pooled cycle 1 to 3 observations for children in two-parent and single-parent families. In general, PPVT tests were administered to four and five year old children although a few children took the test when they were between 42 to 47 months old in cycles 2 and 3.[35]

Parents in the reference family for labour supply work outside the home/study full-time. The results for specification I indicate that parental labour supply and child-care hours have no effect on PPVT scores. Variables that have an impact include parental education, immigration and language status, health of the child, the mother's age at birth, the number of older children, family income, and location. The impacts are in the expected direction.

Specification I does not allow any interactions between labour supply and education. Furthermore, parenting skills and reading time coefficients have been constrained to equal zero. As these

[35] Since some of the children can come from the same household, or indeed can even be children who took the test at 3 and then at 5 years old, the estimation procedure specifies that the observations are independent across households, but not necessarily independent within households. The procedure affects the estimated standard errors and variance-covariance matrix of the estimators but not the estimated coefficients. There are 120 children who were sampled twice (110 in dual parent families and 10 in single parent families). I estimated OLS equations excluding one of the observations on these children and the results were nearly identical to the ones presented here.

variables are added into specification II, the positive parental education and the negative child-care hours effects decline. Labour supply variables are not significant in either of these two basic specifications.

Because of the labour supply interaction variables, the results shown for specifications III and IV in table 2 are somewhat difficult to interpret. These specifications test whether education effects vary with maternal and paternal labour supply and whether consistency effects vary with PMK labour supply. An interaction dummy variable for maternal and paternal education and for PMK parenting skills is created for each of three labour supply level. This allows the coefficients on education and parenting skills to vary for each of these levels. P-values for tests of whether the maternal education and PMK parenting skills coefficients are equal across the different labour supply levels are shown at the bottom of the third page of the table. These results indicate that while the hypothesis that maternal education coefficients are equal across labour supply levels cannot be rejected, the hypothesis that parenting skills coefficients are equal across the labour supply levels is rejected. In particular, the parenting skills coefficient for married stay-at-home PMKs is greater than the parenting skills coefficient for married PMKs who work full-time outside the home. In other words, one 'unit' of parenting skills is 'worth' more to the child with a stay-at-home PMK than it is to the child of a PMK who works outside the home. For ease of exposition, from now on I will assume that the mother is the PMK.[36]

According to specification III, for children in two-parent families with a father who works full-time outside the home and identical other characteristics, the difference between the predicted score for a child whose mother stays at home and one whose mother works outside the home and uses 40 hours of child-care is:[37]

(7) -0.412 + (0.066 - 0.052) * mother's years of education + (0.024 – 0.005) * PMK parenting skills - 40*(-0.001)
= -0.372 + 0.014*mother's years of education + 0.019*PMK parenting skills

[36] About 92-94% of PMK's in two-parent families are women.
[37] With the different labour supplies there is likely to also be an income effect, but assuming incomes of more than $80,000 for both groups reduces this effect to zero. Children in that income group do not perform significantly differently than children in the $50,000 – $59,999 income group.

Given average education levels and parenting skills this difference is very small, but is sensitive to parenting skills. [38] The same exercise can be repeated for a child with a mother who stays at home and a child with a mother who works outside the home but does not use child-care. The difference is:

(8) -0.412 + 0.014*mother's years of education + 0.019*PMK parenting skills

At average parenting skills and education for working mothers, (7) equals .115 and (8) equals .058, which are rather negligible.[39] Children of highly educated and consistent mothers benefit when their mothers do not work outside the home, because each unit of education and consistency is worth more to them than to children of mothers who work outside the home. Similarly, children of poorly educated and inconsistent mothers do slightly better when their mothers do work. At education of 18 and consistency of 20, equation (7) equals 0.282, and at education of 8 and consistency of 9, it equals –0.069.[40] Figures 1 and 2 illustrate these differences with specification III, and show that the differential effects are not large.

[38] There is also sensitivity to education, although the p-value testing whether the two education coefficients are equal is 34.5 percent.
[39] A value of .115 in equation (7) means that a child of a mother who stayed at home had an average score .115 of a standard deviation higher than that of a child of a mother working full-time.
[40] All the calculations were performed on the non-rounded coefficients.

FIGURE 1
PPVT (Z) Scores, Labour Supply & Education:
Average Parenting Skills

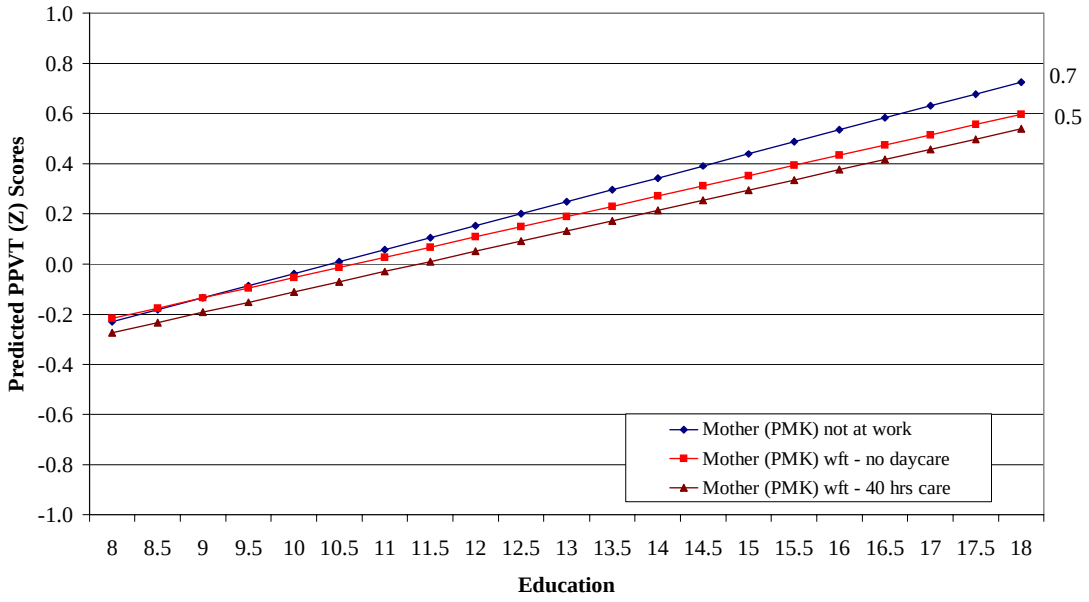
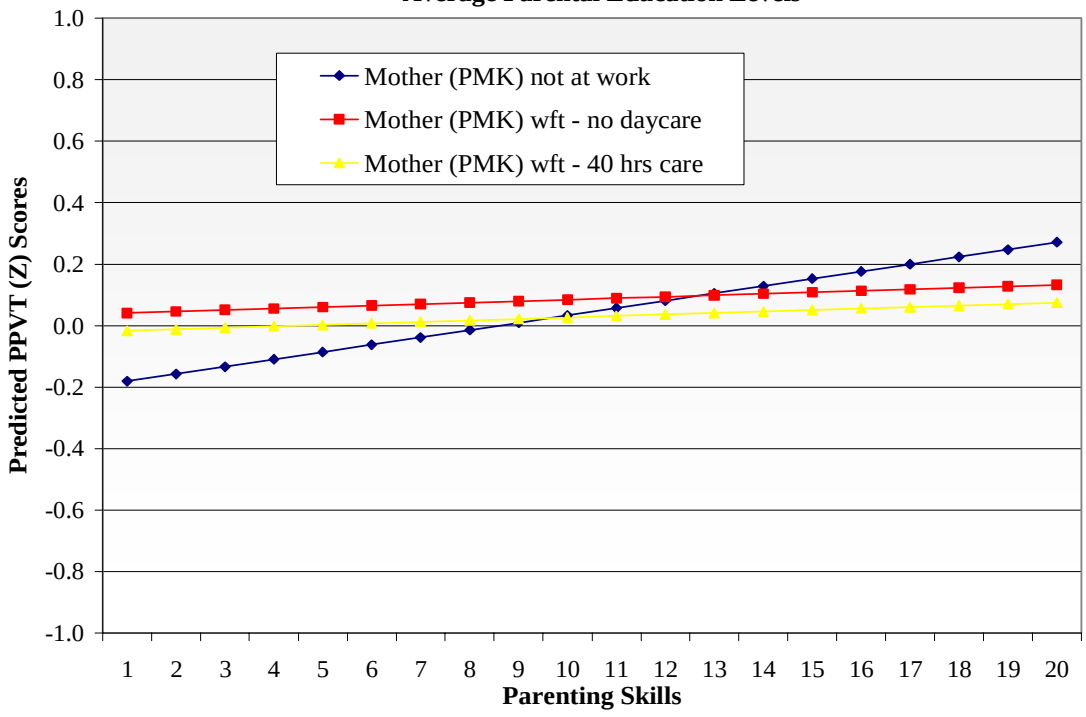


FIGURE 2
PPVT (Z) Scores, Labour Supply & Parenting Skills:
Average Parental Education Levels



Specification IV allows the effect of hours in care to vary with the family income level for children in two-parent families. Results indicate that in terms of fostering children's cognitive abilities, quality of care may be increasing in income. The break-even income level where hours in care have no effect occurs at around $94,000. This effect would not necessarily be expected for single parents, since many low-income single parents qualify for child-care subsidies which allows them to purchase higher quality care or requires that they purchase licensed care services.

Table 2 also indicates that children of older mothers score slightly better, and that children who are higher in the birth order and children in larger families tend to score worse. In single-parent families, the family size effect is quite important, while the birth order coefficient is insignificant; the parental age coefficient is also more than twice as large as the two-parent families parental age coefficient, but this effect is not large in either single or dual parent families.

Children in two-parent families who read or are read to daily score around 19 percent of a standard deviation more than children who do not, and those who read or are read to several times daily score around 36 percent of a standard deviation more. Although the PMK depression score does not significantly affect children's score in two-parent families, it does in single-parent families. Family dysfunction has also a negative effect on children's score, although the coefficients are not significant in single-parent families.

Specifications III and IV also show an important labour supply interaction effect with fathers' education. The education effect of fathers who work part-time is significant and large, but it must be viewed in concert with the 'father worked part-time' coefficient. Before controlling for education, children of fathers who work part-time have a predicted score that is half of a standard deviation lower than that of children of fathers who work full-time outside the home. However, at a level of paternal education of 12.6 years (an average level), there is no difference in predicted scores as is confirmed in specifications I and II. Hence it is at the extreme levels of education that these interactions yield significant differences in children's scores. Children of well educated fathers benefit when these fathers work part-time rather than full-time, but children of poorly educated fathers fare better when these fathers work full-time.

Table 2

OLS Regression Coefficients - Standard PPVT (Z) Scores

(t-ratios in parenthesis)

	Dual-Parent Families								Single-Parent Families							
	I		**II**		**III**		**IV**		**I**		**II**		**III**		**IV**	
N	11,254		11,254		11,254		11,254		1,981		1,981		1,981		1,981	
R - Squared	*0.145*		*0.167*		*0.170*		*0.173*		*0.188*		*0.215*		*0.217*		*0.218*	
Means																
Constant	-1.004	(-3.64)	-1.080	(-3.70)	(-0.94)	-3.100	-0.837	(-2.68)	-1.218	(-2.22)	-1.162	(-2.03)	-1.080	(-1.61)	-1.070	(-1.59)
Parental Employment, Education and Parenting Skills																
(Both parents work full-time)																
Mother/sp did not work	0.027	(0.44)	0.017	(0.28)	-0.412	(-1.62)	-0.516	(-1.98)	-0.090	(-0.77)	-0.108	(-0.96)	0.056	(0.11)	0.104	(0.20)
Mother/sp worked p/t	-0.016	(-0.33)	-0.026	(-0.53)	0.065	(0.22)	-0.009	(-0.03)	0.028	(0.28)	0.010	(0.10)	-0.533	(-1.14)	-0.497	(-1.09)
Father did not work	-0.100	(-1.06)	-0.077	(-0.83)	-0.021	(-0.07)	-0.033	(-0.10)								
Father worked part-time	-0.017	(-0.22)	0.009	(0.12)	-0.504	(-1.93)	-0.528	(-2.04)								
Mother/sp years of educ.	0.058	(5.36)	0.050	(4.60)					0.101	(4.87)	0.091	(4.59)				
Did not work					0.066	(4.27)	0.068	(4.36)					0.070	(2.05)	0.068	(1.98)
Worked part-time					0.031	(1.66)	0.032	(1.70)					0.112	(4.44)	0.110	(4.41)
Worked full-time					0.052	(3.44)	0.046	(3.03)					0.095	(3.09)	0.097	(3.19)
Father years of education	0.041	(4.47)	0.033	(3.69)												
Did not work					0.023	(0.80)	0.023	(0.81)								
Worked part-time					0.070	(3.35)	0.071	(3.45)								
Worked full-time					0.030	(3.26)	0.029	(3.18)								
Parenting skills			0.014	(2.58)							0.001	(0.11)				
PMK did not work					0.024	(3.20)	0.023	(3.18)					0.001	(0.08)	0.001	(0.11)
PMK worked part-time					0.018	(2.32)	0.017	(2.30)					0.017	(1.25)	0.017	(1.25)
PMK worked full-time					0.005	(0.72)	0.004	(0.68)					-0.009	(-0.56)	-0.009	(-0.55)

continued

Table 2 (continued)

OLS Regression Coefficients - Standard PPVT (Z) Scores

(t-ratios in parenthesis)

	Dual-Parent Families								Single-Parent Families							
	I		II		III		IV		I		II		III		IV	
Child and Family Characteristics																
Child age in months	-0.003	(-0.85)	-0.002	(-0.66)	-0.002	(-0.66)	-0.002	(-0.67)	-0.006	(-0.92)	-0.003	(-0.54)	-0.004	(-0.58)	-0.003	(-0.56)
Boy	-0.056	(-1.66)	-0.041	(-1.26)	-0.044	(-1.35)	-0.044	(-1.37)	-0.042	(-0.56)	-0.058	(-0.79)	-0.052	(-0.72)	-0.051	(-0.71)
Speaks no Eng. or Fr.	-0.642	(-4.07)	-0.584	(-3.68)	-0.581	(-3.77)	-0.576	(-3.73)	-0.306	(-1.95)	-0.236	(-1.29)	-0.225	(-1.21)	-0.221	(-1.19)
Immigrant parents	-0.576	(-7.21)	-0.551	(-6.89)	-0.548	(-6.81)	-0.542	(-6.71)	-0.880	(-4.16)	-0.863	(-4.26)	-0.849	(-4.35)	-0.845	(-4.31)
Poor health	-0.436	(-3.93)	-0.449	(-4.32)	-0.446	(-4.31)	-0.454	(-4.37)	0.051	(0.19)	0.077	(0.27)	0.078	(0.28)	0.078	(0.28)
In kindergarden	0.029	(0.53)	0.026	(0.49)	0.029	(0.54)	0.029	(0.56)	0.099	(1.06)	0.062	(0.68)	0.077	(0.85)	0.078	(0.86)
Mother (parent) age at birth	0.009	(2.47)	0.009	(2.31)	0.009	(2.37)	0.009	(2.34)	0.017	(2.47)	0.018	(2.61)	0.017	(2.47)	0.017	(2.51)
Number of children < 17	-0.037	(-1.36)	-0.042	(-1.59)	-0.044	(-1.65)	-0.043	(-1.63)	-0.179	(-2.89)	-0.174	(-2.83)	-0.176	(-2.86)	-0.177	(-2.90)
Number of older children	-0.081	(-2.94)	-0.066	(-2.44)	-0.064	(-2.38)	-0.066	(-2.53)	-0.057	(-0.81)	-0.054	(-0.79)	-0.049	(-0.70)	-0.048	(-0.70)
Reads or is read to daily			0.187	(5.10)	0.186	(5.09)	0.183	(5.05)			0.121	(1.59)	0.124	(1.62)	0.126	(1.65)
" " several times a day			0.359	(4.87)	0.357	(4.85)	0.357	(4.83)			0.025	(0.17)	0.035	(0.24)	0.037	(0.25)
PMK depression score			-0.004	(-0.98)	-0.004	(-1.09)	-0.004	(-1.09)			-0.011	(-1.92)	-0.011	(-2.07)	-0.011	(-2.09)
Family dysfunction			-0.010	(-2.78)	-0.009	(-2.69)	-0.009	(-2.67)			-0.006	(-0.74)	-0.006	(-0.77)	-0.006	(-0.76)
Child Care Hours																
Total hours	-0.002	(-1.42)	-0.002	(-0.99)	-0.001	(-0.92)	-0.006	(-2.25)	0.000	(-0.07)	-0.001	(-0.26)	0.000	(-0.05)	0.002	(0.57)
Hours*household income/10k							0.001	(1.69)							-0.001	(-0.74)
Family Income																
Less than $20,000	-0.411	(-3.87)	-0.382	(-3.58)	-0.360	(-3.36)	-0.361	(-3.38)	-0.095	(-0.34)	-0.047	(-0.16)	-0.043	(-0.14)	-0.094	(-0.27)
$20,000 - $29,999	-0.268	(-3.77)	-0.269	(-3.77)	-0.256	(-3.61)	-0.256	(-3.63)	-0.041	(-0.15)	-0.011	(-0.04)	-0.007	(-0.02)	-0.049	(-0.14)
$30,000 - $39,999	-0.152	(-2.62)	-0.145	(-2.56)	-0.142	(-2.50)	-0.141	(-2.48)	-0.068	(-0.23)	-0.044	(-0.14)	-0.045	(-0.14)	-0.068	(-0.20)
$40,000 - $49,999	-0.216	(-3.48)	-0.228	(-3.72)	-0.230	(-3.77)	-0.230	(-3.76)	-0.052	(-0.16)	-0.056	(-0.16)	-0.049	(-0.14)	-0.058	(-0.17)
$60,000 - $69,999	-0.070	(-1.22)	-0.083	(-1.47)	-0.077	(-1.35)	-0.084	(-1.48)	-0.145	(-0.38)	-0.213	(-0.57)	-0.194	(-0.52)	-0.153	(-0.44)
$70,000 - $79,999	-0.027	(-0.43)	-0.040	(-0.67)	-0.030	(-0.51)	-0.044	(-0.73)	0.255	(0.58)	0.259	(0.59)	0.283	(0.63)	0.349	(0.84)
$80,000 +	0.047	(0.76)	0.020	(0.33)	0.034	(0.54)	-0.019	(-0.28)	0.298	(0.91)	0.228	(0.61)	0.258	(0.68)	0.373	(1.04)

continued

Table 2 (continued)

OLS Regression Coefficients - Standard PPVT (Z) Scores

(t-ratios in parenthesis)

	Dual-Parent Families								Single-Parent Families							
	I		II		III		IV		I		II		III		IV	
Location																
Newfoundland	0.125	(1.90)	0.069	(1.05)	0.091	(1.36)	0.096	(1.42)	0.334	(2.20)	0.260	(1.67)	0.267	(1.71)	0.260	(1.68)
Prince Edward Island	0.010	(0.13)	-0.017	(-0.23)	-0.004	(-0.05)	-0.001	(-0.02)	0.347	(2.01)	0.259	(1.52)	0.279	(1.62)	0.286	(1.63)
Nova Scotia	0.138	(2.02)	0.125	(1.91)	0.125	(1.90)	0.123	(1.89)	0.344	(2.40)	0.306	(2.11)	0.313	(2.15)	0.312	(2.14)
New-Brunswick	-0.092	(-1.73)	-0.094	(-1.79)	-0.088	(-1.65)	-0.086	(-1.62)	-0.147	(-1.14)	-0.193	(-1.46)	-0.185	(-1.40)	-0.183	(-1.38)
Quebec	0.066	(1.31)	0.136	(2.73)	0.144	(2.89)	0.144	(2.90)	0.158	(1.42)	0.141	(1.26)	0.145	(1.32)	0.143	(1.30)
Manitoba	0.076	(1.09)	0.063	(0.92)	0.068	(1.00)	0.074	(1.07)	0.131	(0.73)	0.136	(0.98)	0.136	(0.97)	0.129	(0.92)
Saskatchewan	0.085	(1.49)	0.080	(1.42)	0.075	(1.31)	0.073	(1.28)	0.015	(0.12)	-0.025	(-0.20)	-0.039	(-0.31)	-0.039	(-0.31)
Alberta	0.155	(2.69)	0.145	(2.60)	0.146	(2.62)	0.144	(2.59)	0.256	(2.04)	0.210	(1.60)	0.207	(1.59)	0.205	(1.57)
British Columbia	0.008	(0.10)	-0.018	(-0.23)	-0.016	(-0.21)	-0.018	(-0.25)	0.094	(0.77)	0.031	(0.25)	0.038	(0.32)	0.034	(0.29)
Urban - 500k +	-0.097	(-2.05)	-0.091	(-1.96)	-0.094	(-2.01)	-0.098	(-2.12)	-0.009	(-0.08)	0.002	(0.02)	0.002	(0.02)	-0.004	(-0.04)
Urban - 100 - < 500k	0.005	(0.12)	0.004	(0.08)	0.005	(0.12)	0.005	(0.12)	0.110	(1.13)	0.083	(0.88)	0.089	(0.94)	0.084	(0.88)
Urban < 100k	-0.009	(-0.25)	-0.009	(-0.27)	-0.009	(-0.25)	-0.008	(-0.23)	0.086	(0.92)	0.083	(0.92)	0.087	(0.95)	0.084	(0.92)
P-Values for tests of equality between:																
Mother/single parent years of education																
Did not work = worked part-time						0.13		0.11						0.29		0.29
Worked part-time = worked full-time						0.38		0.54						0.66		0.72
Did not work = worked full-time						0.48		0.28						0.58		0.52
Parenting skills																
Did not work = worked part-time						0.49		0.48						0.35		0.36
Worked part-time = worked full-time						0.12		0.11						0.17		0.17
Did not work = worked full-time						0.01		0.01						0.62		0.61

In single-parent families, parental education has a strong positive effect, but the consistency score does not. With a smaller sample size, coefficients in the single parent equations are less likely to be statistically significant.

Children in two-parent families with income of $50,000 - $59,999 have the highest scores. At low paternal income levels, maternal labour supply can have a positive impact on children via the income effect. For children in single-parent families, family income does not have a significant impact on PPVT scores, although scores are higher at high-income levels.

Overall results indicate that for the average family, labour supply and child-care have little or no effect on children's cognitive scores, that children of highly skilled mothers tend to do somewhat better if their mothers do not work, that children of poorly skilled mothers tend to do slightly better if their mothers work outside the home than if they do, and that higher income is associated with higher quality care in two-parent families.

b.) Fixed-effects estimates

I estimate a family fixed-effects equation for PPVT scores.[41] If an unobserved variable that affects child outcomes is correlated with income, labour supply, and/or possibly also child-care use, the OLS coefficient estimates will be biased. A family fixed-effects model assumes that the unobserved heterogeneity is family-based, as opposed to child-based. For example, if mothers who work outside the home have greater cognitive ability or are more 'driven' than mothers who stay home, then their children might have higher scores for reasons other than their mother's labour supply. But if these differences are unobserved, the labour supply variable in an OLS regression would also capture these effects and either overestimate the positive effects of mothers' labour supply or underestimate its negative effects. While education can capture some of these differences, education is not a perfect proxy for cognitive ability or drive.

[41] Alongside the fixed effect estimates, I also estimated a random effects equation. Using a Hausman test that compares fixed effects to random effects coefficients, the hypothesis that the unobserved effect is not correlated with the right-hand side variables is rejected. Given the results of this test, the random effects specification is inappropriate. See Wooldridge (2002), p. 289, for further discussion of this test.

Table 3 shows the result of family fixed-effects estimations. As shown in equation (3) family variables disappear in the differencing; these include parental education, immigrant status, and location.[42]

The family fixed-effects model exploits siblings differences and differences between PPVT scores for the same child at two different points in time [43], reducing the number of available observations available for the estimation to 1,686.

Specification II does not interact parenting skills with labour supply. In specification III, I use consistency or family functioning [44] as an interaction variable with labour supply. Specification II shows that overall, as with the OLS results, neither maternal labour supply nor hours in care have an effect on children's scores. However, specification III shows that consistency effects have different signs for PMKs who worked outside the home from those who did not, but the coefficients are not statistically significant. PPVT scores for children of mothers who stay at home are affected by the family functioning measure, while those of mothers who work outside the home are not. Family dysfunction scores range between zero and thirty-six with a mean of 7.6 and a standard deviation of 5.1. A decrease in family dysfunction of one standard deviation would result in an increase in the PPVT score of around 1.5 for children of mothers who stay at home.

Poor health and family size and parental age at the child's birth all have a depressing effect on the children's scores, while being in kindergarden has a positive effect. In contrast with the OLS result where maternal age has a positive effect on the PPVT scores, in the fixed-effects equation, the mother's age at birth variable is negatively related to the child's score and may well be picking up a birth order effect.

[42] Tabulations using the longitudinal data for cycle 2 and 3 children indicate that in families where the adult guardian/parents are the same as in the previous cycle (over 90% of families), fewer than 2% of the children had changed province from one cycle to another, that around 4% of children's mothers and/or fathers reported increased education levels of 2 years or more over one cycle, that around 11% of children's mothers and/or fathers reported increased education levels of 1 year over one cycle, and that around 85% of children's mothers and/or fathers reported the same education level from one cycle to another.
[43] There are 120 children in the sample who are represented over two cycles and they are included here.
[44] In the fixed-effects model, family functioning is significant as an explanatory variable but consistency is not.

None of the specifications support an income effect on PPVT scores. However, since the same children or children in the same family are being compared, it is likely that there is little variation in this variable.

Table 3

Fixed Effects Regression Coefficients*
Standard PPVT (Z) score
(t-ratio in parenthesis)

	II		III			
			Consistency Interacted		Family Functioning Interacted	
Number of pairs			*1,686*			
Constant	0.865	(2.77)	0.817	(2.58)	0.851	(2.71)
Parental Employment and Parenting Skills						
and Parenting Skills						
(Mother works full-time)						
Mother did not work	0.099	(1.23)	0.448	(2.76)	0.233	(2.22)
Mother worked part-time	-0.015	(-0.24)	-0.134	(-1.06)	0.004	(0.04)
Parenting skills						
PMK did not work			-0.017	(-1.61)	0.019	(2.40)
PMK worked part-time			0.015	(1.51)	0.003	(0.45)
PMK worked full-time			0.007	(0.76)	0.001	(0.19)
Child and Family Characteristics						
Child age in months	-0.002	(-0.50)	-0.002	(-0.48)	-0.002	(-0.65)
Boy	-0.027	(-0.73)	-0.028	(-0.75)	-0.026	(-0.70)
Speaks no English or French	0.036	(0.23)	0.040	(0.25)	0.015	(0.10)
Poor health	-0.281	(-2.52)	-0.278	(-2.50)	-0.275	(-2.47)
In kindergarden	0.134	(2.40)	0.131	(2.35)	0.138	(2.46)
Mother (parent) age at birth	-2.358	(-3.30)	-0.018	(-3.13)	-0.017	(-3.05)
Number of children < 17	-0.113	(-1.82)	-0.114	(-1.84)	-0.117	(-1.88)
Number of older children	-0.078	(-2.37)	-0.079	(-2.40)	-0.081	(-2.45)
Reads or is read to daily	0.029	(0.56)	0.027	(0.53)	0.031	(0.61)
" " several times a day	0.079	(0.95)	0.076	(0.92)	0.077	(0.93)
PMK depression score	0.007	(1.19)	0.006	(1.12)	0.006	(1.02)
Consistency score	0.002	(0.27)			0.002	(0.25)
Family dysfunction score	-0.011	(-2.01)	-0.011	(-2.00)		
Family Income						
Less than $20,000	-0.074	(-0.56)	-0.084	(-0.63)	-0.074	(-0.56)
$20,000 - $29,999	-0.130	(-1.26)	-0.128	(-1.24)	-0.142	(-1.38)
$30,000 - $39,999	-0.034	(-0.40)	-0.038	(-0.44)	-0.042	(-0.48)
$40,000 - $49,999	-0.012	(-0.17)	-0.007	(-0.10)	-0.017	(-0.22)
$60,000 - $69,999	-0.024	(-0.31)	-0.023	(-0.29)	-0.026	(-0.34)
$70,000 - $79,999	-0.006	(-0.07)	-0.007	(-0.07)	-0.006	(-0.07)
$80,000 +	0.136	(1.34)	0.136	(1.35)	0.131	(1.29)
Child Care Hours						
Total hours	-0.001	(-0.66)	-0.001	(-0.58)	-0.001	(-0.66)

*Only children in two-parent families are included here

c.) Test of Endogeneity

Consider the following two-equation system:

(9) $y_1 = \gamma y_2 + \boldsymbol{\beta_1}'\mathbf{X_1} + \varepsilon_1$

(10) $y_2 = \varphi y_1 + \boldsymbol{\beta_2}'\mathbf{X_2} + \varepsilon_2$

Assume a bivariate normal distribution with zero means. Also assume that y_2 is censored, that is, $y_2 = \max(0, y_2^*)$. In this context, y_1 represents a child outcome while y_2 represents maternal hours of work.[45] Here, the assumption that maternal labour supply is an exogenous variable is relaxed. This model is due to Nelson and Olsen (1978) and is described in Maddala (1983) chapter 8.8 and in Greene (1998) section 28.4.

The estimation procedure is as follows:

(1) Estimate a reduced-form equation for y_1 (PPVT scores) and obtain its variance, σ^2_1.

(2) Estimate a reduced-form tobit equation for y_2 (maternal hours of work) and obtain predicted hours and variance-covariance matrix **V0** and σ^2_2.

(3) To obtain the correlation between the two equations (ρ_{12}), I follow Greene (1998) section 28.4: first run a reduced-form probit on maternal labour supply; retrieve the inverse Mills ratio, append to a reduced-form PPVT score equation and estimate with OLS; the coefficient on the inverse Mills ratio is equal to $\rho_{12}\sigma_1$.

(4) Estimate a structural equation for PPVT scores using OLS by substituting the predicted value for maternal hours of work for the actual value.

(5) Calculate the variance-covariance matrix for the structural equation, which equals:

$$\mathbf{V^{IV}} = (\sigma^2_1 - 2\gamma\rho_{12}\sigma_1\sigma_2)*[\mathbf{Z'Z}] + \gamma^2[\mathbf{Z'Z}]*\mathbf{M}*[\mathbf{Z'Z}];$$

where, $\mathbf{M} = [\mathbf{X'Z}]'*\mathbf{V0}*[\mathbf{X'Z}]$

and, $\mathbf{X}$ = matrix of exogenous variables for the system

[45] Equations (2.10) and (2.11) correspond to equations (2.4) and (2.5) respectively.

and, $\mathbf{Z}$ = matrix of explanatory variables for PPVT with maternal hours of work replaced by predicted maternal hours of work.

Since maternal income and child-care hours depend on maternal labour supply, these variables will be endogenous if maternal labour supply is endogenous. Thus, maternal income and child-care use were not included as explanatory variables when maternal labour supply was tested for endogeneity. The measured effect of maternal labour supply thus would incorporate related income and child-care effects.[46] In addition, students were deleted from this equation because their hours of work do not include their hours of study.

I used two slightly different instruments in two separate procedures for the test of endogeneity. The first is the unemployment rate by province and year of survey: observations originate from three separate years (1994, 1996, 1998) and unemployment rates for the prior years were used to coincide with hours of work in the last 52 weeks. While maternal labour supply is expected to vary with current local economic conditions, there is no theoretical reason to believe that PPVT scores would be directly affected.[47] The second measure is the unemployment rate for women aged fifteen years and over by Census Metropolitan Area (CMA).[48]

The IV estimates on maternal labour supply had a large but statistically insignificant positive sign with the provincial unemployment rate, and a large but statistically insignificant negative sign with the CMA female unemployment rate. The hypothesis of exogeneity could not be rejected with the standard Hausman test.

6. Conclusion

The above analysis indicates that maternal labour supply alone does not have any detrimental effect on pre-school children's cognitive scores for parents with average education and parenting skills.[49]

[46] There are not enough instruments to allow for two additional endogenous variables.
[47] The unemployment rate varies by region, but dummy province variables are included to capture regional differences.
[48] The Labour Force Survey provides unemployment rates for 25 CMAs. For children who do not live in these CMAs, I have calculated a provincial unemployment rate that takes into account CMA unemployment rate information (i.e., the unemployment rate for the remainder of the province).
[49] Here parenting skills refer to consistency scores.

Findings are also consistent with the hypothesis that children of parents with better parenting skills tend to benefit slightly more in terms of cognitive skills from additional parental time than children of less skilled parents but the effects are small. Although hours in care have no overall effect on PPVT scores, there is evidence that quality of care in terms of its impact on cognitive outcomes may be increasing in income. Fixed-effects models indicate that increased family dysfunction has statistically significant but small adverse effects on children's cognitive scores.

When I test for endogeneity of maternal labour supply, I find contradicting evidence on the sign of maternal labour supply, although neither of the coefficient is statistically significant. Using the standard Hausman test, the hypothesis of exogeneity of maternal labour supply cannot be rejected.

References

Amemyia, Takeshi. 1979. "The estimation of a simultaneous equation tobit model." *International Economic Review* 20(1):169-81.

Baydar, Nazli and Jeanne Brooks-Gunn. 1991. "Effects of maternal employment and child-care arrangements on preschoolers cognitive and behavioural outcomes: evidence from the children of the National Longitudinal Survey of Youth." Development Psychology 27(6):932-945.

Blau, David M. 1991. "The quality of child-care: an economic perspective." In *The Economics of Child-care*, ed. by David M. Blau, 145-73. New York: Russell Sage Foundation.

_____. 1997. "The production of quality in child-care centers." *Journal of Human Resources* 32:354-87

Blau, Francine D., and Adam J. Grossberg. 1992. "Maternal labor supply and children's cognitive development" *Review of Economics and Statistics* 74(3):474-81.

Burchinal, Margaret R. 1999. "Child-care experiences and developmental outcomes." *Annals of the Academy of Political and Social Science* 563:73-97.

Burchinal, Margaret R., Joanne E. Roberts, Laura A. Nabors, and Donna M. Bryant. 1996. "Quality of center child-care and infant cognitive and language development." *Child Development* 67:606-620.

Burchinal, Margaret R., Joanne E. Roberts, Rhodus Riggins, Jr., Susan A. Zeisel, Eloise Neebe, and Donna Bryant. 2000. "Relating quality of center-based child-care to early cognitive and language development longitudinally." *Child Development* 71(2):339-357.

Connor, Sarah and Satya Brink. 1999. "The impacts of non-parental care on child development." HRDC Working Paper No. W-00-2E. Ottawa: Human Resources Development Canada

Crockenberg, Susan, and Cindy Litman. 1991. "Effects of maternal employment on maternal and two-year-old child behaviour. *Child Development* 62:930-953.

Cryer, Debby. 1999. "Defining and assessing early childhood program quality." *Annals of the Academy of Political and Social Science* 563:39-55.

Currie, Janet, and Duncan Thomas. 1995 "Does Head Start make a difference?" *American Economic Review* 85:341-64.

Currie, Janet. 1997a. "The intergenerational transmission of "intelligence": down the slippery slopes of "the bell curve"." CIAR Working Paper No. 106. Toronto: Canadian Institute for Advanced Research.

_____. 1997d " School quality and the longer-term effects of Head-Start." CIAR Working Paper No. 110. Toronto: Canadian Institute for Advanced Research.

Green, William H. 1993. *Econometric Analysis, 2nd ed*. New York: Macmillan Publishing Company.

Greenstein, Theodore H. 1993. "Maternal employment and child behavioural outcomes." *Journal of Family Issues* 14:323-54.

Hanushek, Eric A. 1992. "The trade-off between child quantity and quality." *Journal of Political Economy* 100:84-117.

Heckman, James J. 1995 "Lessons from the bell curve." *Journal of Political Economy* 103:1091-120.

Hill, M. Anne, and Jane O'Neill. 1994. "Family endowments and the achievement of young children with special reference to the underclass." *Journal of Human Resources* 29:1064-1099.

Hotz, V. Joseph. 1992. "Special issue on child-care: introduction." *Journal of Human Resources* 27(1):1-39.

Kennedy, Peter. 1992. *A Guide to Econometrics, third edition.* Cambridge, Mass.: MIT Press.

Kohen, Dafna E., Clyde Hertzman, and Michele Wiens. 1998. "Environmental changes and children's competencies." HRDC Working Paper No. W-98-25E. Ottawa: Human Resources Development Canada

Kohen, Dafna E., Clyde Hertzman, and Jeanne Brooks-Gunn. 1998. "Neighbourhood influences on children's school readiness." HRDC Working Paper No. W-98-15E. Ottawa: Human Resources Development Canada

Lefebvre, Pierre, and Philip Merrigan. 1998. "Family background, family income, maternal work and child development." HRDC Working Paper No. W-98-12E. Ottawa: Human Resources Development Canada

_____. 2000. "The effects of child-care arrangements on development outcomes of young children." Paper prepared for the Conference on Families, Labour Markets, and Well-Being of Children, University of British Columbia, Vancouver, Canada, June 1-2, 2000.

Lipman Ellen L., Michale H. Boyle, Martin D. Dooley, and David R. Offord . 1998. "Children in lone-mother families: an investigation of factors influencing child well-being." HRDC Working Paper No. W-98-11E. Ottawa: Human Resources Development Canada.

Lipps, G., and J. Yiptong-Avila. 1999. "From home to school – how Canadian children cope." Culture, Tourism and the Centre for Education Statistics, Statistics Canada, Catalogue No. 89F0117XIE. Ottawa: Statistics Canada.

Maddala, G.S. 1983. *Limited-Dependent and Qualitative Variables in Econometrics.* New York: Cambridge University Press.

Mott, Frank L. 1991. "Developmental effects of infant care: the mediating role of gender and health." *Journal of Social Issues* 47(2):139-158.

Nelson, Forrest and Lawrence Olson. 1978. "Specification and estimation of a simultaneous-equation model with limited dependent variables." *International Economic Review* 19(3):695-709.

NICHD Early Child-care Research Network. 1997. "The effects of infant child-care on infant-mother attachment security: results of the NICHD study of early child-care." *Child Development* 68(5):860-879.

O'Brien Caughy, Margaret, Janet A. DiPietro, and Donna M. Strobino. 1994. "Day-care participation as a protective factor in the cognitive development of low-income children." *Child Development* 65:457-471.

Phillips, Meredith, and Jeanne Brooks-Gunn et al. 1998. "Family background, parenting practices and the Black-White test score gap." In *The Black-White Test Score Gap*, ed. C. Jencks and M. Phillips. Washington, DC: Brookings Institution Press.

Posner, Jill K., and Deborah L. Vandell. "Low-income children's after-school care: are there beneficial effects of after-school programs?" *Child Developme*nt 65:440-456.

Ross, David P., Paul A. Roberts, and Katherine Scott. 1998. "Variations in child development outcomes among children living in lone-parent families." HRDC Working Paper No. W-98-7E. Ottawa: Human Resources Development Canada.

Ryan, Bruce A., and Gerald R. Adams . 1998. "Family relationships and children's school achievement: data from the national longitudinal survey of children and youth." HRDC Working Paper No. W-98-13E. Ottawa: Human Resources Development Canada.

Ruhm, Christopher J. 2000. "Parental employment and child cognitive development." NBER Working Paper No. 7666. Cambridge, Mass: National Bureau of Economic Research

Stata User's Guide Release 7 (2001). Stata Press: College Station, Texas.

Statistics Canada. 1998. *The Daily*, Catalogue no. 11-001E, June 9, 1998. Ottawa: Government of Canada.

Sui-Chu, Ester Ho, and J. Douglas Willms. 1996. "Effects of parental involvement on eight-grade achievement." *Sociology of Education* 69:126-41.

Wooldridge, Jeffrey M. 2002. *Econometric Analysis of Cross Section and Panel Data.* Cambridge, Mass: MIT Press.

Zaslow, Martha J. 1991. "Variation in child-care quality and its implications for children." *Journal of Social Issues* 47(2):125-138.

Zukewich Galam, Nancy. 1997. “Attitudes toward women, work and family.” *Canadian Social Trends*, Catalogue No. 11-008-XPE, No. 46, Statistics Canada . Ottawa: Government of Canada.