SCHOOL OF ECONOMICS AND MANAGEMENT

ECONOMICS WORKING PAPER 2008-12

Timing of Family Income, Borrowing Constraints and Child Achievement

Maria Knoth Humlum

UNIVERSITY OF AARHUS
BUILDING 1322 - 8000 AARHUS C - DENMARK ☎ +45 8942 1133fa

Timing of Family Income, Borrowing Constraints and Child Achievement*

Maria Knoth Humlum†

September 1, 2008

Abstract

In this paper, I investigate the effects of the timing of family income on child achievement production. Detailed administrative data augmented with PISA test scores at age 15 are used to analyze the effects of the timing of family income on child achievement. Contrary to many earlier studies, tests for early borrowing constraints suggest that parents are not constrained in early investments in their children's achievement, and thus that the timing of income does not matter for long-term child outcomes. This is a reasonable result given the setting in a Scandinavian welfare state with generous child and education subsidies. Actually, later family income (age 12-15) is a more important determinant of child achievement than earlier income.

Keywords: child human capital, timing of family income.
JEL classifications: I2, J24.

*Acknowledgement: I am indebted to Helena Skyt Nielsen and Rune Majlund Vejlin for their many useful comments and suggestions. I thank Michael Svarer, Marianne Simonsen, and Astrid Würtz for helpful comments. All remaining errors are the responsibility of the author.

†School of Economics and Management, University of Aarhus, Universitetsparken, Building 1322, DK-8000 Aarhus C, Denmark. Email: mhumlum@econ.au.dk.

1 Introduction

Family income is rarely constant over the course of childhood. Income shocks and other events that affect family income cause the family income profile to be non-constant. Simply due to the positive relationship between wage and experience, the family income profile would generally be expected to be increasing over the course of childhood, ceteris paribus. But is it only the "aggregate" family income over the entire childhood that matters for child human capital accumulation, or does it also matter *when* family income is high or low? That is the basic question addressed in this paper. For the purpose of designing effective policies aimed at boosting child human capital accumulation, knowledge of the effects of the timing of resources is essential. If parents are borrowing constrained in early investments in their children's achievement, public policy should be directed at interventions in early childhood stages.

Many studies have explored the empirical relationship between family income and children's achievement outcomes. Fewer studies have looked at whether there are differential effects of family income at different childhood stages. More specifically, only a couple of studies have considered the importance of the timing of family income using European data, see Jenkins and Schluter (2002), who use German survey data, and Aakvik et al. (2005), who use Norwegian administrative data. In this paper, using a combination of Danish survey and administrative data, I consider the importance of the timing of family income for adolescent outcomes in the setting of a Scandinavian welfare state. Even in Denmark where inequality is relatively low, socioeconomic background is an important predictor of children's cognitive outcomes at age 15.[1] Recently, the Danish Economic Council declared that one of the important goals of the Danish welfare state is to ensure that children from poor families have the same life chances as other children, DORS (2006).

There are several reasons why the timing of family income during childhood may be important for determining later child achievement. First, the achievement production function may reflect a specific production technology that e.g. has the property that early inputs are more important than later inputs as is suggested in Cunha et al. (2006). Secondly, in the presence of borrowing constraints, the timing of family income will matter for child achievement. Another simple reason why the family environment may be more important in the early stages of childhood is that children gradually spend more time out of the home as they grow older. Thus, other inputs, e.g. school inputs, peer inputs, become more important. Of course, family income is not a direct input into achievement production. However, family income is considered a strong determinant of many of the direct inputs into child achievement production. Although the links between socioeconomic background and children's outcomes are well-established, the mechanisms through which family background work are less clear. Family income has a potential direct effect on child achievement since a higher family income means that parents are able to invest more in their children's achievement production. However, family income is also widely believed to be indirectly associated with children's outcomes through its effects on parents' general behavior towards their children and thereby the "quality" of the parents, e.g. low-income parents are more likely to be exposed to income-related stress, Mayer (1997).

For the empirical analysis, I employ a rich data set that combines the Danish part of the PISA 2000 survey, which includes PISA test scores and a range of PISA survey variables, and Danish administrative data on the children and their parents from the year of birth, 1984, onwards. A similar data set based on the PISA 2006 survey is used for robustness checks. Detailed information on family income, family structure, and parental labor market history is available for each year in the period 1984-2005, which means that I also have information on post-outcome income. The primary outcome considered is a measure of cognitive ability at age 15, namely the Programme for International Student Assessment (PISA) reading score. In addition, the richness of the data set allows analyses of standard education outcomes such as high school grade point average and completion of youth education, but also noncognitive outcomes such as

[1] See table 5.21b in OECD (2007).

academic and mathematical self-concepts.

Since other stage-specific family conditions are likely to be related to stage-specific family income, and are also considered to be strong determinants of child achievement (see, e.g., Ruhm, 2004, and the survey in Haveman and Wolfe, 1995), I include stage-specific controls for family structure and parental unemployment in the analyses. A thorough analysis of how the timing of family income relates to child achievement outcomes requires the incorporation of these stage-specific controls, see Duncan et al. (1998). In addition, the rich data set provides an extensive conditioning set containing child background characteristics, detailed information on parental education etc. A rich conditioning set is essential since family income is potentially endogenous in the child achievement regression. The results can be given a causal interpretation given the assumption that all individual heterogeneity is sufficiently controlled for. The literature on the timing of family income is not extensive, but the estimation methods usually employed to deal with the endogeneity of the timing variables are a large conditioning set or sibling fixed effect estimation, see, e.g., Levy and Duncan (2000) and Duncan et al. (1998). The fundamental assumption made in sibling fixed effects models is that unobserved family characteristics are constant over siblings. Especially for the purpose of investigating the relationship between an outcome and the timing of family conditions, the method of sibling fixed effects is problematic since siblings for whom family income differs at stages of their childhood are likely to have different unobserved family characteristics. Of course, the estimation method still ensures that family fixed effects that are constant over time are controlled for. Unfortunately, the PISA samples do not include data on siblings.

The next section will summarize some of the relevant literature for the timing of family income, while section 3 discusses some methodological issues. Section 4 contains the data description, and section 5 presents the results. Section 6 concludes.

2 Existing Literature

First, I summarize the literature on the effects on child outcomes of the timing of family income. Then, I briefly describe some of the theoretical concepts in the literature on the technology of skill formation.

2.1 Family Income

Family income is considered an important determinant of children's outcomes, Dahl and Lochner (2005). Duncan et al. (1998) summarize the literature about child development and family income and state three main conclusions. First, the effects of parental income vary a lot over the outcomes considered. Secondly, the effects of family income on achievement outcomes are usually statistically significant, but there is no consensus about the size of the effects. Finally, unmeasured family characteristics are likely to cause estimates of the effects of income to be upward-biased since family income will be capturing other favorable family characteristics. Mayer (1997) tends to be less convinced of the existence of sizeable effects of family income on children's outcomes. First, the effects of family income are not large, but there are positive effects of family income on children's outcomes. Secondly, the effects of income on various outcomes are generally small, but since income can be expected to affect nearly any child outcome, the cumulative effects of family income may be large. Third, current government policies to reduce poverty are part of the reason why the observed effects of family income are relatively small. Cunha et al. (2006) summarize a smaller number of studies on US data that examine the effects of income in different periods on later outcomes and the importance of borrowing constraints at different stages. They conclude that the evidence on the timing of income is mixed, and that the studies that actually find that timing matters do not find large effects.

According to the studies by Duncan and Brooks-Gunn (1997b) and Duncan et al. (1998), early family income is more important for child achievement than later family income. The

results of Duncan and Brooks-Gunn (1997b) suggest that an increase in family income will have larger effects for children in low-income families than for children in high-income families. In addition, they find that family income tends to be a better predictor of achievement than parental education and family structure. The study by Duncan et al. (1998) uses a range of different specifications (linear, spline, natural logarithm, dummies) and both OLS and sibling fixed effects. Levy and Duncan (2000) use sibling fixed effect techniques and find that the timing of family income during childhood is important. Specifically, they consistently find positive and significant effects of early family income (age 0-4). In some cases, they also find positive and significant effects of late family income (age 13-16). The primary outcome considered in these studies are children's completed schooling.

The findings of the above-mentioned studies are subject to the critique set forward by Carneiro and Heckman (2003), who argue that real family income at all ages should be discounted to the same base year in order to make income at different stages comparable in present value terms, and additionally that permanent income should be controlled for. Neglecting to take this into account can lead to ambiguous results in that in the above-mentioned studies it is unclear whether early income is really more important than later income, or whether the timing of income is actually unimportant and only permanent income matters. They find that permanent income is very important for college enrollment, but that both early and late income are relatively unimportant implying that neither early nor late borrowing constraints appear to be important for college enrollment. In a similar exercise, Caucutt and Lochner (2005) use a sample of children of the National Longitudinal Survey of Youth (NLSY) mothers to employ three different tests of intragenerational borrowing constraints to establish whether the timing of parental income matters for children's achievement as measured by a combination of Peabody Individual Achievement Test (PIAT) math and reading scores. Based on these tests, they conclude that some families do indeed face early borrowing constraints.

Very few studies examine the effects of income at different childhood stages on children's outcomes using non-US data. Aakvik et al. (2005) use the same approach as Carneiro and Heckman (2003) on administrative data for Norwegian children born 1968-1972, and find that permanent income is a significant determinant of years of education and college enrollment. More surprisingly though, they also find that holding permanent income constant, there is an additional positive effect of both income at early ages (age 0-6) and late adolescence (age 16-18).

Jenkins and Schluter (2002) consider the impact of stage-specific income on the type of school German children attend at age 14 using the German Socio-Economic Panel Survey. They estimate ordered probit models and find that unconditional income effects are much larger than conditional income effects. Also, for German children they find, contrary to many of the US studies, that late income (age 11-14) is more important than early income (age 0-5), and middle childhood income (age 6-10) is generally less important than early and late income. They also investigate potential nonlinearities in income, but they do not find any evidence of this. Their study suffers from a very low sample size (only 522 observations), and they lack information on family income in all years. Their income measure is household annual net income, but they do not discount incomes to the same base year. However, discounting should amplify their results making later income even more important.

2.2 The Technology of Skill Production

The recent theoretical literature on the production technology of abilities and skills has emphasized the potential importance of the timing of inputs into skill production. The technology of skill formation presented in Cunha et al. (2006) and Cunha and Heckman (2006) exhibits two important characteristics: self-productivity and dynamic complementarity. In their framework, early inputs are more important than later inputs in order to reflect the findings of a large body of empirical evidence - some of which is surveyed in Cunha et al. (2006) - that suggests that experiences in the first years of a child's life are very important for shaping later achievements.

Parents maximize their utility which depends on their consumption and the skill level of

their child subject to the technology of skill accumulation and the budget constraint in each period t. A simple representation of the decision problem faced by parents can be expressed as

$$\begin{aligned} & \max_{\mathbf{C},\mathbf{I}} U(\mathbf{C},\mathbf{S}) \\ s.t.\ S_t &= f_t(S_{t-1}, I_t),\ t = 0, ..., T \\ M_t &= p_t \cdot C_t + I_t,\ t = 0, ..., T \end{aligned}$$

This is a very simple representation where the parents are assumed to make a one-shot decision about the level of consumption and investment in each period. $\mathbf{C}$, $\mathbf{S}$, and $\mathbf{I}$, are vectors of the consumption level, the skill level, and the investment level in each period, respectively. M is the income and p the price of consumption. Obviously, the parental decision problem depends on the technology of skill production, and the properties of this technology therefore affect the optimal investment level.

In the following, some of the basic ideas regarding the technology of skill production presented in Cunha et al. (2006) and Cunha and Heckman (2006) are described. To simplify their exposition, suppose that children possess only one type of skills.[2] Let the stock of skills at stage t be denoted by S_t. The child's skill endowment is given by S_0, which could include e.g. genetic endowments. At each stage t during childhood, parents can make investments in their children's skill production, I_t. The technology of skill formation at stage t is given by:

$$S_t = f_t(S_{t-1}, I_t)$$

Two important characteristics of the technology of skill formation are those of self-productivity and dynamic complementarity. When the stock of skills in stage t increases the stock of skills in stage $t+1$, the production function is said to exhibit self-productivity. Mathematically, this can be expressed as

$$\frac{\partial S_t}{\partial S_{t-1}} = \frac{\partial f_t(S_{t-1}, I_t)}{\partial S_{t-1}} > 0$$

Dynamic complementarity refers to the fact that investments in different stages are complementary, i.e.

$$\frac{\partial^2 S_t}{\partial S_{t-1} \partial I_t} = \frac{\partial^2 f_t(S_{t-1}, I_t)}{\partial S_{t-1} \partial I_t} > 0$$

Thus, an increase in the stock of skills in one stage will increase the marginal productivity of investments in the next stage. Both self-productivity and dynamic complementarity will lead to early inputs being more important than later inputs.

3 Methodology

This section discusses issues concerning the specification and estimation. First, a brief review is given of the problems associated with using a specification that includes only undiscounted incomes when investigating the effects of the timing of family income. Secondly, some specification issues are discussed, and finally, the implemented tests for borrowing constraints are described.

[2] I simplify their exposition considerably since the main focus here is on giving some intuition on how the timing of inputs may affect skill production.

3.1 The Timing of Family Income

The intuitive way to estimate the effects of family income at different childhood stages is to simply include an income measure from each period as regressors in the model. Some earlier studies (see, e.g., Duncan and Brooks-Gunn, 1997b, and Levy and Duncan, 2000) follow this procedure which generally corresponds to estimating the following model:

$$T_i = \alpha + \beta_0 y_{i0} + \beta_1 y_{i1} + ... + \beta_T y_{iT} + u_i \tag{1}$$

where T_i is a measure of achievement for child i (e.g., a test score), y_{it} is the family income of child i in period t, and u_i is an error term. The studies mentioned find that early family income matters more for child achievements than later family income. The validity of the results obtained from studies that specify a model like (1) has been questioned by Carneiro and Heckman (2003). They argue that these results do not tell us anything about the importance of the timing of family income since the results are also consistent with the permanent income (PI) hypothesis.

According to the permanent income hypothesis, permanent income is the only income that matters for consumption and investment decisions. If individuals can borrow at some rate r against their future income, only permanent income will matter. Transitory income flows will be unimportant. Assume that the PI hypothesis holds and that permanent family income is the only thing that matters for child achievement such that

$$T_i = \gamma_0 + \gamma_1 PI_i \tag{2}$$

where $PI_i = \sum_{j=0}^{T} \frac{1}{(1+r)^j} y_{ij}$ is permanent income, and y_{ij} is the (undiscounted) family income for child i at age j. Parents are unconstrained and they can borrow and save at rate r. Suppose that the PI hypothesis is true, and (1) is used to estimate the effects of income on child achievement as measured by a test score. By construction, this yields $\beta_t > \beta_{t+1}$ for all positive discount rates, r, since $\beta_t = \frac{1}{(1+r)^t}\gamma_1$. To overcome the ambiguous results that may arise from the estimation of (1), Carneiro and Heckman (2003) suggest discounting all incomes to the same base year. When incomes are not discounted to the same base year, the result that early income matters more than later income may simply be an artifact of the permanent income model.

3.2 Specification

To ease exposition, childhood is divided into four stages in the empirical analysis.[3] For each stage, a measure of income is constructed as the present value of total stage income, i.e. the income measure for ages u through v is

$$I_{i,u-v} = \sum_{t=u}^{v} \frac{1}{(1+r)^t} y_{it} \tag{3}$$

where all income measures are discounted to the child's year of birth.[4][5] Note that $I_{i,0-15} = PI_i$. The model of interest is given by:

$$T_i = X_i\delta + \gamma_1 PI_i + \alpha_1 I_{i,0-3} + \alpha_2 I_{i,4-7} + \alpha_3 I_{i,8-11} + \alpha_4 I_{i,12-15} + \varepsilon_i \tag{4}$$

where X_i is a vector of other explanatory variables: control variables including stage-specific control variables. When considering the importance of the timing of income, what is of interest

[3] Dividing childhood into stages is common in this literature, see e.g. Duncan and Brooks-Gunn (1997b), and Jenkins and Schluter (2002).

[4] In the particular sample used, this corresponds to discounting all incomes to the same base year since the children are all born in 1984.

[5] The analyses might be sensitive to the choice of the discount rate r, and therefore several choices of r are considered.

is the effect of increasing income in one specific period holding permanent income constant. Obviously, there is perfect multicollinearity if both permanent income and the discounted income from every stage are included as explanatory variables. Consequently, it is not possible to identify all of the parameters, $\gamma_1, \alpha_1, ..., \alpha_4$. Omitting $I_{i,12-15}$ from the specification implies that the following parameters can be estimated: $\beta_0 = (\gamma_1 + \alpha_4), \beta_1 = (\alpha_1 - \alpha_4), \beta_2 = (\alpha_2 - \alpha_4)$, and $\beta_3 = (\alpha_3 - \alpha_4)$. The estimated coefficient on income in stage s will reflect the difference between the effect of income in stage s on child achievement and the effect of income in the last stage. The estimated coefficient on permanent income will reflect the total effect of permanent income and income in the last stage.

I estimate the following model:

$$T_i = X_i\delta + \beta_0 PI_i + \beta_1 I_{i,0-3} + \beta_2 I_{i,4-7} + \beta_3 I_{i,8-11} + \varepsilon_i \tag{5}$$

where the β_i can be expressed in terms of the parameters of the original model as noted above. For example, the interpretation of a positive estimate of β_1 is that stage 1 income is more important for child achievement than stage 4 income, in the sense that an increase in stage 1 income and a corresponding decrease in stage 4 income will increase child achievement. Correspondingly, a negative estimate of β_1 implies that an increase in stage 1 income relative to stage 4 income will decrease child achievement.

A couple of things are important to keep in mind when estimating this model. First, insufficient variation in family incomes over time will lead to problems with multicollinearity. Secondly, family income is potentially endogenous, and a rich conditioning set is needed to ensure that the estimated coefficients are unbiased. Caucutt and Lochner (2005) argue that with respect to the timing of family income, issues of selection are likely to be relatively unimportant since permanent income is controlled for. However, they mention the possibility of selection on age as younger parents are likely to have steeper income profiles. Third, as noted in Blau (1999), actual inputs into achievement production and variables reflecting actions chosen jointly with the inputs should not be included in a reduced-form model of this type. Finally, it can be debated whether it makes sense to use actual income. Economic agents do not make their decisions based on actual income, but on their expected income. Using actual income assumes that agents correctly predict their future income stream.[6]

3.3 Tests for Borrowing Constraints

In order to investigate the importance of the timing of income for child achievement, I implement several tests of borrowing constraints. Caucutt and Lochner (2005) distinguish between two types of borrowing constraints: intergenerational borrowing constraints and intragenerational borrowing constraints. *Intergenerational borrowing constraints* arise when parents cannot borrow against their children's future income, whereas *intragenerational borrowing constraints* arise when parents cannot borrow against their own future income. The presence of intergenerational borrowing constraints suggests that family permanent income is important for child achievement, but in the absence of intragenerational borrowing constraints, the *timing* of family income is not important for child achievement. If families are faced with intragenerational borrowing constraints, such that they are unable to make the desired investments in their children at specific points in time, then the timing of family income will matter for child achievement. In addition, even if a family is faced with intragenerational borrowing constraints, the specific timing of family income will not matter if investments in child achievement are perfectly substitutable over time. Thus, the tests for intragenerational borrowing constraints are actually joint tests of borrowing constraints and perfect substitutability of investments over time.

Caucutt and Lochner (2005) suggest three tests for intragenerational borrowing constraints. The first test estimates the effects of past income on child achievement conditional on perma-

[6] I choose to use actual income as there are no better alternatives, and it is the approach used in the existing literature.

nent income and compare the estimated effects of early income and late income. The second test estimates the effects of future income and past income on child achievement. If the PI hypothesis holds, then of course past and future income should have similar effects on current child achievement. The third test amounts to testing whether the slope of the income profile has significant effects on child achievement conditional on permanent income. If timing matters, one would expect a steeper slope to be associated with lower levels of child achievement.

The first test is performed by estimation of (5).[7] This specification is more flexible than the one used in Caucutt and Lochner (2005) since they restrict the effect of income at time j on achievement to be a linear function of age at the time of the test and age at time j. This simplifies the interpretation of their test because they only have to look at one parameter. The second test is straightforward. In a world with no borrowing constraints, future income would be just as important as past income in determining child achievement. Mayer (1997) also looks at the differential effects of past and future income. Her main interpretation of the results is different than that of Caucutt and Lochner (2005). She argues that given past income, future income should have no additional effect on child outcomes unless parental income captures some unobserved parental characteristics. Thus, in Mayer's terminology this is a test of the presence of unobserved parental characteristics. Of course, from an economic perspective, future income is important if parents can borrow against their future income. The third test considers the effects of the slope of the family income profile controlling for permanent income. A steep income profile suggests that the family is more likely to have been borrowing constrained when the child was younger. Mayer (1997) also employs this test and gives her results a similar interpretation as Caucutt and Lochner (2005). In addition, I look at whether fluctuations in family income are important for child achievement by including the standard deviation of family income.

4 Data

The main data set used for the empirical analysis is the Danish part of the international OECD PISA 2000 survey which sampled children born in 1984. This survey has been merged with administrative data adding detailed information on the children, their parents, and their parents' partners for each year from 1984 to 2005. The combined data set provides an excellent opportunity to follow children and their parents over time and therefore to look at the (long-term) effects of the timing of family income on child achievement. The original sample consists of almost 4,000 children. The later OECD PISA 2006 survey is used for robustness checks.[8]

The data set features information about the labor market history (e.g., income, employment) of the children's parents and the parents' partners as well as other relevant variables (e.g., education, cohabitation status, number of persons in household, region of residence) for each year from 1984 to 2005. There are several measures of income available in the data set, but my analyses will focus on *annual disposable income*, a measure of the income available for consumption after taxes and interest payments.[9] This is the income that should supposedly be important for parents in making decisions about investments in their children. The data

[7] A fully flexible specification would just include permanent income and family income in each year, except the last year.

[8] The PISA 2006 survey sampled children born in 1990. It differs from the PISA 2000 survey on a few points. Most importantly, the focus area of PISA 2006 was science, while the focus area of PISA 2000 was reading. However, the 2006 data set includes test scores on both reading, math, science, and problem solving. Also, some variables are not available in the 2006 data set. Specifically, some survey questions about family structure, birth order, and the number of siblings are not included in the 2006 survey, nor is post-outcome income available. The 2006 survey also includes some questions that were not in the 2000 survey. These were mainly science-related questions. Descriptive statistics for the 2006 sample are presented in tables 12-14.

[9] Certain public transfers are included in the disposable income: child benefits, housing benefits, and early retirement supplements.

In 2000 and 2001, the disposable income does not include the rental value of own home. To adjust for this break, I use the cash value of real estate owned and a rough version of how the tax authorities calculated the rental value of own home in previous years.

set provides detailed information about the family structure on a yearly basis. The fact that the data set contains information on both parents and potential new partners allows for the study of not only the importance of parental income, but also the study of household income.[10] Detailed information about both parents' education level can be used as proxies for children's innate ability which would be contained in S_0, see section 2.2. For the PISA 2006 sample, I am also able to include parents' high school GPA.

In Denmark, the PISA 2000 survey sampled children born in 1984, using two-stage stratified cluster sampling where schools were the primary sampling units.[11] The children were all tested in reading, which was the focus area of PISA 2000. The data offers the possibility to investigate various adolescent outcomes (e.g., completion of a youth education, high school GPA, and college enrollment). However, the main focus in this paper is on child achievement as measured by the PISA reading score, but for comparison I also consider other outcomes. The PISA reading scores were designed to measure competencies needed in everyday life, labeled "reading literacy". Contrary to many other tests, the PISA tests are not designed to measure specific skills that children should have acquired by a certain age, i.e. they are not curriculum-oriented. OECD (2001) defines reading literacy as: *"Reading literacy (...) is the ability to understand, use and reflect on written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate effectively in society"*. Since PISA aims to measure the competencies considered to be widely applicable in everyday life, the PISA test scores are likely to be good indicators of future labor market outcomes.[12] PISA test scores cannot yet be empirically coupled with labor market outcomes, but a Canadian study has documented a positive relationship between PISA reading scores and educational outcomes at age 19 (Knighton and Bussière, 2006).[13] The exact nature of the test and the type of questions asked are described thoroughly in OECD (2001). The test score for each individual is represented by five plausible values (PV), and the methods described in OECD (2005) are employed in order to obtain valid estimates and standard errors.

The original sample consists of 3,954 children. The fact that the analysis focuses on timing puts very strong requirements on the data since, e.g., information is needed on parental income in each year during childhood. Naturally, the analysis also requires that children must be observed in every year up to the point of the test.[14] About 350 observations are dropped due to children not observed in all years during childhood. Subsequently, about 175 observations are dropped due to parents not observed in all years. Finally, 156 observations are dropped due to missing values of one or more of the explanatory variables. In addition, I find it necessary to trim the data such that only observations between the 1 % and 99 % income percentiles are included. There is a smaller number of outliers that would otherwise drive the results. The final sample consists of 3,097 observations.

[10] In studies on US data, family income is usually understood to be household income. In my main analysis, family income will be parental income, not household income, but I am able to look at the results for household income as well.

[11] All the empirical analyses take the complex sampling design into account by employing the final student weights and the Balanced Repeated Replications (BRR) technique with Fay's modification to obtain correct parameter estimates and standard errors. A thorough description of the correct treatment of PISA data is given in OECD (2005).

[12] Hanushek (1986) doubts the appropriateness of using test scores as outcome measures because they may not be strong predictors of outcomes outside the education system. The PISA test scores should be less likely to suffer from this shortcoming since they are designed to measure competencies needed not only inside, but also outside the education system.

[13] In the present data set, I also find a positive association between the score obtained in PISA and the high school GPA.

[14] Individuals who are missing in the Danish registers are primarily individuals who were not present in Denmark in the year in question. As a results, only a small number of immigrants will remain in the sample after restricting the sample.

4.1 Stage-Specific Variables

The analysis focuses on the timing of family income, but I also include stage-specific controls for family structure and parental unemployment. In the following, these variables are defined. Following the literature on timing (see, e.g., Duncan et al.,1998, Ermisch et al., 2004), childhood is divided into stages. I divide childhood into four stages: age 0-3, age 4-7, age 8-11, and age 12-15.

4.1.1 Income

For the main analyses, I use parental income as a measure of family income. The parental income is based on the incomes of the parents of the child at each point in time.[15] All income measures are deflated or inflated to year 2000 DKK using the consumer price index of Statistics Denmark.

In order to make the interpretation of results as simple as possible, the income measures I include in the regressions are just the present value of income at each stage. Let y_{it} denote the income for individual i in period t measured in hundreds of thousands of year 2000 DKK. Let the present value of income from ages u to v be given by

$$PV_{i,u-v} = \sum_{t=u}^{v} \frac{1}{(1+r)^t} y_{it}$$

Permanent income (or past income) for child i is then simply $PI_i = PV_{i,0-15}$. A moderate discount rate of $r = 0.05$ is used in the computations.[16] All income measures are discounted to the same base year, 1984, which was the year of birth of all the children in the sample. As described in section 3.2, there will be perfect multicollinearity between $PV_{i,0-3}$, $PV_{i,4-7}$, $PV_{i,8-11}$, $PV_{i,12-15}$, and $PV_{i,0-15}$. Consequently, one of these variables will be left out in the analyses.

I define a measure of future income as the present discounted value of family income from the time of the test to the end date of the data, i.e. the present discounted value of future income is $PV_{i,16-20}$. The slope of the family income profile is defined as the average slope over ages 0-15, i.e. $\alpha_i = \frac{1}{15} \cdot \sum_{t=1}^{15} (y_{i,t} - y_{i,t-1})$, where $y_{i,t}$ is (undiscounted) income in period t.[17] The standard deviation of family income is computed as $\sigma_i = \frac{1}{16} \sqrt{\sum_{t=0}^{15} (y_{i,t} - \overline{y_i})}$, where $\overline{y_i} = \frac{1}{16} \sum_{t=0}^{15} y_{i,t}$.

In section 5.5.5, I also consider the results using household income. The household income is based on the current family structure at each point in time. It is computed using the incomes of the adults living in the same household as the child. For a traditional nuclear family, family income is simply the total of the parents' incomes. For a mother cohabitating with a new partner, the family income will be the total of these two people's incomes. This is the relevant income measure for the child given that the income of a parent outside the household is unimportant, and that a potential new partner will fully contribute his income to the household.[18]

[15] The definition uses the legal parents (not necessarily the biological parents), implying that children can "change" parents over time, e.g. in the event of adoption of the child by a new step dad.

[16] $r = 0.05$ is also used in e.g. Carneiro and Heckman (2003), and Caucutt and Lochner (2005). Section 5.2.5 takes a closer look at the consequences of changing this discount rate.

[17] The slope of the income profile could also be defined using the logarithm of income. Results are similar in this case.

[18] I also compute per capita income using information about the number of adults and children in the household, but these results are not presented. The family structure variables and the number of siblings will partially account for household size.

4.1.2 Single-Parent Family

For each year in the period 1984-1999 (corresponding to children's ages 0-15), I define indicators for whether or not the child experienced his/her first occurrence of living in a single-parent family. In this context, a single-parent family is defined as a family where the father and the mother of the child are not living together. Only the first occurrence of living in a single-parent family is captured by these indicators, implying that given a child lives in a single-parent family in 1984, the remaining indicators for living in a single-parent family will be zero. In general, if in period t the parents do not live together, but they did so in all periods prior to period t, then the child is defined as having the first occurrence of a single-parent family structure at time t.[19]

4.1.3 Parental Unemployment

Due to data limitations, parental employment is only available from 1985 onwards.[20] The indicator for parental unemployment in period t is set equal to one if either one of the parents have had what corresponds to more than three months of unemployment during period t.[21] The threshold of three months is chosen to ensure that very short spells of unemployment that are more likely to be voluntary and less detrimental are not included.

4.2 Descriptive Statistics

In the analyses, I control for a range of *basic* background characteristics: gender, month of birth, birth order, number of siblings, age of the mother at birth, age of the father at birth, immigrant or immigrant descendant, region of residence, and type of city of residence. In addition, some specifications include the education levels of the parents. Parental education level is the maximum education level observed in the period 1984-1999. The inclusion of parental education serves mainly as a proxy for parental ability. Region of residence and type of city of residence are measured ultimo 1999. Information on all of these background characteristics stem from the administrative data, except birth order and the number of siblings which are from the PISA survey. The stage-specific controls are an indicator for living in a single-parent family and an indicator for parental unemployment during each stage. Table 1 displays means and standard deviations for all variables used in the empirical analyses. For the indicator variables, the standard deviations are suppressed.[22] Tables 11-13 present similar descriptive statistics for the PISA 2006 sample.

The PISA reading scores were standardized across all OECD countries to have a mean score of 500 and a standard deviation of 100. In this sample, the mean and standard deviation are rather close to these values at 501 and 96, respectively. The official score for Denmark was slightly lower at 497. The present value of family income (measured in 100,000 DKK) decreases as children get older, but this is simply a reflection of the fact that the income measures are discounted to age 0. The present value of future income (age 16-20) is higher than in the previous stage as future income is aggregated over more years. The slope of family income is 0.07, which

[19] To account for the fact that some families might temporarily appear to be single-parent families even though they are not, I further make the assumption that a child cannot be in a single-parent family in year t if the child lived with both parents at both times $t-1$ and $t+1$. Thus, a breakup is conditioned on the parents living apart for at least two consecutive years. Specifically, for 1984, children did not incur a breakup if parents are living together the following year.

[20] I use the cumulative unemployment degree to quantify parents' unemployment. Since this variable is only available for 1984 onwards, this implies that unemployment in a given year can only be quantified from 1985 onwards.

[21] I have considered other thresholds (6, 9, and 12 months) as well as separate indicators for maternal and paternal unemployment. Although there are some differences in the significance and the size of the coefficients, all coefficients turn insignificant when all controls and timing variables are included in the specification.

[22] I also look at a couple of other outcomes. From the administrative data: completion of youth education and high school GPA. From the PISA survey: academic self-concept, mathematical self-concept, and an index of effort and perseverance. The PISA variables are indices with mean 0 and standard deviation 1 in the entire OECD sample. A thorough description of PISA 2000 questions and constructed indices are given in OECD (2002).

corresponds to an increase in family income of around 7,000 DKK per year - indicating moderate increases in real income on average. The standard deviation of a child's family income during childhood is 0.49 on average. About 30 % of the children in the sample have lived in a single-parent family by age 15, and the majority of these (19 %) have already lived in a single-parent family by age 7. There is a tendency for the children's parents to be less unemployed as the children grow older. During the first stage (age 0-3), as many as 43 % of the sample have incurred having one or both of their parents unemployed within a year.

As would be expected, about 50 % of the children are girls, and the age in months averages close to 15 years and 6 months. Only 5.7 % of the children are only children, and the average number of siblings is 1.8. Partly as a consequence of the strict data requirements of the analyses, only 2 % of the sample are immigrants or have immigrant parents. The majority of the sample resided in the regions of Zealand and Jutland in 1999, and about 60 % live in rural areas. A look at the parental education level distribution reveals that the majority of parents have a basic or a vocational education. The education distributions in the sample resemble that of the distribution of highest completed education level of 50-54-year-old men and women in Denmark in 2006.[23]

In the raw data, we observe some distinct differences in achievement scores across the three timing variables. Table 2 shows that children who have experienced life in single-parent families tend to have lower achievement scores, and they also tend to do worse in a number of other outcomes. This is especially pronounced for early changes (age 0-3) to the family structure. Contrary to this, both early parental unemployment and early presence in the lowest income quartile tend to be associated with better outcomes than late parental unemployment and late presence in the lowest income quartile. Those who never experience parental unemployment, living in a single-parent family, or presence in the lowest income quartile have higher achievement scores than all other categories.

Table 3 summarizes different income measures by parental education combinations. Clearly, parental education and family income are closely related. With few exceptions, children of parents with higher education levels have higher family income. Parental education level turns out to be a very important predictor of child achievement. The observed differences in outcomes across different income groups can to some extent be explained by differences in education. Both the slope of the family income profile and the standard deviation of family income are generally increasing with the parents' levels of education.

In order to identify the effects of family income at different childhood stages, there must be sufficient variation in the data. In other words, there must be a certain degree of income mobility between childhood stages. Table 4 shows correlations between the different (discounted) income measures used in the analyses. The correlations between the entire childhood family income and each of the stage incomes are high and range from 0.81 to 0.90. The correlation between income at one stage and income at the next stage is around 0.75, but the correlation between early childhood income (age 0-3) and late childhood income (age 12-15) is only 0.48. The sizes of the correlations are similar to those of Jenkins and Schluter (2002), who also report relatively high correlations between different income measures over time. Table 5 shows that the high correlations are consistent with a certain degree of income mobility over time. Based on the discounted family income measures for early and late childhood, children are placed in income quartiles. From the table, we see that out of those who were in the lowest income quartile at ages 0-3, about 47 % were also in the lowest quartile at ages 12-15. For the second, third, and fourth quartiles, the numbers are 36 %, 32 % and 55 %, respectively. This suggests a lower income mobility at the top and the bottom of the distribution as is also found in Jenkins and Schluter (2002).[24] I consider this ample evidence that the data provide adequate variation in income measures over time.

[23] Statistics Denmark, www.statistikbanken.dk.

[24] Looking at similar transition matrices for the combination of different income stages yields similar results although, of course, the persistence tends to be higher for family incomes in stages closer to each other in time.

5 Results

This section presents the results. All analyses are OLS regressions of child achievement on a range of explanatory variables unless explicitly stated otherwise. The income variables are of primary interest and the coefficients of the remainder of the explanatory variables are generally not reported. To ensure that the estimated income effects are unbiased, a rich conditioning set is needed. The data provides information about stage-specific variables, detailed child and family background characteristics (e.g. birth order, number of siblings, age of parents), region, parental education level, and labor market history. Differences in income patterns due to these covariates, such as longer education etc., are thereby controlled for. The rich set of covariates ensures that the estimated coefficients can be interpreted as causal effects.

5.1 Permanent and Stage-Specific Family Income

Table 6 displays the estimated coefficients and standard errors from a specification that includes stage-specific family income, stage-specific controls, basic background controls, and parental education. The estimated coefficients on family income are generally small and insignificant. Even a 100,000 DKK increase in permanent income only increases the reading score by 2.6 points. Generally, the results suggest no statistically significant effect of the timing variables on the achievement score.[25] The only exception is a large negative and significant effect of a recent parental breakup (age 12-15). Whether it is late parental breakup or a recent parental breakup that matters cannot be determined. Given the size of the standard errors, the possibility of detrimental effects of early parental breakups cannot be excluded. The estimated coefficients on breakups at ages 4-7 and 8-11 are small and insignificant. The estimated coefficients on parental unemployment are generally small and insignificant. These results are contrary to those of Ermisch et al. (2004), who find significant associations between the timing of family structure, parental joblessness, and a range of adolescent outcomes. For the background controls, the estimated coefficients are generally of the expected sign. Being a girl increases the PISA reading score by about 30 points, which is about one third of a standard deviation. Younger children have lower achievement scores, and being the oldest child is associated with a positive, but insignificant, effect on the child's achievement. The number of siblings has a small negative and insignificant effect. The results suggest that older parents have children with higher achievement scores. Having a mother who was older than 34 years old at the time of birth increases the reading score by 20 points.[26] Being an immigrant or having immigrant parents is associated with a huge negative effect of almost one entire standard deviation. Region of residence appears to be unimportant. Generally, a higher parental education level is associated with higher achievement scores. Specifically, having parents with long-cycle higher education increases the reading score by as much as 60 points. Thus, parental education appears to be a much stronger determinant of adolescent outcomes than family income.

Table 7 shows different specifications for the first test for borrowing constraints. This specification includes the family income of the first three stages and permanent income, i.e. family income aggregated over all four stages. If timing of family income is not important, we should observe no additional effects of stage family income on child achievement once permanent income is held constant. More control variables are sequentially added to the specifications. In general, the observed pattern is a positive association between child achievement and permanent income, but with respect to timing, the pattern shows that, if anything, family income at later stages is more important than family income at earlier stages. This is consistent with the results of Jenkins and Schluter (2002), but contrary to the results of several US studies (see, e.g., Duncan

[25] The next section will consider the importance of the timing of family income in more detail.

[26] There is likely to be some interrelated effects of the age of the parents and their education, but the exact effects of these variables are not of interest in the present paper, and will not be discussed further.

In addition, there could be interaction effects between parents' age at birth and the timing variables. I abstract from this and simply estimate the effect of the timing variables on the achievement outcome conditional on age.

et al.,1998, Duncan and Brooks-Gunn, 1997a) that emphasize the importance of early family conditions and especially early family income. When parental education is controlled for there are no significant effects of family income whatsoever. Even the association between permanent income and child achievement is insignificant, and the estimated coefficient indicates at most a very small effect. With only two stages, the estimated coefficients remain significant, and later income is more important than earlier income.

Even in the raw data I find that the correlation between children's test scores and family income is higher for later measures of family income. And, in the above OLS regressions, the general pattern is that family income at ages 12-15 is more important (although coefficients are not always statistically significant) than family income at all other stages. These results are contrasted by the results that early income matters more often found in studies using US data. One obvious explanation for this is that the institutional setting in the US is quite different from that in Denmark, a Scandinavian welfare state. One would expect the importance of borrowing constraints to be smaller in Denmark than in the US, and since even US studies do not find strong evidence of borrowing constraints, we would not expect to find this in the Danish data either. The results are quite reasonable given the institutional setting. Recent or current income is simply more important for child outcomes than past income.

5.2 Past and Future Family Income

In table 8, the results from the second test of borrowing constraints are presented. The income measures included in these specifications are past and future family income. The intuition behind this test is that if the timing of income is unimportant, future family income should have similar effects as past family income on child achievement. At a first glance, the results are a bit counterintuitive as it looks as if future income is actually more important than past family income in explaining child achievement. When additional controls are included, the coefficients on both income measures become insignificant, and the coefficients are of similar size. Again, observed differences in child achievement can be explained by differences in family and parental background characteristics. One reason why we observe this pattern where future family income appears to be more important than past family income could again be the mechanism described above where later income is simply a better measure of parental abilities and skills which are passed along to children. In comparison, Caucutt and Lochner (2005) find small and insignificant effects of future income.

5.3 Slope of Family Income Profile

Table 9 presents specifications that include permanent income and the average slope of the income profile as income measures. The slope of the family income profile is generally positively associated with child achievement.[27] In the presence of borrowing constraints, one would expect that families with steeper income profiles (holding permanent income constant) would be more likely to be borrowing constrained. The results display no evidence of borrowing constraints, and the coefficient of the slope does not even have the expected sign. This could be a reflection of the fact that higher ability parents are more likely to be at an earlier point in their career and therefore at a steeper segment of their income profile. In the data, parents with higher education levels do tend to have higher income slopes, see table 3. In comparison, Caucutt and Lochner (2005) find negative, but mostly insignificant, effects of the slope of the family income profile.

[27] Using the logarithm of income in the definition of the slope of the income profile or defining separate variables for different intervals of the slope does not change this result.

5.4 Income Fluctuations

The specifications in table 10 include the following income measures: the standard deviation of family income and permanent income. The idea is to look at whether fluctuations in income are important for child achievement. In the presence of uncertainty about future earnings parents might be borrowing constrained for human capital investments in their children's achievement. Of course, the standard deviation of family income does not measure income uncertainty, per se, but it is an indicator of the volatility of family income. It is plausible that families with less volatile income profiles find it easier to predict their future income. The results suggest that once all background characteristics are controlled for, the standard deviation of family income has no additional effect on child achievement. However, the standard deviation of family income is generally positively associated with child achievement. This is counterintuitive, but can perhaps be rationalized by the fact that, e.g., parents with higher education levels tend to have higher standard deviations of income, see table 3. When parental education is added to the specification, the coefficient on the standard deviation of family income drops to about one third of its original size.

5.5 Robustness checks

In order to get an idea of the robustness of the results, this section presents some robustness checks. Actual results are briefly summarized, but not presented here.

5.5.1 PISA 2006 Sample

No matter which outcome is considered (reading, math, or science), the overall results with respect to income are replicated for the PISA 2006 sample. Late income matters more than early income. There are slight differences, but the results are qualitatively the same. Generally, income at ages 4-7 and permanent income tend to be significant for the 2006 sample though.

5.5.2 Alternative Outcomes

As described earlier, the analyses are performed on a number of alternative outcomes. The overall pattern that late income is more important than early income is unchanged compared to the results using the PISA reading score. There is no particular reason to believe that large effects of the timing of family income would be found on other outcomes than those considered here. With respect to family income, there is a consensus that family income tends to have larger effects on children's achievements and abilities than on their behavioral and health outcomes (see Duncan et al. (1998) for a short summary of the stylized facts in the literature on family income and child development).

5.5.3 The Discount Factor

The choice of discount factor is obviously important in this type of analysis. In the main analysis, I use a discount factor of 5 %, which has also been used elsewhere (e.g., Carneiro and Heckman, 2003, Caucutt and Lochner, 2005). I reran the tests for borrowing constraints using two other reasonable values of the discount factor, namely 3 % and 7 %. The results are very similar. Generally, the numerical size of the coefficients increase when the discount factor is increased. Specification 1) in table 7 yields similar results, but family income at ages 8-11 turns insignificant at lower values of the discount factor (i.e. 3 %). When background controls are included, the results are still qualitatively the same, in that family income at ages 8-11 is insignificant for all values of the discount rate. In the specification that includes parental education, the income measures are insignificant at both values of the discount factor. The observed pattern that early income is associated with negative coefficients is present even at a discount rate of 0 % (no discounting). Thus, this result cannot be attributed to the choice of the discount rate. Of course,

the size of the coefficients also change slightly when using different discount rates. However, the span is only a couple of points from a discount rate of 3 % to the discount rate of 7 %.

5.5.4 Selection on Parental Ability

Since family income is likely to be correlated with parental ability, it is essential that parental ability is sufficiently controlled in the outcome equation. Therefore, detailed information about parental education levels is included in the analysis above. Neglecting to include sufficient controls for parental ability can lead to inconsistent estimates of the effects of family income on child achievement. First, if parental ability is not sufficiently controlled and wages earned later in life are a better reflection of an individual's actual "abilities", and these "abilities" are transferred from parents to children, late income would tend to have larger effects than early income per construction. This could be the case with a wage setting mechanism similar to that in the Jovanovic (1979) job matching model, where the estimate of a worker's productivity is assumed to become more precise as tenure increases and the workers are paid their perceived marginal products. From this perspective, later parental income appears to be more important because this income is a less noisy measure of innate ability than the earlier ones. This mechanism would tend to bias the estimated effects of later income relative to early income upwards. This describes a slight variation of the case where family income is observed to have an effect on child achievement because more able parents have more able children. If this mechanism is present in the US, it could help explain why some US studies find none or only weak evidence of early borrowing constraints, even though early family conditions are widely believed to be very important. Caucutt and Lochner (2005) mention another mechanism through which the omission of parental ability can lead to upward biased estimates of later family income: If more able parents earn their income later, and more able parents have more able children, then families earning their incomes at later ages will have more innately able children.

Two alternative strategies are pursued to check the robustness of the results with respect to the inclusion of parental ability. First, using the PISA 2006 sample, I include parental GPA as a measure of parental ability. Secondly, I use a number of variables from the PISA 2000 survey that can be considered proxies of parental ability (i.e., cultural possessions, cultural activities, home educational resources). Although both approaches tend to move the coefficients on the stage-specific income measures in the expected direction, neither of them succeeds in reversing the pattern that late income is more important than early income.

5.5.5 Household Income

Using an alternative measure of family income, namely household income, the results are qualitatively the same. This measure of family income is closer to the one used in US studies where surveys often sample households. For the first test, using household income I still find no evidence of borrowing constraints, and again if anything, later income appears to be more important than early income. With respect to the second test, results are now more in line with those of Caucutt and Lochner (2005): the coefficients on past and future income are closer to each other. Both income measures still turn insignificant when additional controls are included in the specification.

6 Conclusion

In this paper, I consider the effect of the timing of family income on child achievement production. Detailed administrative data augmented with PISA test scores are used to analyze the association between the timing of income and child achievement. Tests for early borrowing constraints suggest that parents are not constrained in early investments in their children's achievement, and thus that the timing of income does not matter for long-term child outcomes. If anything, later family income is more important than earlier income. Even in the raw data,

I find that the correlation between children's test scores and family income is higher for later measures of family income. These results are contrasted by results that early income matters more which are reported in various studies using US data. One potential explanation for this is that parental ability is not sufficiently controlled and an individual's income earned later in life is a better reflection of his "abilities". This would bias the coefficient of later income upwards if more able parents have more able children. If this mechanism is also present in the US data, the implication would be that the estimate of the effect of early income is biased downwards in the existing US studies. This could potentially explain why some US studies find none or only weak evidence of early borrowing constraints, even though early family conditions are widely believed to be very important. Another explanation is simply that one would expect the extent of borrowing constraints to be even smaller in Denmark, a welfare state with numerous policies aimed at reducing income inequality, also at the child level. Overall, Denmark is a country with generous public transfers, low income inequality, and a low wage dispersion. In the context of children, Denmark is characterized by publicly provided education, the availability of high quality day care, and publicly funded maternity leave schemes. Thus, the above results are not unreasonable given an institutional setting that differs considerably from that in the US. The analysis does not lend support to the hypothesis of the importance of early childhood conditions, but the hypothesis cannot be rejected either based on the evidence presented here.

References

[1] Aakvik, A., Salvanes, K. G., and K. Vaage (2005): "Educational Attainment and Family Background", *German Economic Review*, Vol. 6, No. 3, pp. 377-394.

[2] Blau, D. M. (1999): "The Effect of Income on Child Development", *The Review of Economics and Statistics*, Vol. 81, No. 2, pp. 261-276.

[3] Carneiro, P. and J. J. Heckman (2003): "Human Capital Policy", in Heckman, J. J., Krueger, A. B. and B. M. Friedman (Eds.), *Inequality in America. What Role for Human Capital Policies?*, MIT Press, Cambridge, MA.

[4] Caucutt, E. M. and L. Lochner (2005): "Early and Late Human Capital Investments, Borrowing Constraints, and the Family", Draft.

[5] Cunha, F. and J. J. Heckman (2006): "The Technology of Skill Formation", *American Economic Review*, Vol. 97, No. 2, pp. 31-47.

[6] Cunha, F., Heckman, J. J., Lochner, L. and D. V. Masterov (2006): "Interpreting the Evidence on Life Cycle Skill Formation", in E. A. Hanushek and F. Welch (Eds.), *Handbook of the Economics of Education*, Vol. 1, Elsevier, Amsterdam: North-Holland.

[7] Dahl, G. B. and L. Lochner (2005): "The Impact of Family Income on Child Achievement", Working paper 11279, NBER.

[8] DORS (2006): Vismandsrapporten, Fall 2006, DORS.

[9] Duncan, G. J. and J. Brooks-Gunn, eds. (1997a): *Consequences of Growing Up Poor*, Russell Sage, New York.

[10] Duncan, G. J. and J. Brooks-Gunn (1997b): "Income effects across the life span: Integration and interpretation", in: Duncan, G. J. and J. Brooks-Gunn (Eds.), *Consequences of Growing Up Poor*, Russell Sage, New York, pp. 596-610.

[11] Duncan, G. J., Yeung, W. J., Brooks-Gunn, J. and J. R. Smith (1998): "How Much Does Childhood Poverty Affect the Life Chances of Children?", *American Sociological Review*, Vol. 63, No. 3, pp. 406-423.

[12] Ermisch, J., Francesconi, M. and D. J. Pevalin (2004): "Parental partnership and joblessness in childhood and their influence on young people's outcomes", *Journal of the Royal Statistical Society, Series A*, Vol. 167, Part 1, pp. 69-101.

[13] Haveman, R. and B. Wolfe (1995): "The Determinants of Children's Attainments: A Review of Methods and Findings", *Journal of Economic Literature*, Vol. 33, No. 4, pp. 1829-1878.

[14] Jenkins, S. P. and C. Schluter (2002): "The effect of family income during childhood on later-life attainment: evidence from Germany", Working Papers of the Institute for Social and Economic Research, paper 2002-20, Colchester, University of Essex.

[15] Jovanovic, B. (1979): "Job Matching and the Theory of Turnover", *Journal of Political Economy*, Vol. 87, No. 5, Part 1, pp. 972-992.

[16] Knighton, T. and P. Bussière (2006): "Educational Outcomes at Age 19 Associated with Reading Ability at Age 15", *Culture, Tourism and the Centre for Education Statistics research papers*, Statistics Canada.

[17] Levy, D. and G. J. Duncan (2000): "Using sibling samples to assess the effect of childhood family income on completed schooling", Working paper, JCPR.

[18] Mayer, S. E. (1997): *What Money Can't Buy. Family Income and Children's Life Chances*, Harvard University Press, Massachusetts.

[19] OECD (2001): *Knowledge and Skills for Life: First Results from the OECD Programme for International Student Assessment (PISA) 2000*, OECD.

[20] OECD (2002): *Manual for the PISA 2000 Database*, OECD.

[21] OECD (2005): *PISA 2003 Data Analysis Manual*, OECD.

[22] OECD (2007): *PISA 2006: Volume 2 Data*, OECD.

[23] Ruhm, C. J. (2004): "Parental Employment and Child Cognitive Development", *Journal of Human Resources*, Vol. 39, No. 1, pp. 155-192.

A Tables

Table 1: Descriptive Statistics - 2000 sample

	Mean	Std. Dev.	Min	Max
Explained variable				
PISA reading score	500.973	95.517	88.110	818.350
Family Income				
Age 0-3	8.376	1.614	3.060	14.280
Age 4-7	7.622	1.594	2.692	14.128
Age 8-11	6.914	1.499	2.702	13.959
Age 12-15	6.368	1.519	2.800	14.099
Age 0-15	29.281	5.338	14.033	52.984
Age 16-20	8.315	2.320	2.523	19.779
Slope of family income	0.070	0.060	-0.531	0.540
St.d. of family income	0.492	0.326	0.083	3.670
Stage-specific controls				
Single-parent family				
Age 0-3	0.115		0	1
Age 4-7	0.079		0	1
Age 8-11	0.061		0	1
Age 12-15	0.035		0	1
Parental unemployment				
Age 0-3	0.432		0	1
Age 4-7	0.403		0	1
Age 8-11	0.366		0	1
Age 12-15	0.263		0	1
Background controls				
Girl	0.495		0	1
Month of birth (1-12)	6.319	3.291	1	12
Only child	0.057		0	1
Oldest child	0.365		0	1
Middle child	0.223		0	1
Youngest child	0.355		0	1
Number of siblings	1.836	1.219	0	12
Mother's age at birth				
<24	0.200		0	1
>34	0.077		0	1
Father's age at birth				
<24	0.073		0	1
>34	0.202		0	1
Immigrant or immigrant parents	0.018		0	1
Region of residence, 1999				
Zealand	0.378		0	1
Funen	0.087		0	1
Jutland	0.534		0	1
Type of city of residence, 1999				
Urban, larger cities	0.168		0	1
Urban, medium cities	0.251		0	1
Rural	0.581		0	1

Continued on next page

Table 1 – Continued

	Mean	Std. Dev.	Min	Max
Father's education level				
Basic	0.262		0	1
High school	0.034		0	1
Vocational	0.461		0	1
Higher education, short	0.042		0	1
Higher education, medium	0.118		0	1
Higher education, long	0.082		0	1
Mother's education level				
Basic	0.319		0	1
High school	0.038		0	1
Vocational	0.332		0	1
Higher education, short	0.044		0	1
Higher education, medium	0.231		0	1
Higher education, long	0.037		0	1
Number of observations		3,097		

Notes:
a) Original sample weights used.
b) For the reading score, the min and max reports the min and max over all 5 plausible values.
c) For future income the number of observations is 3,059.

Table 2: Outcomes summarized by the timing of family conditions - 2000 sample

		Outcomes											
		PISA reading score		Completed youth education		High school GPA		Mathematical self-concept		Academic self-concept		Index of effort and perseverance	
		Mean	Std.err.	Mean	Std.err.	Mean	Std.err.	Mean	Std.err.	Mean	Std.err.	Mean	Std.err.
Family income in lowest quartile	Age 0-3	495.768	(4.504)	0.428	(0.020)	8.117	(0.053)	0.492	(0.038)	0.419	(0.039)	-0.073	(0.035)
	Age 4-7	489.061	(3.850)	0.401	(0.020)	7.995	(0.053)	0.434	(0.041)	0.325	(0.042)	-0.088	(0.038)
	Age 8-11	480.597	(4.275)	0.394	(0.018)	8.012	(0.054)	0.445	(0.043)	0.322	(0.038)	-0.050	(0.034)
	Age 12-15	480.019	(3.909)	0.382	(0.019)	7.946	(0.054)	0.439	(0.053)	0.273	(0.047)	-0.067	(0.031)
	Ever	488.860	(2.965)	0.417	(0.014)	8.007	(0.036)	0.443	(0.034)	0.328	(0.032)	-0.091	(0.024)
	Never	511.539	(3.132)	0.567	(0.015)	8.290	(0.036)	0.547	(0.031)	0.471	(0.028)	-0.004	(0.024)
Single-parent family	Age 0-3	475.551	(5.658)	0.332	(0.024)	7.958	(0.087)	0.212	(0.054)	0.115	(0.054)	-0.216	(0.054)
	Age 4-7	496.572	(5.813)	0.456	(0.030)	8.217	(0.083)	0.480	(0.066)	0.428	(0.061)	-0.093	(0.063)
	Age 8-11	498.478	(6.396)	0.424	(0.040)	8.138	(0.096)	0.327	(0.091)	0.346	(0.079)	-0.190	(0.068)
	Age 12-15	479.622	(11.494)	0.433	(0.044)	8.077	(0.141)	0.331	(0.085)	0.345	(0.094)	-0.076	(0.082)
	Ever	486.604	(3.788)	0.397	(0.015)	8.094	(0.048)	0.323	(0.036)	0.276	(0.036)	-0.160	(0.032)
	Never	506.863	(2.649)	0.538	(0.012)	8.204	(0.030)	0.571	(0.025)	0.458	(0.021)	0.003	(0.022)
Parental unemployment	Age 0-3	489.054	(2.946)	0.420	(0.016)	8.087	(0.038)	0.413	(0.031)	0.320	(0.029)	-0.088	(0.025)
	Age 4-7	485.063	(3.351)	0.395	(0.013)	8.060	(0.041)	0.411	(0.036)	0.319	(0.029)	-0.114	(0.029)
	Age 8-11	483.121	(3.595)	0.382	(0.016)	8.035	(0.051)	0.375	(0.036)	0.292	(0.035)	-0.126	(0.030)
	Age 12-15	481.653	(4.653)	0.373	(0.020)	8.056	(0.061)	0.382	(0.038)	0.309	(0.035)	-0.100	(0.033)
	Ever	491.304	(2.755)	0.429	(0.012)	8.085	(0.033)	0.435	(0.027)	0.345	(0.022)	-0.085	(0.022)
	Never	516.831	(3.669)	0.609	(0.017)	8.292	(0.040)	0.604	(0.035)	0.503	(0.032)	0.022	(0.027)

Notes:
a) High school GPA is only observed for those who complete high school.
b) Placement in income quartiles is made based on discounted family income (unweighted).
c) Original sample weights are used and standard errors are estimated using BRR methods.
d) The mathematical self-concept, the academic self-concept, and effort and perseverance are measured by PISA indices. These indices have been normalized to have a mean of zero and a standard deviation of one in the entire PISA OECD sample.

Table 3: Income measures summarized by parental education levels - 2000 sample

		Father					
Mother		Basic		Vocational		Higher education	
Basic	Variable	Mean	Std.err.	Mean	Std.err.	Mean	Std.err.
	Age 0-3	7.910	0.098	7.986	0.075	8.874	0.204
	Age 4-7	7.049	0.095	7.210	0.067	7.957	0.241
	Age 8-11	6.268	0.072	6.443	0.060	7.458	0.214
	Age 12-15	5.611	0.060	5.846	0.062	7.108	0.217
	Age 0-15	26.838	0.269	27.485	0.211	31.397	0.768
	Slope	0.054	0.003	0.060	0.003	0.087	0.009
	St.d.	0.408	0.010	0.447	0.016	0.630	0.045
	Age 16-20	6.998	0.077	7.429	0.085	9.298	0.233
Vocational	Age 0-3	8.166	0.075	8.254	0.062	8.924	0.171
	Age 4-7	7.298	0.078	7.424	0.056	8.154	0.145
	Age 8-11	6.510	0.064	6.711	0.052	7.620	0.148
	Age 12-15	5.932	0.072	6.161	0.054	7.132	0.146
	Age 0-15	27.907	0.234	28.549	0.183	31.830	0.522
	Slope	0.057	0.004	0.062	0.002	0.084	0.005
	St.d.	0.448	0.022	0.468	0.012	0.603	0.039
	Age 16-20	7.614	0.113	8.078	0.074	9.604	0.291
Higher education	Age 0-3	8.511	0.137	8.387	0.091	9.123	0.095
	Age 4-7	7.679	0.133	7.628	0.080	8.704	0.092
	Age 8-11	6.949	0.133	6.918	0.077	8.081	0.088
	Age 12-15	6.336	0.114	6.459	0.076	7.602	0.094
	Age 0-15	29.475	0.468	29.392	0.273	33.510	0.333
	Slope	0.067	0.003	0.073	0.003	0.101	0.003
	St.d.	0.428	0.019	0.520	0.020	0.602	0.017
	Age 16-20	8.158	0.218	8.599	0.110	10.225	0.160

Notes:
a) Original sample weights are used and standard errors are estimated using BRR methods.
b) Vocational includes high school educations.

Table 4: Correlations between family income measures - 2000 sample

Family income	Age 0-3	Age 4-7	Age 8-11	Age 12-15	Age 0-15	Age 15	Age 16-20
Age 0-3	1	-	-	-	-	-	-
Age 4-7	0.704	1	-	-	-	-	-
Age 8-11	0.569	0.746	1	-	-	-	-
Age 12-15	0.477	0.609	0.778	1	-	-	-
Age 0-15	0.809	0.895	0.897	0.828	1	-	-
Age 15	0.420	0.520	0.659	0.856	0.710	1	-
Age 16-20	0.413	0.507	0.618	0.761	0.666	0.701	1

Notes:
a) Original sample weights used.

Table 5: Income mobility between early and late childhood - 2000 sample

Family income	Age 12-15				
Age 0-3	Q1	Q2	Q3	Q4	Total
Q1	**0.474**	0.232	0.177	0.117	1.000
	(367)	(185)	(135)	(88)	(775)
Q2	0.284	**0.360**	0.224	0.132	1.000
	(222)	**(280)**	(174)	(98)	(774)
Q3	0.173	0.285	**0.323**	0.219	1.000
	(129)	(222)	**(256)**	(167)	(774)
Q4	0.074	0.109	0.266	**0.552**	1.000
	(57)	(87)	(209)	**(421)**	(774)
Total	0.252	0.247	0.247	0.254	1.000
	(775)	(774)	(774)	(774)	(3,097)

Notes:
a) Original sample weights used.
b) Row proportions, number of observations in parentheses.

Table 6: OLS REGRESSION OF ACHIEVEMENT ON TIMING VARIABLES AND BACKGROUND CONTROLS

Dependent variable: PISA reading score	Coef.	Std. Err.
Family income		
Age 0-3	-0.837	1.528
Age 4-7	-1.624	2.012
Age 8-11	2.246	2.160
Age 0-15	2.554	1.831
Stage-specific controls		
Single-parent family		
Age 0-3	-8.941	6.020
Age 4-7	-0.656	6.262
Age 8-11	-1.526	6.809
Age 12-15	-21.866**	9.927
Parental unemployment		
Age 0-3	0.834	5.278
Age 4-7	-4.821	5.712
Age 8-11	-1.447	4.080
Age 12-15	-0.335	4.697
Background controls		
Girl	30.457***	3.909
Month of birth (1-12)	-0.846*	0.510
Only child	-9.362	12.290
Oldest child	5.917	5.493
Youngest child	-11.907**	5.956
Number of siblings	-4.781**	2.326
Mother's age at birth		
<24	-5.171	4.818
>34	19.177**	7.942
Father's age at birth		
<24	-7.204	6.993
>34	11.427**	5.625
Immigrant or immigrant parents	-88.012***	14.405
Region of residence, 1999		
Zealand (left out)		
Funen	-11.986	8.310
Jutland	2.033	4.434
Type of city of residence, 1999		
Urban, larger cities	-4.889	6.245
Urban, medium cities	-7.902	5.154
Rural (left out)		

CONTINUED ON NEXT PAGE

Table 6 – Continued

Dependent variable:	PISA reading score	
	Coef.	Std. Err.
Father's education level		
Basic (left out)		
High school	36.274***	11.380
Vocational	15.415***	3.665
Higher education, short	29.417***	8.664
Higher education, medium	42.685***	5.952
Higher education, long	52.953***	8.723
Mother's education level		
Basic (left out)		
High school	47.153***	8.134
Vocational	14.074***	4.148
Higher education, short	32.986***	9.490
Higher education, medium	41.566***	5.055
Higher education, long	58.881***	9.490
Constant	457.822***	15.859
Number of observations	3,097	
R-squared	0.197	

Notes:
a) Statistical significance at the 1 percent level ***, 5 percent level **, 10 percent level *
b) Original sample weights are applied and standard errors are estimated using BRR methods
c) Reported r-squared is the average r-squared from regressions with each of the 5 plausible values of the test score.

Table 7: Using permanent income to test for borrowing constraints

Dependent variable:	(1)	(2)	(3)	(4)
PISA reading score	Coef./	Coef./	Coef./	Coef./
	Std. Err.	Std. Err.	Std. Err	Std. Err.
Income variables				
Family income				
Age 0-3	-11.587***	-10.582***	-3.721	-0.837
	(2.569)	(2.408)	(2.512)	(1.528)
Age 4-7	-10.541***	-8.007***	-4.341	-1.624
	(3.044)	(2.944)	(2.790)	(2.012)
Age 8-11	-6.154*	-4.001	-0.161	2.246
	(3.676)	(3.499)	(3.387)	(2.160)
Age 0-15	10.529***	8.246***	2.725	2.554
	(1.920)	(1.827)	(1.831)	(1.831)
Background controls				
Basic	-	+	+	+
Parental education level	-	-	+	+
Stage-specific controls	-	-	-	+
Number of observations	3,097	3,097	3,097	3,097
R-squared	0.047	0.120	0.194	0.197

Notes:
a) Statistical significance at the 1 percent level ***, 5 percent level **, 10 percent level *.
b) Original sample weights are applied and standard errors are estimated using BRR methods.
c) Reported r-squared is the average r-squared from regressions with each of the 5 plausible values of the test score.

Table 8: Using future income to test for borrowing constraints

Dependent variable:	(1)	(2)	(3)
PISA reading score	Coef./	Coef./	Coef./
	Std. Err.	Std. Err.	Std. Err
Income variables			
Family income			
PV of past income	1.440***	1.075**	0.284
	(0.457)	(0.482)	(0.462)
PV of future income	6.683***	5.363***	1.333
	(1.130)	(1.081)	(1.092)
Background controls			
Basic	-	-	+
Parental education level	-	+	+
Number of observations	3,059	3,059	3,059
R-squared	0.050	0.118	0.191

Notes:
a) Statistical significance at the 1 percent level ***, 5 percent level **, 10 percent level *.
b) Original sample weights are applied and standard errors are estimated using BRR methods.
c) Reported r-squared is the average r-squared from regressions with each of the 5 plausible values of the test score.

Table 9: Using slope of income profile to test for borrowing constraints

Dependent variable:	(1)	(2)	(3)
PISA reading score	Coef./	Coef./	Coef./
	Std. Err.	Std. Err.	Std. Err
Income variables			
Family income			
Age 0-15	2.722***	1.919***	0.297
	(0.424)	(0.429)	(0.411)
Slope of family income			
Age 0-15	160.452***	153.783***	80.827**
	(34.064)	(32.460)	(34.146)
Background controls			
Basic	-	+	+
Parental education level	-	-	+
Number of observations	3,097	3,097	3,097
R-squared	0.044	0.118	0.194

Notes:
a) Statistical significance at the 1 percent level ***, 5 percent level **, 10 percent level *.
b) Original sample weights are applied and standard errors are estimated using BRR methods.
c) Reported r-squared is the average r-squared from regressions with each of the 5 plausible values of the test score.

Table 10: Analyzing association of income fluctuations with child achievement

Dependent variable:	(1)	(2)	(3)
PISA reading score	Coef./	Coef./	Coef./
	Std. Err.	Std. Err.	Std. Err
Income variables			
Family income			
Age 0-15	3.062***	2.232***	0.470
	(0.426)	(0.440)	(0.416)
St.d. of family income			
Age 0-15	16.177**	17.164***	6.178
	(6.821)	(6.333)	(6.437)
Background controls			
Basic	-	+	+
Parental education level	-	-	+
Number of observations	3,097	3,097	3,097
R-squared	0.037	0.113	0.192

Notes:
a) Statistical significance at the 1 percent level ***, 5 percent level **, 10 percent level *.
b) Original sample weights are applied and standard errors are estimated using BRR methods.
c) Reported r-squared is the average r-squared from regressions with each of the 5 plausible values of the test score.

Table 11: Descriptive Statistics - 2006 sample

	Mean	Std. Dev.	Min	Max
Explained variables				
PISA science score	498.577	90.169	97.854	829.846
PISA reading score	496.408	86.635	88.485	805.877
PISA math score	515.269	82.362	140.435	810.477
Family income				
Age 0-3	8.069	1.628	3.222	14.661
Age 4-7	7.838	1.576	3.465	16.281
Age 8-11	7.939	1.918	3.819	19.554
Age 12-15	8.196	2.282	3.541	21.884
Age 0-15	32.041	6.364	18.086	63.721
Slope of family income	0.129	0.108	-0.773	1.776
St.d. of family income	0.855	0.490	0.148	6.623
Stage-specific controls				
Single-parent family				
Age 0-3	0.118		0	1
Age 4-7	0.067		0	1
Age 8-11	0.058		0	1
Age 12-15	0.038		0	1
Parental unemployment				
Age 0-3	0.468		0	1
Age 4-7	0.367		0	1
Age 8-11	0.251		0	1
Age 12-15	0.215		0	1
Background controls				
Girl	0.507		0	1
Month of birth (1-12)	6.485	3.351	1	12
Mother's age at birth				
<24	0.118		0	1
>34	0.107		0	1
Father's age at birth				
<24	0.056		0	1
>34	0.237		0	1
Immigrant or immigrant parents	0.036		0	1
Region of residence, 2005				
Zealand	0.402		0	1
Funen	0.086		0	1
Jutland	0.513		0	1
Type of city of residence, 2003				
Urban, larger cities	0.216		0	1
Urban, medium cities	0.244		0	1
Rural	0.539		0	1

Continued on next page

Table 11 – Continued

	Mean	Std. Dev.	Min	Max
Father's education level				
Basic	0.221		0	1
High school	0.048		0	1
Vocational	0.472		0	1
Higher education, short	0.057		0	1
Higher education, medium	0.120		0	1
Higher education, long	0.082		0	1
Mother's education level				
Basic	0.210		0	1
High school	0.055		0	1
Vocational	0.404		0	1
Higher education, short	0.050		0	1
Higher education, medium	0.234		0	1
Higher education, long	0.048		0	1
Number of observations		3,348		

Notes:
a) Original sample weights used.
b) For the science score, the min and max reports the min and max over all 5 plausible values.

Table 12: Outcomes summarized by the timing of family conditions - 2006 sample

		Outcomes											
		PISA science score		PISA reading score		PISA math score		Self-concept in science		Self-confidence in ICT tasks		Science self-efficacy	
		Mean	Std.err.	Mean	Std.err.	Mean	Std.err.	Mean	Std.err.	Mean	Std.err.	Mean	Std.err.
Family income in lowest quartile	Age 0-3	485.712	(4.169)	485.754	(4.056)	502.763	(3.849)	-0.108	(0.035)	0.036	(0.028)	-0.121	(0.042)
	Age 4-7	481.915	(4.823)	479.858	(4.410)	499.829	(4.072)	-0.103	(0.034)	0.055	(0.034)	-0.118	(0.038)
	Age 8-11	475.601	(4.607)	473.202	(4.486)	493.293	(4.165)	-0.117	(0.035)	0.033	(0.034)	-0.176	(0.039)
	Age 12-15	472.847	(4.704)	473.837	(4.383)	490.402	(4.052)	-0.153	(0.041)	0.014	(0.038)	-0.184	(0.041)
	Ever	483.852	(3.363)	483.735	(3.523)	501.336	(2.939)	-0.128	(0.027)	0.022	(0.025)	-0.157	(0.031)
	Never	510.846	(3.877)	506.967	(3.731)	526.878	(3.131)	-0.064	(0.031)	0.002	(0.024)	-0.050	(0.035)
Single-parent family	Age 0-3	487.958	(5.688)	488.392	(4.954)	502.789	(4.748)	-0.243	(0.058)	-0.026	(0.038)	-0.228	(0.045)
	Age 4-7	493.224	(6.101)	487.795	(6.945)	508.152	(5.137)	-0.122	(0.071)	0.108	(0.064)	-0.080	(0.070)
	Age 8-11	498.977	(6.384)	497.442	(5.828)	512.880	(6.839)	-0.150	(0.085)	0.005	(0.067)	-0.138	(0.078)
	Age 12-15	489.340	(9.012)	486.097	(8.455)	508.101	(8.876)	0.134	(0.096)	0.124	(0.092)	-0.038	(0.092)
	Ever	491.682	(3.359)	489.811	(3.439)	506.880	(3.135)	-0.145	(0.043)	0.033	(0.028)	-0.148	(0.041)
	Never	501.279	(3.689)	498.993	(3.833)	518.556	(3.085)	-0.073	(0.022)	0.002	(0.018)	-0.079	(0.029)
Parental unemployment	Age 0-3	489.116	(3.592)	486.576	(3.586)	505.591	(3.027)	-0.129	(0.028)	0.014	(0.023)	-0.120	(0.032)
	Age 4-7	485.555	(3.605)	484.202	(3.821)	502.624	(3.329)	-0.132	(0.029)	0.018	(0.027)	-0.132	(0.031)
	Age 8-11	481.453	(4.195)	480.920	(4.634)	499.140	(3.797)	-0.166	(0.037)	-0.005	(0.034)	-0.179	(0.035)
	Age 12-15	484.997	(4.420)	485.087	(4.409)	501.082	(4.156)	-0.151	(0.043)	-0.005	(0.036)	-0.122	(0.041)
	Ever	490.481	(3.289)	488.279	(3.325)	507.181	(2.867)	-0.120	(0.025)	0.007	(0.020)	-0.121	(0.030)
	Never	510.824	(4.105)	508.704	(4.123)	527.504	(3.434)	-0.053	(0.033)	0.016	(0.024)	-0.063	(0.038)

Notes:
a) High school GPA is only observed for those who complete high school.
b) Placement in income quartiles is made based on discounted family income (unweighted).
c) Original sample weights are used and standard errors are estimated using BRR methods.
d) The self-concept in science, the self-confidence in ICT tasks, and science self-efficacy are measured by PISA indices. These indices have been normalized to have a mean of zero and a standard deviation of one in the entire PISA OECD sample.

Table 13: Income measures summarized by parental education levels - 2006 sample

				Father			
Mother		Basic		Vocational		Higher education	
Basic	Variable	Mean	Std.err.	Mean	Std.err.	Mean	Std.err.
	Age 0-3	7.288	(0.079)	7.741	(0.084)	8.019	(0.246)
	Age 4-7	7.041	(0.071)	7.524	(0.076)	7.688	(0.244)
	Age 8-11	6.763	(0.085)	7.376	(0.095)	8.274	(0.322)
	Age 12-15	6.649	(0.102)	7.452	(0.114)	8.587	(0.377)
	Age 0-15	27.741	(0.286)	30.092	(0.294)	32.568	(0.986)
	Slope	0.086	(0.006)	0.100	(0.006)	0.165	(0.019)
	St.d.	0.617	(0.029)	0.733	(0.026)	1.104	(0.110)
Vocational	Age 0-3	7.672	(0.081)	7.891	(0.050)	8.501	(0.127)
	Age 4-7	7.375	(0.055)	7.618	(0.048)	8.262	(0.128)
	Age 8-11	7.294	(0.062)	7.649	(0.057)	8.616	(0.171)
	Age 12-15	7.345	(0.078)	7.875	(0.086)	9.077	(0.209)
	Age 0-15	29.686	(0.206)	31.034	(0.193)	34.456	(0.564)
	Slope	0.110	(0.004)	0.124	(0.004)	0.149	(0.008)
	St.d.	0.714	(0.020)	0.812	(0.016)	0.993	(0.042)
Higher education	Age 0-3	7.652	(0.133)	8.157	(0.082)	9.051	(0.089)
	Age 4-7	7.447	(0.123)	7.916	(0.073)	8.949	(0.098)
	Age 8-11	7.430	(0.132)	8.312	(0.107)	9.264	(0.106)
	Age 12-15	7.523	(0.172)	8.551	(0.114)	9.958	(0.137)
	Age 0-15	30.052	(0.496)	32.936	(0.311)	37.222	(0.403)
	Slope	0.115	(0.008)	0.142	(0.005)	0.168	(0.005)
	St.d.	0.758	(0.027)	0.957	(0.034)	1.069	(0.025)

Notes:
a) Original sample weights are used and standard errors are estimated using BRR methods.
b) Vocational includes high school educations.

Economics Working Paper

2007-17 Nabanita Datta Gupta and Marianne Simonsen: Non-cognitive Child Outcomes and Universal High Quality Child Care

2007-18 Agne Lauzadyte: Unemployment, Employment and Inactivity in Denmark: An Analysis of Event History Data

2007-19: Christian Dahl Winther: Timing of product introduction in network economies under heterogeneous demand

2008-01: Richard Barnett, Joydeep Bhattacharya and Helle Bunzel: Choosing to keep up with the Joneses

2008-02: Christian Dahl Winther: Popularity and Debut

2008-03: Knud Jørgen Munk: Welfare Effects of Tax and Price Changes Revisited

2008-04: Erich Gundlach and Martin Paldam: A farewell to critical junctures: Sorting out long-run causality of income and democracy

2008-05: Torben M. Andersen and Michael Svarer: The role of workfare in striking a balance between incentives and insurance in the labour market

2008-06: Michael Svarer: Crime and Partnerships

2008-07: Marianne Simonsen and Lars Skipper: The Incidence and Intensity of Formal Lifelong Learning

2008-08: Torben M. Andersen and Allan Sørensen: Globalisation squeezes the public sector - is it so obvious?

2008-09: Kristin Kleinjans: Do Gender Differences in Preferences for Competition Matter for Occupational Expectations?

2008-10: Martin Paldam: Development and foreign debt: The stylized facts 1970-2006

2008-11: Christian Dahl Winther: Brand popularity, endogenous leadership, and product introduction in industries with word of mouth communication

2008-12: Maria Knoth Humlum: Timing of Family Income, Borrowing Constraints and Child Achievement