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Mannheim, 23.07.2009 *Katja Coneus*

Contents

List of Tables

List of Figures

List of Abbreviations

abbr.	Abbreviate
adj.R^2	Adjusted R-squared
ADHD	Attention-Deficit Hyperactivity Disorder
APGAR	Appearance, Pulse, Grimace, Activity and Respiration
BMI	Body mass index
c	Continuous variable
CFT	Culture Fair Test
cm	Centimeter
CMMS	Columbia Mental Maturity Scale
cov	Covariance
CTG	Cardiotokographie
DEM	Deutsche Mark
DIW	Deutsches Institut für Wirtschaftsforschung (German Institute for Economic Research)
DSM	Diagnostic and Statistical Manual of Mental Disorder
ed.	Editor
eds.	Editors
e.g.	Exempli gratia
EPH	Epedema proteineria hypertonia
et al.	Et alii
etc.	Et cetera
F.E.	Fixed Effect

g	Gram
GED	General Educational Development
HOME	Home Observation for Measurement of the Environment
i.e.	Id est
IQ	Intelligence Quotient
ISSP	International Social Survey Programme
ITPA	Illinois Test of Psycholinguistic Abilities
IUGR	Intrauterine Growth Retardation
IV	Instrumental variables
IZA	Institute for the Study of Labor
Kg	Kilogram
KTK	Body coordination test for children
l	liter
LBW	Low birth weight
LR-test	Likelihood Ratio-test
log	Logarithm
LoWER	Low-Wage Employment Research Network
m^2	Square meter
MARS	Mannheim Study of Children at Risk
Max	Maximum
MDI	Mental Developmental Index
MFED	Münchener Funktionale Entwicklungsdiagnostik
Min	Minimum
ml	Milliliter
mmol/l	Millimol per liter
MN	Minnesota
MOT	Test of Motor Abilities
MQ	Motor quotient
N	Numbers (of observations)
NBER	National Bureau of Economic Research
NC	Noncognitive
NHIS	National Health Interview Survey
No.	Number
NV-IQ	Nonverbal Intelligence Quotient
NYLS	New York Longitudinal Study
NYLS79	National Longitudinal Surveys (first survey in 1979)

OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
p.	page
pp.	pages
pH	pondus Hydrogenii
PDI	Psychomotor Developmental Index
PSID	Panel Study of Income Dynamics
ref.	Reference
RWI	Rheinisch-Westfälisches Institut für Wirtschaftsforschung
SOEP	Socio-Economic Panel Study
Std.dev.	Standard deviation
2SLS	Two-Stage Least Squares
TV	Television
U.K.	United Kingdom
U.S.	United States
V-IQ	Verbal Intelligence Quotient
vs.	Versus
WHO	World Health Organization
ZEW	Zentrum für Europäische Wirtschaftsforschung (Centre for European Economic Research)
ZI	Zentralinstitut für seelische Gesundheit

Introduction

It is a well-known fact that human capital plays a central role in modern countries on the macro as well as on the micro level. On the macro level, human capital is one of the most important factors of explaining growth and employment in today's economy. On the micro level, hundreds of empirical studies, mostly embedded in the traditional human capital earning function by Mincer, in many different economics and for different years, confirmed that more educated individuals earn higher wages and have a lower probability of being unemployed (for example Card (1999)). In addition, there is also a large and persistent association between education and non-market outcomes, for example health, reduced crime, family composition, fertility and democracy (e.g. Currie and Stabile (2003), Lochner and Moretti (2004)). Human capital can therefore be considered as one of the top points on the political agenda, for both the growth of modern economies as well as for individual's well-being.

Although several studies have focused on estimating the (causal) relationship of parents human capital and their child's human capital, there is hardly evidence on what is behind the observed strong intergenerational correlation of human capital. The purpose of this thesis is to shed some light inside the black box of transmission of human capital and to disentangle potential channels through which human capital is transmitted from parents to their children. Since differences in skills between children are observed at the very beginning of life, this thesis expands the recent discussion of the economics of education by taking the early childhood education in Germany into account.

Traditional studies from psychologists, neuroscientists and biologists show that the first years are crucial for the development of a variety of skills due the dramatic speed of the brain development (Knudson, Heckman, Cameron, and Shonkoff, 2006). Experiences conducted during the early years can change the biochemistry and the architecture of the neuronal circuits. When environmental influence during the first years of life happened during a limited time window, it is referred to the so-called 'sensitive period'. During this period, the connection among neurons becomes relatively stable; afterwards, it is very difficult to alter the architecture of neuronal circuits (Cameron, 2004). As a results of the plasticity of the brain, some skills are malleable over a longer period in life, some skills reached their pike as early as at the end of childhood.

From an economic point of view, these findings have important implications on how investments in education should be distributed over the life cycle. An optimal investment strategy would be to invest relatively less in human capital when individuals are old and to invest more when individuals are at younger ages (Cunha, Heckman, Lochner, and Masterov, 2006; Heckman, 2000).

This dissertation considers different aspects of early childhood education in Germany. It aims to be an empirical contribution to four different issues in early childhood education: the development of cognitive and noncognitive skills, the intergenerational transmission of a child's health, the institutional child care, and the long-term consequences of early noncognitive skills. This is done by using two data sets: First, we use the mother and child data from the German Socio-economic Panel (SOEP) for the years 2003-2008. It is a representative national longitudinal data set which surveys households and individuals on a yearly basis. The mother and child questionnaire, firstly implemented in 2003, contains detailed information on a child's cognitive and noncognitive skills and health, starting from the time of birth. This information on a child's human capital was assessed by the mothers. Second, we exploit a prospective psychological longitudinal panel study on child development from birth until adulthood, the Mannheim Study of Children at Risk (MARS). These data allow us to use more reliable information on a child's cognitive and noncognitive skills from the age of three months on. However, this study is not representative because children at risk are oversampled.

In chapter 1, 2 and 3, we consider the skill formation process during (early) childhood. The aim of these chapters is to present evidence that skills evolve over the life cycle but to different degrees and at different stages over the first (3) 11 years of life. The empirical analysis of the first chapter is based on a representative data set for Germany (SOEP) and contains detailed information on a child's skills and health until age 3. Empirical analysis of chapter 2 and 3 are based on the Mannheim Study of Children at risk which follows individuals at risk from birth until adulthood (Laucht, 2005). In contrast to the SOEP this data provides detailed psychometric assessments as well as medical and psychological expert ratings for a child's cognitive and noncognitive skills.

The findings suggest that these different types of skills differ in their malleability at different stages. Moreover, the stock of (non)cognitive skills acquired at a previous stage increases (non)cognitive at later stages. Empirical results of chapter 2 and 3 suggest that cognitive skills seem to developed faster than noncognitive skills. For example, cognitive skills tend to peak between eight and eleven years. In contrast, noncognitive skills increase monotonically from birth until late childhood. Finally, parental investments toward the skill development of their children and initial condition play a major role for explaining the gap between children's cognitive and noncognitive skills.

Institutional child care can be regarded as one element of the education and socialization of children. This aspect is addressed in chapter 4. A working woman who becomes a mother has to decide whether or not to return to work and whether or not to use non-parental child care. We provide evidence on the determinants of institutional child care addressing the endogeneity of the mother's labor supply by using an instrumental variable approach. Based on the SOEP, our empirical result suggests that the impact of the mother's labor supply is considerably larger taking the simultaneity decision into account. Thus, parents might regard the use of institutional child care as an investment in education during childhood.

Chapter 5 focuses on the intergenerational transmission of health in early childhood. Recent studies have shed light on the lasting impact of poor infant health on economic as well as on non-economic outcomes. The goal of the study was to investigate how maternal and paternal health and health behavior transmit to a child's health. Based on the SOEP, our results suggest that even if we control for many family background variables and child characteristics, there is still a significant relationship between parental health and health behavior and a child's health during the first six years of life.

In recent years, a number of economic studies have demonstrated the importance of noncognitive skills for school and labor market outcomes. In the last chapter, we address the role of noncognitive skills and asked whether or not they have lasting impacts on a variety of social outcomes in adolescence. Therefore we use the Mannheim Study of Children at Risk. Our fixed effects results suggest that early noncognitive skills are crucial for the development of social outcomes in later life. In particular, the attention span and approach have emerged as dominant factors of noncognitive skills regarding educational performance, health behavior and delinquency.

All in all, the different studies suggest that parental investment (economic resources or non-economic resources) in children explain, at least to some extent, the development of cognitive and noncognitive skills as well as the child's health status. Scope for further research is pointed out, particularly related to long-term consequences of cognitive and noncognitive skills acquired during early childhood. A deeper understanding of how skills developed over the life cycle promises to enrich the economic theory and helps to understand the sources as well as the solutions for inequality.

1 Self-Productivity in Early Childhood

Abstract:[1] Self-productivity is a crucial feature in the process of skill formation. It means that skills developed in previous stages enhance the development of skills during later stages. This paper presents an empirical investigation of self-productivity in early childhood in Germany. The data are drawn from the mother-child questionnaire of the German Socio-Economic Panel for the birth cohorts 2002-2007. The magnitude of self-productivity varies between skills and stages. In particular, the effect of skills acquired in the first stage on skills acquired at the second stage varies between 0.08 and 0.19 standard deviations, while the effect of skills developed at the second stage on skills developed on the third stage varies between 0.08 and 0.49. Our family fixed effects estimates support the hypothesis of the importance of self-productivity during early childhood.

Keywords: self-productivity, early childhood, skill formation, birth outcomes
JEL-classification: I20, J13, J24

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[1]This chapter mainly based on the ZEW discussion paper version No. 053-2007.

1.1 Introduction to Chapter 1

The development of cognitive skills (memory, learning skills, information speed, verbal skills) and noncognitive skills (motivation, self-esteem, persistence, risk preference) is a cumulative process which starts during the prenatal period and extends throughout the early childhood years. The early childhood years, including the first three years of life, are crucial for the development of skills because of the dramatic speed of brain development. Some of the most formative aspects of brain development occur prenatally, when brain growth is supported by good maternal nutrition but can be undermined by maternal exposure, or unhealthy behavior (Nelson, Haan, and Thomas, 2006). This implies that inequality in skill development already reveals itself at birth.

The brain architecture develops in the first years of childhood and these developmental processes are substantially completed within the first five years of life (Knudson et al., 2006). This implies that the development of more advanced capabilities is based on the quality of the child's early development. Throughout the entire life, the development of more advanced skills depends on basic skills developed during earlier stages. In sum, the development of these basic competencies is directly linked to the degree of school readiness and the acquisition of adult skills that are important for success (Shonkoff and Phillips, 2000).

There has been a long debate about whether skill development can mainly be attributed to heredity or to parental investments. Evidence from neuroscience clearly shows that both factors are essential. Genes determine the general shape of the brain and determine how it reacts to parental investments and the environment parents choose. Additionally, parental investments are important for the connections of the synaptic. Although cognitive skills, often proxied with IQ, are less malleable over the life cycle than noncognitive skills (Blomeyer, Coneus, Laucht, and Pfeiffer, 2009), the stock of both types of skills is built in early childhood (Heckman, 2007). Hence, because families decide about the type and degree of parental investments as well as the environment in which children grow up, the role of the family is of key importance to a child's skill formation.

In recent years, a growing economic literature has focused on the importance of the early years for economic and non-economic outcomes in adolescence and adulthood. The studies of Almond, Chay, and Lee (2005), Oreopoulos, Stabile, Walld, and Roos (2008) or

Black, Devereux, and Salvanes (2007) for example, investigate the long-term consequences of poor infant health at birth. Oreopoulos et al. (2008) analyse the effects of birth outcomes (birth weight, APGAR, gestational age) on subsequent health, education and labor market outcomes using sibling and twin models to account for unobserved heterogeneity across families. They find that in both samples poor infant health at birth also increases the probability of mortality within one year and at the age of 17. Moreover, the results indicate that children born without risk at birth show greater human capital formation and participate less in welfare programs.

A second strand of literature focuses on the cost-benefit analysis of early childhood interventions, in particular for children from disadvantaged families (Heckman and Masterov, 2007). Educational policy often faces an equity-efficiency tradeoff. For the U.S. there is evidence showing that post-school intervention such as public job training and the General Educational Development (GED) Program yield low returns. To the contrary, findings from early intervention programs for example, the Perry Preschool program and the Chicago program attain benefit-to-cost ratios of 9.11 and 7.77 respectively. The positive cost-benefit ratio for participants from disadvantaged families results from higher achievement test scores, less time to invest in special education and lower crime rates.

In this paper we empirically investigate the development of skills from birth until the age of three years. In particular, we focus on the effects of skills developed in one stage for the development of skills at later stages, which is known as self-productivity (Cunha et al., 2006). Self-productivity is an essential feature in the process of skill formation, which postulates that skills acquired at one stage enhance the formation of skills at later stages (Cunha et al., 2006). Our paper focuses explicitly on the empirical importance of self-productivity during the first three years of life.

Using the German Socio-Economic Panel (SOEP) for the birth cohorts 2002-2007, we empirically investigate self-productivity in early childhood. Our contribution to the empirical literature on self-productivity (Cunha and Heckman, 2008, 2007) in early childhood is threefold: First, based on the technology of skill formation, we estimate the impact of self-productivity during the first three years of a child's life. For this purpose we use various skill measures at different stages in early childhood. At birth, we use birth weight and fetal growth (birth weight divided by gestational age) as first skill measures. When children are between 4-19 months old, we observe noncognitive skills. These consist of five different aspects of a child's temperament. At the end of early childhood, we observe verbal, motor, social, everyday skills as well as noncognitive skills of the 2-3 years old. For each skill observed in the study, mothers were asked to rate their child's abilities.

Second, we analyse the effect of parental 'investments' on a child's skills at birth, at the age of 4-19 months and at the age of 26-47 months. The data provides information regarding maternal health and health behavior during and after pregnancy, the father's support, parental activities, child care information as well as various family background variables such as education, family composition and migration.

Finally, using family fixed effects models, we explicitly account for the endogeneity of the skills developed at earlier stages. The stock of skills acquired at previous stages is likely to be endogenous, because these skills are affected in part by parental investments and unobserved endowments of the child. Hence, introducing family background variables and parental investment in the OLS estimation at each stage should eliminate the most obvious source of endogeneity. Moreover, we obtain additional evidence on self-productivity at a constant family background by analysing sibling models.

Our empirical findings provide evidence of self-productivity during early childhood. While the effect differs somewhat between stages and models, we find that having high skills at earlier stages increases a child's skills at subsequent stages. For the 4-19 months old, the effect of a birth weight that is one standard deviation higher on the child's noncognitive skills in subsequent stages ranges between 0.09 (OLS) and 0.19 (F.E.) standard deviations. For the same age-cohorts, the average effect of an increase of fetal growth by one standard deviation at birth on the child's noncognitive skills lies between 0.08 in the cross-section model and 0.19 in the family fixed effects model.

A one standard deviation increase of a child's noncognitive skills acquired at the second stage on a child's skills acquired at the third stage lie between 0.08 (verbal) and 0.32 (noncognitive) standard deviations in the cross-section models and between 0.23 (verbal) and 0.49 (noncognitive) standard deviations in the family fixed effects model. Our sibling estimates support the hypothesis that skills produced at previous stages foster the production of skills at subsequent stages in early childhood.

The rest of the chapter is organized as follows. In section 1.2, we introduce the technology of skill formation and the concept of self-productivity. Section 1.3 describes the sample and the descriptive statistics, based on the SOEP for the birth cohorts 2002-2007. Section 1.4 presents the empirical strategy and discusses the results. Section 1.5 concludes.

1.2 The technology of skill formation

It is well-documented that individuals have different skills and that substantial gaps between skills already manifest themselves before children enter school. In accordance with Cunha and Heckman (2007), our empirical investigation is based on a simple economic model of skill formation.[2] A large number of studies document the importance of the early childhood for the development of various skills over the life cycle. Thus, we model the technology of skill formation with multiple stages in early childhood. Each stage corresponds to a period in early childhood. We investigate a child's skill development at birth, at the age of 4-19 months and at the age of 26-47 months.

In accordance with the technology of skill formation, it is assumed that current skills result from skills produced at previous stages as well as from current investments. Equation 1.1 presents the skill production function, where $S_t = (S_t^C, S_t^N)$ denotes the level of skills (cognitive and noncognitive) acquired at stage t, $S_{t-1} = (S_{t-1}^C, S_{t-1}^N)$ denotes the level of skills (cognitive and noncognitive) acquired at the stage before $t-1$ and $I_t = (I_t^C, I_t^N)$ denotes the vector of parental investments at stage t. At all three stages $t = 1, 2, 3$ we observe how skills develop during early childhood.

$$S_t = f_t\left(S_{t-1}, I_t\right). \tag{1.1}$$

Parental investments can be different at all three stages of early childhood. They can be stage-specific or more general. The former category implies that the timing of investments plays an important role (e.g. healthy behavior of the mother during pregnancy when we observe birth outcomes), while the latter relates to rather time-invariant investments of the parents, such as their education or the economic resources of the family. For example,

[2]This technology of skill formation is based on an extension of the Ben-Porath model on investment over life cycle (Ben-Porath, 1967). Unlike in the Ben-Porath model, different types of investments, skills and technologies are allowed for each stage (Cunha and Heckman, 2007).

Chevalier and O'Sullivan (2007) find, in line with Currie and Moretti (2003), that one additional year of maternal education increases on average birth weight by 70 grams. Higher returns to education are identified for mothers at the lower end of the educational range.

Central to our analysis is the concept of self-productivity (Cunha et al., 2006). Self-productivity means that skills produced at one stage foster the development of skills at later stages (see equation 1.2).

$$\frac{\partial S_t}{\partial S_{t-1}} = \frac{\partial f_t\left(S_{t-1}, I_t\right)}{\partial S_{t-1}} > 0 \quad t = 1, 2, 3 \tag{1.2}$$

Self-productivity may differ between different types of skills and at different stages of early childhood. The concept implies the idea that skills produced in the past are relevant for skills at later periods. Thus, a higher stock of skills produced in the stage before increases the stock of skills in subsequent stages. Self-productivity applies to both cognitive and noncognitive skills. Moreover, the vector $S_t = (S_t^C, S_t^N)$ consists of both types of skills, cognitive as well as noncognitive. Thus self-productivity also implies that the stock of cognitive skills produced in previous stages can increase the stock of current noncognitive skills and vice versa (Cunha et al., 2006).

We empirically investigate the concept of self-productivity between birth and the age of 4-19 months, as well as between the age of 4-19 months and 26-47 months. The following sections introduce the data and empirically investigate the concept of self-productivity in early childhood.

1.3 The data set and descriptive statistics

1.3.1 Data

The German Socio-Economic Panel (SOEP) is a representative annual national longitudinal data set which surveys households and individuals beginning in 1984 (Wagner, Frick, and Schupp, 2007). Since 2003, detailed information on the birth of children have been integrated into the SOEP by an extra 'Mother-Child' questionnaire. It provides an informative data base with a rich set of children's cognitive and noncognitive skill measures at several stages in early childhood.

This questionnaire is addressed to all mothers who gave birth to a child in the current survey year or in the year before. Thus, the age of the child varies between 0 and 19 months. We obtain data on newborns for the birth cohorts 2002 to 2007, among them we can identify which are siblings. The sample of newborns amounts to 1066 children, among them are about 460 siblings. The second sample of children between 4 and 19 months consists of more than 900 (400) children (siblings) and is a subsample of the newborn (sibling) sample. For the newborns we observe detailed information about the mother's pregnancy, birth outcomes and a child's noncognitive skills after birth.

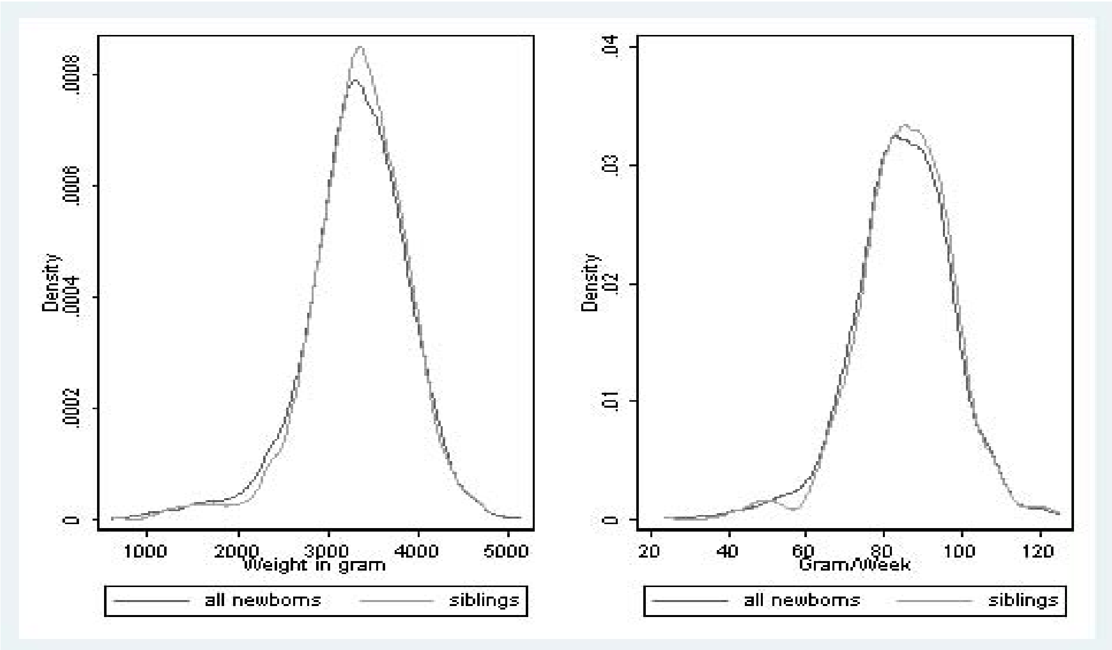
In the year 2005, the second 'Mother-Child' questionnaire for 2-3 year old children was introduced. Hence, children (siblings) born between 2002 - 2004 have been repeatedly observed in 2005 - 2007. Excluding missing observations, the third sample contains more than 600 children and more than 260 siblings. This 'Mother-Child questionnaire' includes detailed information about maternal assessments of various cognitive and noncognitive skills of the 26-47 months old, as well as information about parental experiences and investments in their child.

1.3.2 Skill measurement and investment

Tables A.5 and A.6 report descriptive statistics for all mothers with children born between 2002 and 2007. It contains means and standard deviations of all relevant variables used in the estimation for the pooled sample as well as for the sibling sample. All child-related information at different stages in childhood are derived from the two mother-child questionnaires, while information about the mothers are derived from the personal questionnaire.

Our two 'skill' measures at birth are the child's birth weight in grams and fetal growth (birth weight in grams divided by gestational age). We use both birth outcomes, although both are highly correlated (0.55), to disentangle factors that affect weight at birth through a shorter gestational age from factors influencing the growth of the fetus at given gestation length, which is known as intrauterine growth retardation (IUGR). The distribution of both birth outcomes for all newborns and for siblings are presented in Figure 1.1. The birth outcome distributions are very similar. Tables A.5 and A.6 confirm the similarity in birth outcomes across both samples and across stages in early childhood. For instance, the mean of birth weight is about 3300 gram for newborns and is close to the average birth weight found in the existing literature related to birth outcomes (for example Almond et al. (2005), Black et al. (2007) or Reichman (2005)).

Figure 1.1: The distribution of birth outcomes



Source: SOEP 2003-2007. Own calculations.

The mothers were asked about five aspects of their child's temperament at the age of 4-19 (26-47) months (for a detailed description of these items see Table A.1). They could specify on a Likert Scale to what extent the statements apply: 'applies fully', 'applies more', 'applies less' and 'does not apply'. In our analysis we use the maternal assessment of a child's temperament as measure of a child's noncognitive skills. We sum all five items to obtain a unidimensional scale for a child's noncognitive skill at the second and third stage. The scale ranges between 5 to 20 at both ages.[3] A high score indicates strong noncognitive skills, while a low score indicates weak noncognitive skills. The average noncognitive skill level lies on the upper bound of the skill distribution in the second (18.07) as well as in the third stage (17.64).

[3] In order to compare skill development between stages, we standardized noncognitive skills at the second and at the third stage by mean 0 and standard deviation of 1.

Besides a child's noncognitive skills at the age of 26-47 months, we observe four stage-specific outcomes (verbal, motor, social, everyday skills). These outcomes based on the German Vineland scale (Sparrow, Balla, and Cicchetti, 1984) and have been developed and used by researchers studying child development.[4] For each of the four skills, mothers were asked to rate their child's ability to perform each of five tasks as either 'yes', 'to some extent', or 'no'. 'Yes' was scored as three points, 'to some extent' was scored as two points, and 'no' was scored as one point. Scores were summed across the five tasks to create an index ranging from 5 to 15. Moreover, we calculate a total score, which is the sum of all four skill dimensions.[5] A small value of the index indicates a low level of developmental functioning in one of these skills, a high value indicates a good level of developmental functioning. For a detailed description of all items see Table A.2. While the level of skills varies between verbal, motor, social and everyday skills, there is no variation across samples. The average level of a child's verbal and social skills is more than two points higher than the average value of a child's everyday skills. One possible reason for this might be the early development of verbal skills which again influence social skills. Children begin to speak between 10 and 18 months. When they are 18 months old, children have a vocabulary tool of more than 50 words (Tracy, 2000). Furthermore, the acquisition of verbal skills is also possible for children whose other cognitive skills are limited (Grimm, 1999; Laucht, 2005).

Tables A.5 and A.6 lists 'investments' and controls for all three stages observed in this study. We use the term 'investments' in accordance to the technology of skill formation presented in the previous section 1.2. Investments at the first stage, which are likely to be correlated with our birth outcomes are maternal education ('no degree', 'vocational degree' or 'university degree'), age, health (current health status), Body mass index (BMI = weight in kg/height^2), fetal environment (a very good mental and physical state three months before birth), whether the mother smoked during pregnancy and a migration dummy (German nationality). Studies related to low birth weight (LBW) tend to point out that an important factor for LBW is tobacco use during pregnancy. In our data, every fifth mother smoked at any point of time during pregnancy. In all regressions we control for a child's sex, for twins and whether the child is firstborn.

[4]Cawley and Spiess (2008) use these measures to explore the link between childhood obesity and the developmental functioning at younger ages.

[5]For our regression analysis, we standardize verbal, motor, social, everyday skills and the total Vineland scale by mean 0 and standard deviation of 1.

At the second stage, we observe those parental investments in our data which tend to have a direct impact on a child's noncognitive skills at this stage. For example, differences in noncognitive skills might arise because of the home environment, including a strong support of the father and the post-fetal environment of the mother, which might partly reflect the quality of maternal investments. At the second stage, we control for a child's age and a child's disorders. In our data, about 8% of the children have any kind of disorders, such as motor impairments (see Tables A.3, A.5 and A.6).

Table A.4 lists stage-specific investments associated with our skill outcomes at the third stage. We create a stage-specific investment of the parents called 'parental activity', which is based on nine questions derived from the mother- child questionnaire of the 2-3 years old. The mothers were asked how often (in days) they sing, watch TV, go to the playground and do some other activities with their child.[6] Mothers replied how frequently each investment had been undertaken in the past weeks (1 =never, 4 =everyday). The sum of these nine questions provides a total score of parental activities. The scale of parental activities ranges from 9-36, with an average value of 29.55 (29.71) in the newborn (sibling) sample. The share of mothers who are not employed is somewhat higher in the sibling sample, while the percentage of children who attend institutional child care at least for some hours per week is similar in both samples. The main difference across stages is that the share of children with any kind of disorder increases from 8% to more than 45%.[7] It is important to note that at the third stage a child's disorders also includes certain types of diseases/illness such as asthma or bronchitis.

1.4 Econometric analysis

1.4.1 Estimation strategy

In the literature on skill formation, skill outcomes are considered as a function of skills acquired at previous stages (cognitive and noncognitive) and current parental investments. The major advantage of our data set is that it contains measures of cognitive and noncognitive skills from early childhood on. Our data include a rich set of mother characteristics during and after pregnancy, as well as family characteristics during the first three years of

[6] Watching television or video together with their parents might have a positive impact if parents choose appropriate telecasts or videos for their children.

[7] For a detailed description of both health measures see Table A.3.

a child's skill development.

In all three stages during early childhood, starting at birth, we model the formation of skills as a linear function of skills produced one stage before and current parental investments. For all stages, we first estimate OLS models for the pooled sample, which contain all birth cohorts, and for the sibling sample. Then we attempt to take into account that skills acquired at previous stages might be endogenous through family fixed effects models for siblings. The source of endogeneity for skills acquired one stage before is because of omitted variables.

Both, cognitive and noncognitive skills can be considered as endogenous because they are determined to some extent by the parents' skills and other unobservable environmental factors. The relationship between observed skills and unobserved factors such as genetic endowment or early home environment is much stronger in early childhood than at later stages in life.

Estimating simple OLS models does not enable to account for endogeneity of skills since variables of parental behavior and their motivation to foster the child's skill formation, for example, or variables of the genetic endowment are unobservable. However, controlling for the family background, the mother's investment and the child's characteristics should eliminate at least the most obvious sources of endogeneity. More direct evidence on the effect of early skills on later skills with a constant family background is obtained by estimating panel models with siblings. In these models, we exploit the variation between siblings within families to identify the self-productivity effect.

All regressions presented below are only based on observations of the newborns and (or) of the 2-3 year olds whose mothers fulfilled at least one of these questionnaires. We consider birth weight and fetal growth as the dependent variables at the first stage, child's noncognitive skills at the second stage, and a child's noncognitive, verbal, motor, social and everyday skills at the third stage. Taking into account that skill levels within families are not independent from each other, we cluster the standard errors in all cross-section models at the family level. With this clustering, we allow for serial correlation within a cluster but we do not allow for serial correlation between clusters. So far, data are limited to children up to age 3.

1.4.2 Birth outcome estimation

Our basic estimation equation for all three stages is a linear representation of the skill production function described in section 1.2. S_{it}^k denotes the skill indicator in t, S_{it-1}^k denotes skills k acquired in a previous period and I_{jit} denotes parental investments. Especially the fact whether the mother smoked during pregnancy can be regarded as an (adverse) investment during the first stage. At birth, two different outcomes k are investigated: birth weight (in gram) and fetal growth (birth weight in gram/gestation week).

$$S_{it}^k = \alpha + \beta S_{it-1}^k + I_{jit}'\lambda + X_{jit}'\phi + C_{it}'\gamma + u_{it} \tag{1.3}$$

In Table A.7, we add control variables to reduce unobserved heterogeneity. X_{jit} is a vector of 'parental investments' in t and C_{it} denotes the child's characteristics in t. At the first stage, we add a dummy for maternal well-being during the last three months of pregnancy, which can be considered as a proxy for the fetal environment of the child. The dummy takes the value 1 if mothers assess their mental and physical state three months before birth as 'very good' and 0 otherwise. Moreover, we include three categories for the mother's education, a dummy when the mother is German, the mother's age and age squared as well as the BMI of the mother. All these variables refer to any point in time during pregnancy.[8]

Our main parameter of interest throughout the paper is β. To identify a causal relationship, we study the skill level of siblings ($i \in \{1, 2, 3, 4, 5\}$) in family j at all three stages t using family fixed effects models.[9]

$$S_{ijt}^k = family_j + \beta S_{ijt-1}^k + I_{jit}'\lambda + C_{ijt}'\gamma + u_{ijt} \tag{1.4}$$

If siblings are equally affected by the family background $family_j$ and there is no heterogeneity in skill effects β, the model will recover an asymptotically unbiased estimate under suitable assumptions about the distribution of $family_i$. For identical twins, who share the same genetic endowment, the assumption of identical family effects can be considered as most appropriate. We do not observe identical twins in our data but siblings whose genetic endowments are different, but correlated, and whose conditions of family live are

[8] As mentioned before, in all cross-section models we adjust standard errors at the family level.

[9] Therefor we exploit variations in skill levels between siblings.

correlated. However, by using siblings we are able to use a more representative sample of children, although there is the risk that our sibling estimates are biased due to the potential change in family characteristics between births.

For each birth outcome, we estimate three different models: OLS using the pooled newborn sample; OLS using the sibling sample; and family F.E. models using the sibling sample (see Table A.7). In line with the previous literature, we observe that maternal smoking during pregnancy reduces the birth weight on average by 170 gram and by more than 300 grams in the F.E. estimates. The negative impact of smoking on fetal growth is more than twice as large in the family fixed effects estimates compared to the pooled cross-section estimation.

The mother's BMI and a good fetal environment have a significantly positive influence on birth weight in the OLS models while no such impact can be observed in the F.E. models. When we control for mother's education, we find in line with Currie and Moretti (2003); Chevalier and O'Sullivan (2007); Black et al. (2007) that higher educated mothers have significantly healthier children at birth. Note that the difference in birth outcomes between mothers having only a vocational degree or having a university degree are rather small, while the difference between mothers without any school degree and a vocational or a university degree is at least 150 grams. The influence of maternal education is also significant when we observe fetal growth. Further, we find a significant nonlinear age effect in the pooled newborn sample. The older the mother is at birth the lower is the birth weight and fetal growth. This effect decreases with mother's age.[10]

As shown at the bottom of Table A.7, we find significant differences in birth outcomes regarding gender, twins and birth order for most of the models. Finally, we control for differences between birth cohorts and birth months. None of the presented models show significant differences in birth outcomes depending on the year or month of birth.[11] In accordance with Tamm (2005), we include different variants of the income in the regression and find no significant effects in our birth outcome estimates.

[10]In our data, the within variation of mother's education, age and nationality is quite small among siblings, thus we do not include both variables in the F.E. models.

[11]Hence, we do not include these dummies in our models.

1.4.3 Self-productivity between birth and 4-19 months

We analyse the formation of noncognitive skills using equation 1.3 and equation 1.4 when children are between 4 and 19 months old (see Appendix Table A.8). Our main parameter of interest is β, which indicates how skills acquired at birth are associated with the development of current noncognitive skills. We estimate two variants of both equations using birth weight and fetal growth as first skill indicators in the skill production function at the second stage. In accordance to the first stage, we estimate three different models: OLS using the pooled sample of all 4-19 months old; OLS using the sibling sample of all 4-19 months old; and family F.E. models using the sibling sample of all 4-19 months old. For the purpose of comparison, we standardize birth weight, fetal growth and noncognitive skills into mean 0 and standard deviation of 1. Standard errors are clustered at the family level for all cross-section models.

We consider the strong paternal support and the post-fetal environment of the mother as a measure for parental investments. While the former is a dummy variable indicating whether the father strongly supports the mother in the upbringing of their child, the latter reflects the mental and physical state of the mother three months after birth. If both, mental and physical health were assessed as very good, the dummy variable takes the value 1 and 0 otherwise. In line with the regression models presented in the previous section, we add three categories for the mother's education (omitted category = 'no degree') and the mother's nationality in both cross-section samples.

In each model, we also control for the child's characteristics: gender, whether it is a twin, whether it is first born, age and health. During this stage, age and health of the child might be important determinants of noncognitive skills. For this we distinguished between three age groups: age group 1 contains children between 4 and 9 months, age group 2 refers to children between 10 and 14 months and the baseline category is age group 3, which contains children older than 14 months. In addition, we include a dummy variable indicating whether the child has any kind of disorder at birth.

Our results in Table Appendix A.8 indicate that both birth weight and fetal growth have a significant effect on a child's noncognitive skills at this stage for both samples, newborns and siblings. Using OLS, the effect is slightly higher in the sibling sample compared to the pooled sample, while family fixed effects results indicate a much stronger effect of previous skills on current noncognitive skills between siblings. β is nearly twice as large in the siblings estimation. In terms of birth weight, the order of magnitude of the effect ranges from 0.09 to 0.19 standard deviations. A good performance at birth ceteris paribus increases a child's noncognitive skills one stage later in early childhood. This is in line with previous findings of follow-up studies of children born with poor birth outcomes, particulary with LBW, who have lower scores on a variety of cognitive and social abilities (Brooks-Gunn, Klebanov, and Duncan, 1996).

'Investment' also matters. A strong support by the father and a good post fetal environment of the mother fosters the formation of a child's noncognitive skills at this stage. These findings suggest that more attention should be paid to the quality of early parent-child interaction. However, for the family fixed effects models we do not observe an effect of these parental investment on a child's noncognitive skills. This finding might result from the fact that there is no major change in parental investment between siblings, neither for the father's support nor for the post-fetal environment of the mother. Thus, in our data we cannot identify an impact of investments on skills in these models (see Appendix Table A.8).

Girls seem to have higher noncognitive skills than boys in the pooled OLS models, while we find no gender differences for noncognitive skills across siblings. Noncognitive skills are less pronounced for the 4-9 months old compared to children older than 14 months, while differences between age group 1 and age group 2 are not significant.

1.4.4 Self-productivity between 4-19 months and 26-47 months

We finish our empirical analysis by considering how noncognitive skills acquired at the second stage are related to noncognitive skills, the Vineland developmental scale, verbal, motor, social and everyday skills at the age of 26-47 months (see Appendix Tables A.9 - A.11). We introduce measures for investments (parental activity, a dummy for institutional child care), family characteristics (mother's education, nationality, employment) and child characteristics (gender, twins, firstborn, age and health) in equation 1.3 and 1.4. Estimation results are presented for six different skills for three models: pooled OLS model, OLS models for siblings and family fixed effects models for siblings, respectively. In all cross-section models, we cluster standard errors at the family level. All skills at the second and at the third stage and the variable 'parental activity' are standardized at mean

0 and standard deviation 1.

The average effect of past noncognitive skills on current noncognitive skills and the Vineland skill is positive (Table A.9). While the results differ somewhat with regard to skills and models, we find that having a one standard deviation higher noncognitive skills at the second stage increases noncognitive skills and Vineland skills by 0.32 to 0.10 standard deviations, on average. For both skills, we observe that the effect of self-productivity is stronger in the sibling samples, while the effect is slightly higher between siblings within families compared to siblings across families.

In Table A.10, the results on self-productivity indicate that a measure of noncognitive skills at the second stage that is by one standard deviation higher increases the measures of motor skills by 0.09 to 0.45 standard deviations, on average. The effect is much stronger for motor skills compared to verbal, social or everyday skills for both OLS estimates as well as in the family fixed effects estimates.[12] During this stage, noncognitive skills acquired at previous stages seem to play an important role for the development of current skills (see Appendix Tables A.9 - A.11). The higher the stock of past noncognitive skills ceteris paribus the higher is the stock of both cognitive and noncognitive skills at this stage.

Parental activity has a significant effect on all cognitive and noncognitive skills at this stage, and the magnitude of the effect differs only slightly among skills and models. An increase in the parental activities by one standard deviation corresponds to an increase in a child's skills between 0.18 (motor skills) and 0.23 (verbal skill), on average. The more frequent and the more diverse parental activities are, the higher are the current cognitive and noncognitive skills of the child. In most of our models, parental activities seem to be more important for explaining differences in skill development than past noncognitive skills. Since the mother's decision to work after child birth is often a simultaneous decision by attending institutional child care, we include both decisions into our regression model. Attending institutional child care between 26 and 47 months is positively related to higher verbal, social and everyday skills. In our data, the family income seems to have no significant influence on the child's skill development, at least until the age of three years.[13]

[12]Because of the small sample size in the family fixed effects models, the estimation results are less precise.

[13]The results are not reported here, but available from the authors upon request.

Girls seem to have significantly higher verbal skills as well as higher noncognitive, social and everyday skills at least in one of the three model specifications (see Appendix Tables A.9 - A.11). In line with our previous findings, only the youngest age group (26-31 months) has significantly lower skills, while skill differences between the middle (32-37) against the highest (38-47 months) age group are insignificant. Controlling for child health indicates that children with at least one disorder have significantly lower verbal and noncognitive skills.

1.5 Conclusion of Chapter 1

In this paper, we have investigated the formation of skills in the first three years of life, a period in which a variety of skills are developed. Our findings, which are based on the SOEP, indicate that skills developed at a previous stage foster the development of skills at subsequent stages. In the OLS estimates we find a pronounced effect of previous skills between the second and the third stage of a child's life during early childhood. The effect is called self-productivity. In family fixed effects models, we find empirical evidence for self-productivity, taking into account that unobserved factors might influence both the previous stock of a child's skills and the current stock. In the OLS estimations for both the newborn and the sibling sample, the effect of birth outcomes on noncognitive skills at the second stage lies between 0.08 (newborn) and 0.10 (siblings) standard deviations. Comparing OLS and family fixed effects models, these two methods yield effects that concentrate in the range between 0.08 to 0.19 standard deviations. If we account for unobserved family effects within siblings, the magnitude of self-productivity is nearly twice as large compared to the cross-section models for siblings. This means that good birth outcomes in terms of weight and fetal growth increases a child's noncognitive skills at the second stage.

For all model specifications, we find a significant effect of noncognitive skills at the age of 4-19 months on verbal, motor, social and noncognitive skills at the age of 26-47 months. The average effects of a child's noncognitive skills produced at the second stage on a child's skills attained at the third stage lie between 0.08 (verbal) and 0.32 (noncognitive) standard deviations in the pooled cross-section models, between 0.09 (everyday) and 0.45 (noncognitive) in the sibling sample and between 0.23 (verbal) and 0.49 (noncognitive) standard deviations in the family fixed effects estimates. Our results reveal the essential effect of skills developed at previous stages on the successful development of skills in later stages of life for children in Germany.

The empirical analysis of the skill formation process from early childhood until adulthood of children in Germany is still hampered by a lack of data. The measurement of cognitive and noncognitive skills, for instance intelligence and motivation, at different developmental stages over the life cycle is costly and may nevertheless remain ambivalent, in particular for young and very young children. Collecting data for skills over the life cycle together with the main skill formation factors (investments by parents, school, peer groups etc.) is a task of intensive ongoing research. Given the importance of self-productivity in early childhood and its long-run multiplier effects on human capital accumulation, quantitative knowledge on its magnitude is a prerequisite for the formulation of compensational policies. With further data becoming available it should be possible to extend the analysis to larger samples and older cohorts.

Our findings, along with a growing body of literature in this research area, confirm the importance of the first years of life regarding a child's skill formation process. Differences in birth outcomes are related to differences in a child's noncognitive and cognitive skill measures. Understanding the mechanisms behind the skill formation process is helpful for improving a child's human capital formation over the life cycle.

2 Early Life Adversity, Home Environment and Children's Competence Development

Abstract:[1] This paper investigates the role of early life adversity and home resources in terms of competence formation from infancy to adolescence. We study complementarity factors between cognitive, motor and noncognitive abilities and social as well as academic competencies, and discuss alternative educational policies to improve competence development. Our data are taken from the Mannheim Study of Children at Risk, an epidemiological cohort study following the long-term outcome of early risk factors. Results indicate that organic and psychosocial initial risks are important for the development of competencies, as well as socio-emotional home resources in childhood and economic resources during the transition to higher secondary school track. Abilities acquired in early childhood predict achievement at school age. There is a remarkable stability in the inequality of economic and socio-emotional home resources. This is presumably a major reason for the evolution of inequality in competence development from birth to adolescence.

Keywords: organic and psychosocial risks, socio-emotional and economic home resources, intelligence, persistence, peer relationship, school achievement

JEL-classification: D87, I12, I21, J13

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2.1 Introduction to Chapter 2

This paper contributes to the recent multidisciplinary literature on human development and inequality (Heckman, 2007, 2000). Starting with conception, deep-seated skills are formed in a dynamic interactive process between adult caregivers and children. Research based on only a subset of relevant factors may contain some bias. The relationship between early childhood risks (both organic and psychosocial in nature), ongoing parental investments and competence development is analyzed in order to gain an understanding of the childhood skill multiplier.

We examine the relationship between initial organic and psychosocial conditions, socio-emotional and economic home resources and the formation of basic abilities during development and of competencies in social and academic life. Stage-specific parameters of the technology of skill formation (Cunha and Heckman, 2007, 2009) are assessed together with complementarities between basic abilities in childhood and social and educational achievement at school age. Reversed causality between parental child-rearing and ability formation is taken into account. Having a child with low cognitive (or noncognitive) abilities is likely to increase parental investment (home resources) in order to boost development and vice versa. Our study is based on unique data from a developmental psychological approach. The data provide detailed measurements of initial risk conditions, parental stimulation and responsiveness and child outcome.[2] Psychometric assessments were conducted for cognitive, motor and noncognitive abilities during infancy, toddlerhood, preschool age, primary school age and secondary school age, representing significant stages of development.

Our findings demonstrate that interpersonal differences in cognitive, motor and noncognitive abilities are consistently associated with early life adversity and socio-emotional home resources, with the relationship being age- and ability-specific. The findings are in line with the literature on the childhood skill multiplier for lifelong competence formation summarized by Heckman (2007). Children are exposed to a matrix of organic and psychosocial risks, and each factor by itself contributes to their development as well as the sum of all factors. During childhood, the inequality of socio-emotional home resources is a major reason for the further evolution of inequality. The quality of parental stimulation

[2]The data are taken from the Mannheim Study of Children at Risk (abbr. MARS, which has been derived from the German title: MAnnheimer Risikokinder Studie), an epidemiological cohort study that follows children from birth to adulthood (Laucht, Esser, and Schmidt, 1997, 2004).

and responsiveness (home resources) is important for competencies in stage-specific ways. Preschool factors have significant consequences for school achievement.

Our measure of noncognitive abilities, persistence, is significantly related to socio-emotional home resources throughout the early life course. The highest association is observed during preschool and elementary school years (the ages of 4.5 and 8 years). Cognitive abilities, measured by the IQ, are strongly related to socio-emotional home resources during preschool age and only weakly during school age. The influence of socio-emotional home resources declines continuously with age, being highest during infancy. Interestingly, the relationship between socio-emotional home resources and motor abilities, measured with the MQ, is positive, albeit of lower magnitude and not statistically significant. Interindividual differences in the MQ are already primarily determined by the initial organic risk conditions. There is strong evidence for synergies in the development of abilities. Higher cognitive and motor abilities are helpful for the development of higher noncognitive abilities, and higher motor and noncognitive abilities are helpful for the development of higher cognitive abilities (see e.g. Cunha et al. (2006)).

Moreover, it has been demonstrated that abilities at preschool age predict social competencies and school grades at the age of 8. Children with higher cognitive, motor and noncognitive abilities at preschool age have more satisfying peer relationships, interests and better grades in math, reading and spelling at primary school age. Higher cognitive, motor and noncognitive abilities at primary school age predict a higher-track secondary school attendance in Germany, starting at the age of ten years.

The availability of economic family resources creates an additional differential factor for development and inequality during adolescence. Children with similar cognitive, motor and noncognitive abilities who have access to more economic resources more often attend a higher-track secondary school. This effect is statistically significant, although of moderate quantitative magnitude. If economic resources increase by 1%, the probability of entering higher-track secondary schooling increases by 0.18%.

Our findings are also related to the literature on the stability of personality traits (see e.g. Kazdin, Kraemer, Kessler, Kupfer, and Offord (1997); Mischel, Shoda, and Peake (1988)). We contribute to this literature by using psychometric assessments rather than maternal ratings of children's abilities and by applying the analytical framework of the technology of skill formation (Cunha and Heckman, 2007). The stability of personality traits is associated with the stability of socio-emotional home resources during childhood.

Our findings with respect to early life adversity contribute to recent findings on long-term outcomes of birth weight (Black et al., 2007), and on the relationship between health and socio-economic outcomes. The psychometric measures of initial organic and psychosocial conditions in our data extend the knowledge regarding the variety of early risk factors and competence measures. Besides low birth weight, neonatal complications and adverse psychosocial conditions like maternal discord or psychiatric disorders of parents also contribute to the children's development. A related strand of the literature deals with the consequences of maltreatment in childhood for depression in adulthood (Danese, Pariante, Caspi, Taylor, and Poulton, 2007). Maltreatment is an important part of adverse socio-emotional home resources, with long-term negative outcomes.

We conclude that advantages from beneficial home environments and disadvantages from adverse home environments cumulate during the developmental course. The quality of home resources does not differ a great deal over time in social reality. In addition to the adverse factors from initial risks for disadvantaged children, the early development of cognitive abilities is hindered by a low quality of adult care. This disadvantage continues, and noncognitive ability formation at school age is impaired. Children are again hindered during the transition to a higher-track secondary school, when low economic home resources constitute an additional barrier. According to our interpretation, there is still an underinvestment in public resources during preschool age for children who grow up in an adverse home environment. In our study, alternative policies are examined, which are based on our empirical findings and may help children build their competencies in the early life course.

Although the evidence on the role of home resources for competence development presented in this paper and the literature summarized, among others, in Cunha and Heckman (2008) and Todd and Wolpin (2007), is conclusive, some caveats remain. Our results are based on observations from groups of children who often experience a stable beneficial or adverse home environment during the early life course. It is a question of considerable public and scientific interest whether disadvantaged children, who experience adversity in childhood, can develop competence and resilience if they find beneficial and individually well-adapted help after childhood. This is a matter for future research.

The paper is organized as follows. Section 2.2 introduces the data while section 2.3 examines the evolution of economic and socio-emotional home resources and competencies from birth to 11 years. Section 2.4 discusses our estimates of the developmentally specific technology of skill formation. Section 2.5 studies complementarities between abilities in childhood and social competencies and school achievement at school age. Alternative compensating policies during the early life course based on these estimates are investigated in section 2.6. Conclusions are drawn in section 2.7.

2.2 Early organic and psychosocial risk

The Mannheim Study of Children at Risk (MARS) follows infants who are at risk for later developmental disorders in order to examine the impact of initial adverse conditions on the probability of negative health and socio-economic outcomes (Laucht et al., 1997, 2004).[3] To control for confounding effects related to home resources and the infant's medical status, only firstborn children with singleton births to German-speaking parents of predominantly (> 99.0 percent) European descent, born between February 1986 and February 1988 were enrolled in the study. The first 110 children were included consecutively into the study, irrespective of risk-group status. These children form our approximate normative sample.

To separate the independent and combined effects of organic and psychosocial risks on child development, children were selected according to combinations of different risk factors. Infants were rated according to the degree of 'organic' risk and to the degree of 'psychosocial' risk.[4] Each risk factor was scaled as either 'no' risk, 'moderate' risk or 'high' risk, resulting in a 3×3 design (Figure 2.1). All groups are roughly equal in size, with a slight oversampling in the high-risk combinations. Sex is distributed evenly in all subgroups. Removing children with missing values in some waves, 364 children (174 boys, 190 girls), 95 percent of the 384 infants in the initial wave, remained.

[3]Infants were recruited from two obstetric and six children's hospitals in the Rhine-Neckar region of Germany. Children with severe physical handicaps, obvious genetic defects or metabolic diseases were excluded. The initial participation rate was 64.5 percent, with a slightly lower rate in families from low socio-economic backgrounds.

[4]The relevance of APGAR (Appearance, Pulse, Grimace, Activity and Respiration) and birth weight for adult outcomes has been investigated by Almond et al. (2005) and Oreopoulos et al. (2008), among others. Other aspects of the initial risk matrix, such as neonatal complications or psychiatric disorder, have not been widely investigated in economic research.

Organic risk is determined by the degree of pre-, peri- or neonatal complications. The risk factors and their prevalence in the sample are shown in Table B.1. Pre- and perinatal variables were extracted from maternal obstetric and infant neonatal records and are used for organic risk classification. Organic risk is classified as follows:

1. The *non-risk* group consists of infants who were born full-term, had normal birth weight and no medical complications (items 1-4).

2. The *moderate-risk* group contains infants who had experienced premature births or premature labor, or EPH gestosis of the mother but no severe complications (items 5-7).

3. The *high-risk* group comprises infants who had very low birth weight or a clear case of asphyxia with special-care treatment or neonatal complications, such as seizures, respiratory therapy or sepsis (items 8-10).

Psychosocial risk is determined according to a risk index proposed by Rutter and Quinton (1977), which measures the presence of eleven unfavorable family characteristics, for example martial discord or low-skilled parents. The 'enriched' family adversity index includes adverse family factors during a period of one year prior to birth, as reported in Table B.2. Information for the psychosocial risk rating was taken from a standardized parent interview conducted at the 3-month assessment. Psychosocial risk is classified as follows:

1. The *non-risk* group includes infants who had none of the psychosocial risks.

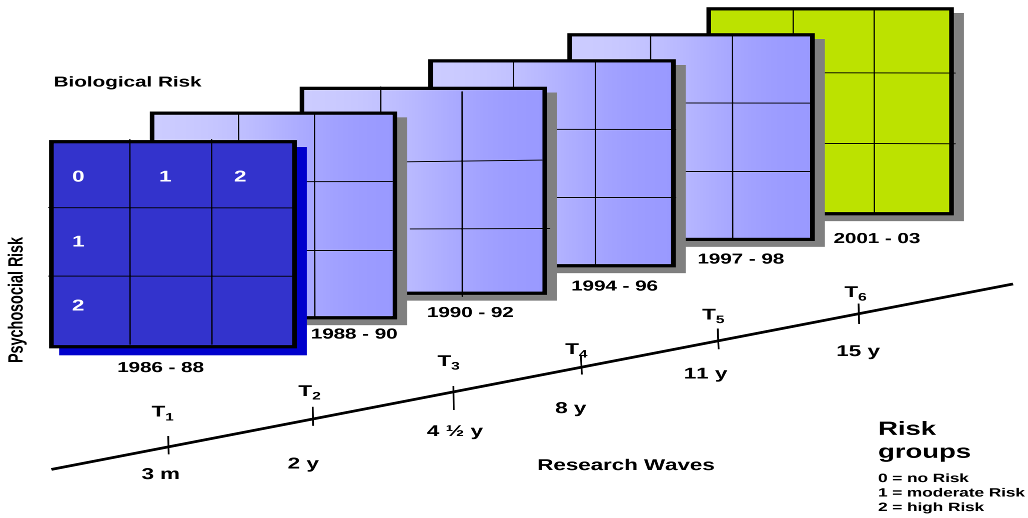
2. The *moderate-risk* group contains infants with one or two of these factors.

3. The infants from the *high-risk* group came from a family dealing with 3 or more of these risk factors.

2.3 Competencies, home

Throughout this paper, the expression 'competencies' summarizes basic abilities of children, such as logical and verbal reasoning, motor abilities and persistence as well as social and school-related achievements, such as peer relationships, autonomy, interests and school

Figure 2.1: The Mannheim Study of Children at Risk (3 month - 15 years)



Source: Mannheim Study of Children at Risk (1986-2003).

grades. The expression 'home environment' summarizes the economic, emotional and social resources available for the child at home.[5] This section introduces the measurement of competencies and home in the MARS data, together with statistics that describe children's competencies and home environment in the cells of the initial risk matrix and their development from infancy to school age. One advantage of the data is that measurement of competencies and home starts in early infancy (at the age of three months), in addition to the availability of early risk conditions.

2.3.1 Cognitive, motor and noncognitive abilities

The terms cognitive, motor, and noncognitive abilities indicate three different, yet dependent and important basic dimensions of human capital and personality. Cognitive abilities include memory capacity, information processing speed, linguistic and logic skills, and general problem-solving abilities (IQ). Motor abilities are assessed as fine and gross motor skills and body coordination (MQ) (for a detailed description of the measurement of cognitive and motor abilities in MARS, see Appendix Table B.3).

[5]The terms home environment, home resources, parental investment or parental stimulation and responsiveness are used synonymously.

Our main dimension of noncognitive abilities measures the child's ability to pursue a particular activity and its continuation in the face of distracters and obstacles, defined as persistence (P). The ratings were generated by experts[6] on 5-point rating scales adapted from the New York Longitudinal Study NYLS (A. Thomas and Chess, 1977). P is a deep-seated noncognitive ability related to effort regulation, perseverance, persistence and self-discipline.[7] Until the age of 2, P is measured in combination with attention span within the same scale. Persistence was derived from a combination of a standardized parent interview and structured direct observations in four standardized settings on two different days in both familiar (home) and unfamiliar (laboratory) surroundings in order to reduce measurement errors.

Table 2.1 contains summary statistics of the abilities IQ, MQ and P in the nine risk groups of MARS.[8] Note that the IQ and the MQ have been normalized in each developmental stage to a mean of 100 and a standard deviation of 15 in an approximate normative sample of 110 children. For reasons of clarity, we restrict the presentation to the ages of 3 months and 11 years. In line with the literature on competence research (Egeland, Carlson, and Sroufe, 1993; Kazdin et al., 1997; Laucht et al., 1997, 2004), our results indicate that unfavorable consequences of initial organic and psychosocial risks seem to persist until adolescence.

Organic and psychosocial risk factors exhibit equally negative effects, but are specific to the areas they affect. Until the age of 11, the individual differences in children's abilities, according to the mean and the standard deviations, have increased. Initial inequality in the risk matrix is magnified over time. While psychosocial risks primarily influence cognitive and socio-emotional functioning, the impact of early organic risks is concentrated on

[6] At the ages of 3 months and 2 years, the interrater reliability was measured in a subsample of 30 children. Satisfactory interrater agreement was obtained between two raters (3 months: mean $\kappa = 0.68$, range 0.51 - 0.84; 2 years: mean $\kappa = 0.82$, range 0.52 - 1.00). To avoid distortions resulting from parental judgment or one-time observations in an unfamiliar surrounding, a mean score was formed out of all 5 ratings.

[7] We examined further dimensions from the NYLS scales, among them the initial reaction to a new stimulation, the length of time needed to adapt and prevailing mood. Our econometric analysis revealed that these dimensions showed no systematic correlations with the cognitive abilities, which seems to be in line with the early literature. Studies cited by A. Thomas and Chess (1977) indicated that none of these temperament measures were associated with the level of the IQ.

[8] IQ, MQ, P is available throughout the first five waves.

Table 2.1: Children's abilities at 3 months and 11 years

	Psychosocial risk					
	no		moderate		high	
	IQ					
Organic risk	3 months	11 years	3 months	11 years	3 months	11 years
no	103*	108*	102*	107*	96**100*	
	(13.5)	(15.3)	(16.7)	(16.3)	(15.9)	(18.9)
moderate	101*	105*	99*	98*	97*	97
	(16.0)	(10.4)	(16.5)	(13.3)	(16.3)	(19.2)
high	95	101*	93	92	88	87
	(13.2)	(20.0)	(17.4)	(24.0)	(19.8)	(27.3)
	MQ					
	3 months	11 years	3 months	11 years	3 months	11 years
no	103*	104*	102*	106*	103*	104*
	(12.1)	(13.0)	(12.5)	(17.2)	(13.9)	(12.8)
moderate	101*	97*	98*	103*	99*	98*
	(13.6)	(12.3)	(15.7)	(14.1)	(13.6)	(18.1)
high	93	98*	92	97*	89	86
	(12.1)	(16.9)	(13.5)	(23.6)	(13.8)	(26.5)
	P					
	4.5 years	11 years	4.5 years	11 years	4.5 years	11 years
no	3.82*	4.27*	3.5*	4.13*	3.17	3.84
	(0.68)	(0.54)	(0.73)	(0.59)	(0.83)	(0.79)
moderate	3.54*	4.02*	3.38	3.87	3.20	3.63
	(0.63)	(0.53)	(0.75)	(0.59)	(0.80)	(0.73)
high	3.61*	3.99*	3.14	3.71	3.07	3.55
	(0.64)	(0.56)	(0.70)	(0.64)	(0.77)	(0.91)

Note: Persistence scores vary between 1.0, 1.1, ... (low) and 5.0 (high); standard deviations are in parentheses. *indicates the significance of differences relative to the highest-risk group at the 5% level; 364 observations.
Source: MARS 1986-2003. Own calculations.

motor and cognitive functioning.

There is a monotonic decrease in the IQ and the MQ in (nearly) all risk dimensions. Differences in average IQ, MQ and P increase between the ages of 3 months and 11 years in the risk matrix. At the age of 3 months, the children free of any risk have an average IQ of 103 compared to the children with high organic and high psychosocial risk, whose average IQ is 88. In addition, differences in the standard deviations increase with risk, from 13.5 in the no-risk group to 19.8 in the highest-risk group (Table 2.1). The results for the MQ provide a similar picture.

Average persistence decreases monotonically along both risk dimensions. There is a 20 percent difference between the no-risk and the high-risk group of children at the age of 4.5 years (3.82 vs. 3.07, Table 2.1), and the heterogeneity of P increases along with the risk dimensions. At the age of 11 years, children without any risk have an average IQ of 108 (std.dev.= 15.3), compared to the children with the highest organic and psychosocial risk, who achieve an average score of 87 (std.dev.= 27.3) (Table 2.1). The average gap in cognitive abilities at the age of 11 between the no-risk and the maximum-risk group has increased from 15 to 21 IQ-points.[9] The results for the MQ at the age of 11 are very similar to the results for the IQ.

Our findings reveal that initial risk conditions are important in terms of inequality of cognitive, motor and noncognitive abilities, and that the cumulative effect of organic and psychosocial risk corresponds to the sum of the single risk effects. Differences in average cognitive, motor and noncognitive abilities accelerate during childhood. Heterogeneity increases with the risk dimensions. Significant sex differences were observed in the IQ only at the ages of 2 and 4.5 (the IQ of girls is 6% higher), and in P after the age of two years (girls score higher, 0.42 at 4.5 years and 0.22 at 11 years).

2.3.2 Home environment

There are two types of home resource variables by which the children were assessed in their early life cycle, summarized in socio-emotional categories, H (HOME score), and economic categories, which were measured by the monthly net equivalence income per household member, Y (Table 2.2). In MARS, the socio-emotional home resources were rated with the Home Observation for Measurement of the Environment (HOME, Bradley, 1989), adapted to German living conditions. All items were evaluated by trained home visitors (interviewers), who were in contact with the primary caregiver. H is the sum of all items.[10]

When the children are aged 3 months, H consists of six subscales: (1) emotional and verbal responsibility of the mother, (2) acceptance of the child, (3) organization of the

[9] The difference is greater when compared to the IQ difference between Romanian adoptees at maximum risk and a group of English adoptees without comparable risk (which amounts to 17, see Beckett et al. (2006))

[10] Todd and Wolpin (2007) also use the HOME-SF (consisting of four different instruments that is available in the NLSY79-CS, starting at age 0-2). Cunha and Heckman (2008) use single items, such as theater visits, musical instruments and books.

Table 2.2: H and Y in children aged 3 months and 11 years

	Psychosocial risk					
	no		moderate		high	
	H: HOME score					
Organic risk	3 months	11 years	3 months	11 years	3 months	11 years
no	106*	108*	102*	105*	93	92
	(12.9)	(6.5)	(12.9)	(10.2)	(17.0)	(19.8)
moderate	105*	107*	100	99	95	92
	(14.2)	(6.9)	(12.9)	(12.6)	(14.1)	(21.7)
high	106*	106*	100*	98	94	94
	(10.5)	(9.1)	(12.7)	(10.8)	(18.6)	(16.6)
	Y: monthly net equivalence income per head					
	3 months	11 years	3 months	11 years	3 months	11 years
no	1,275*	1,699*	1,122*	1,632	775	1,256
	(775)	(681)	(542)	(832)	(465)	(643)
moderate	1,293*	1,644*	903	1,325	948	1,325
	(649)	(627)	(239)	(555)	(774)	(641)
high	1,180*	1,806*	927	1,425	863	1,355
	(403)	(629)	(295)	(495)	(344)	(636)

Note: Y in DEM; H is normalized to a mean of 100 and a std.dev. of 15 in the normative group; standard deviations are in parentheses. *indicates significance of mean differences relative to the highest-risk group at the 5% level; 364 observations.
Source: MARS 1986-2003. Own calculations.

environment, (4) provision of appropriate play materials, (5) maternal involvement with the child, and (6) variability. At the age of 2 years, H comprises the six subscales plus the caretaking activities. At the age of 4.5 years, H consists of the original subscales plus the caretaking activities items and items related to the parent interview. At the age of 8 and 11 years, MARS adopted the original HOME, which consists of 6 subscales and 81 items.

Both measures of a child's home resources decline steadily along with the psychosocial risk dimension (Table 2.2). Within the group of children with high psychosocial risk, Y is on average 60 percent of the value of the no-risk group in infancy. The differences in the average H in the risk matrix show a similar pattern, although the gap is numerically lower. For the group of children with high psychosocial risks, H is 88 percent compared to the no-risk group. In fact, this is a large gap, because parental stimulation and responsiveness are important resources for development. Parent-child interaction is the 'cradle of action' (Heckhausen and Heckhausen (2008), p.384: 'Maternal contingency behavior (also known as responsive behavior) seems to be conducive to the formation of generalized contingency expectations...').

The relationship between H and Y is of special interest for reasons of policy intervention. Although the relationship is positive (a higher Y is associated with a higher H), the magnitude seems to be rather low. If economic resources were doubled, H would on average be 8 to 10 percent higher. The partial elasticity of H with respect to Y is on average 0.08, with some variation over time ($t_1 = 0.06$, $t_2 = 0.09$, $t_3 = 0.11$, $t_4 = 0.08$, $t_5 = 0.07$).

2.3.3 Social competencies

Social competencies of children were assessed in two ways. From the ages of 4.5 to 11 years, the Scales for Levels of Functioning (Marcus, Blanz, Esser, Niemeyer, and Schmidt, 1993) were used, and from 8 to 11 year, the Perceived Competence Scales were administered (Harter and Pike, 1984); German version by Asendorpf and Aken (1993). Based on expert and self-ratings, respectively, these aim at measuring independence in everyday life (autonomy), hobbies (interests), and integration into groups and social life (peers). The results are shown in Table 2.3.

In addition to the expert-rated Levels of Functioning scale, the self-rating indicating perceived peer acceptance is included to facilitate comparison. Peer acceptance is a subscale of the Harter Scales, and consists of 6 items, each ranging from 1 to 4. The items correspond to children's self-perceptions regarding their peer relationships. Children were, for example, asked how many friends they have, whether they are among those children who easily find others to play with, or whether they think themselves as lonely, because they are not asked to join in other children's play.

Table 2.3 contains the means and standard deviations of the competencies variables evaluated at the age of 8 years for the cells of the risk matrix. Initial risk effects cumulate and all social adjustment scores decrease with both dimensions of the risk matrix. The gaps in social competencies at the age of 8 years are significant. The difference between the no-risk and the high-risk groups amounts to roughly 80 percent. However, two exceptions are worth mentioning. First, if there is no psychosocial risk, organic risks seem to lose their association with regard to autonomy, interests and peers. When pursuing various interests and popularity with peers, the initial psychosocial risk load seems to be, on average, more harmful than organic risks. Second, based on the self-rating, little variation in

Table 2.3: Social competencies at the age of 8 years

	Psychosocial risk		
Organic risk	no	moderate	high
	interest/autonomy		
no	5.09*/4.64*	4.87*/4.84*	4.37/4.78*
	(0.74 / 0.81)	(0.89 / 0.73)	(1.17 / 0.98)
moderate	4.98*/4.83*	4.42*/4.52	4.09/4.35
	(0.68 / 0.88)	(0.75 / 1.15)	(0.99 / 1.13)
high	4.92*/4.59	4.31/4.26	3.95/4.07
	(0.83 / 1.04)	(1.06 / 1.31)	(1.21 / 1.42)
	peer (expert-/self-rated)		
no	4.82*/18.23	4.62*/18.20	4.57*/18.36
	(0.92 / 3.0)	(0.89 / 3.56)	(1.15 / 3.73)
moderate	4.48*/18.50	4.45*/18.06	4.39/17.84
	(0.89 / 3.68)	(0.94 / 3.35)	(1.05 / 3.64)
high	4.81*/19.11	4.41/18.27	3.98/18.49
	(0.91 / 3.03)	(1.02 / 3.4)	(1.24 / 2.79)

Note: Social competence scores range from 1.0 (low), 1.1, ... to 5.0 (high), self-concept scores range from 10 (low) to 24 (high); *indicates significant mean differences relative to the highest-risk group at the 5% level; standard deviations are in parentheses; 364 observations.
Source: MARS 1986-2003. Own calculations.

the cells of the risk matrix emerged. From the child's viewpoint, the differences in social life seem to be less significant compared to the expert ratings.

2.3.4 School achievement

School achievement at the age of 8 years, measured with grades in math, spelling and reading, confirm the importance of the initial psychosocial risk conditions (Table 2.4). Grades in the highest-risk group are approximately one grade lower than grades in the no-risk group. A high psychosocial risk has, on average, the largest negative effect. It is not surprising that there is not a great deal of variation between the average grades in these three subjects. Initial risks have comparable implications for all school subjects. As a general rule, school choice in the German tracking system takes place, after the 4th grade, at the age of 10. On average, 45 percent of the children in the MARS attend a Gymnasium, which is the highest-track/grammar school in Germany. 30% attended a Realschule (secondary modern school), 16% a Hauptschule (lowest secondary school track) and 9% more specific school types (Förderschule, Rudolf Steiner Schule). A Förderschule is a school type for children who have learning disabilities or are disabled. According to official statistics on the 2006/07 school year in Baden-Württemberg, 28% of the students in the 9th grade attended a Gymnasium, 31% a Realschule, 29% a Hauptschule, 11% a Förderschule and

1.3% a Rudolf Steiner Schule. We conclude that in our data more children attend the higher-track secondary school compared to the average in Baden-Württemberg for the 9th grade. One explanation for this is that children from immigrant families with poor German language skills and children with severe handicaps were not included.

Table 2.4: School grades at age 8 and secondary school attendance at age 10

	Psychosocial risk		
Organic risk	no	moderate	high
	Grades in reading, spelling, math at age 8		
no	2.0*/2.1*/2.1*	2.2*/2.2*/2.1*	2.3/2.6/2.4*
moderate	2.2*/2.2*/2.2*	2.4/2.4*/2.4	2.8/2.9/2.7
high	2.1*/2.2*/2.3*	2.4/2.4/2.6	2.8/3.0/2.9
	Gymnasium, Realschule, other at age 11		
no	74*/24*/02*	77*/09*/14*	43/21*/36
moderate	45/40*/15*	38/38*/34*	33/23/44
high	54*/23*/23*	27/38/45	15/28/67

Note: In the German educational system, grades range from 1.0 (excellent) to 6.0 (insufficient); *indicates significant mean differences relative to the highest-risk group at the 5% level; 322 to 357 observations, depending on the available information.
Source: MARS 1986-2003. Own calculations.

In terms of selection to attend a grammar school, the initial risks are still important (Table 2.4). In the highest-risk group, only 15 percent of the children attend the Gymnasium, compared to 74 percent in the no-risk group. Average Gymnasium attendance decreases (nearly) monotonically along the two dimensions of our risk design, but there are two exceptions. First, for children born without psychosocial risk, there seems to be no difference between the moderate and the high organic risk groups, and second, for children born without organic risk, the no-risk and the moderate psychosocial risk groups are similar.

2.3.5 First-order temporal correlation

The longitudinal dimension of the data is utilized to examine the stability of the measured competencies and home resources over time. Table 2.5 summarizes the first-order temporal correlations for cognitive, motor and noncognitive abilities and social competencies. These correlations provide empirical measures of the interpersonal rate of consolidation in competencies. While they are presumably lower for some abilities, for example noncognitive abilities during childhood, they may be higher for others, for example motor abilities. A high value is an indication that interpersonal differences have been stable between two periods. Taking measurement errors and further factors of influence into account (discussed in section 2.4), a correlation coefficient between 0.30 and 0.49 indicates low consolidation; a value between 0.5 and 0.69 indicates moderate consolidation, and values above 0.70 suggest high consolidation of interpersonal differences over time.

Table 2.5: First-order temporal correlations

	2 years/3 months	4.5/ 2 years	8/4.5 years	11/8 years
		Abilities		
IQ	0.34	0.72	0.74	0.81
MQ	0.35	0.63	0.53	0.60
P	0.03	0.42	0.59	0.64
		Social competencies		
peers			0.31	0.65
interest			0.58	0.64
autonomy			0.33	0.56

Note: All correlation coefficients are significant at the 5% level with the exception of persistence correlation from 3 months to 2 years; 364 observations.
Source: MARS 1986-2003. Own calculations.

Table 2.5 suggests that interpersonal differences in cognitive and motor abilities in our sample consolidate during preschool age. The correlations vary between 0.63 and 0.72, suggesting a relatively high degree of stability of interpersonal differences in the MQ and IQ. The first-order temporal correlations for persistence are lower. They indicate only moderate stability until the age of 4.5 years and an increase in stability thereafter. There is moderate stability of social competencies between the ages of 4.5 and 8 years and consolidation thereafter. Social competencies such as good peer relationships and interests that demonstrate children's social integration seem to consolidate at an age between 8 and 11 years or later.

With respect to the economic and socio-emotional home resources, Y and H, a high stability from birth until the age of 11 years is evident. In all cases, the first-order temporal correlations exceed the value of 0.7. This demonstrates that children experience a relatively high degree of stability of their economic as well as socio-emotional home environment, irrespective of whether it is adverse or beneficial.

2.4 Ability formation in the early life course

2.4.1 Econometric approaches

Factors that are responsible for the production of abilities, Θ_t, in period t, can be summarized with the term 'technology of skill formation' (Cunha and Heckman, 2007; see equation 2.1). For our study, Θ_t represents the vector of cognitive, motor, and noncognitive abilities. E represents initial conditions, Θ_{t-1} the vector of abilities from the period before, and I_t denotes age-specific investments intended to enhance abilities.

$$\Theta_t = f_t(I_t, \Theta_{t-1}, E) \tag{2.1}$$

The epidemiological cohort data allow a detailed look at early organic and psychosocial conditions. Moreover, the data contain comprehensive psychometric assessments as well as psychological expert ratings of abilities and stage-specific home resources. Data quality helps to reduce measurement errors. It is assumed that equation 2.1 can be represented in a Cobb-Douglas form. Taking the natural logarithm (lower case letters indicate the natural logarithm) yields equation 2.2:

$$\Theta^j_{t,i} = \alpha^{j,R}_{0,t} + \alpha^{h,j}_t h_{t,i} + \alpha^j_t \Theta^j_{t-1,i} + \alpha^{k,j}_t \Theta^k_{t-1,i} + \alpha^{1,j}_t \Theta^1_{t-1,i} + \epsilon^j_{t,i} \tag{2.2}$$

where j, k, l are indices for the three basic abilities *IQ, MQ* and P, and $i = 1, ..., N$ $(= 364)$ is an index for the child. There are five different time periods. The variable R contains all nine cells of the two-dimensional risk matrix in MARS. The error term ϵ, represents random factors related to abilities.

In the econometric analysis, we focus on the role of socio-emotional home resources, H, in period t and the stock of abilities from period $t-1$ for the production of abilities. The Cobb-Douglas form (equation 2.2) implies that actual abilities can be produced continuously by socio-emotional home resources and the stock of abilities available from the past period. All parameters can be interpreted as partial elasticity. While initial conditions can have lasting effects on the level of abilities, the Cobb-Douglas production function implies that change remains possible in each period.

The relationship between parental investments and children's abilities may be reciprocal, leading to reversed causality. Having a child with high abilities is likely to increase H in order to support development. A child with low abilities may be a source of stress for the parents, which may even lead to a reduction of H. If parental investment depends on ability in such a way, then OLS estimates of equation 2.2 may be biased, since children with higher abilities also have higher socio-emotional home resources. To address the endogeneity of H, we compare OLS with two-stage-least square results (2SLS). In the first stage, we estimate H as a function of the ability under consideration, for instance the IQ, and use the economic home resources, Y, as an additional variable. This is equivalent to using Y as an instrument for H in equation 2.2.

Monthly net equivalence income per head, Y, is partially related to H, one necessary condition for an instrumental variable. We find a significant (partial) correlation in each period (reported in section 2.3 above). On average, a 10% increase in Y is associated roughly with a 1% increase in H. A second condition for Y being a valid instrument is that it should only affect abilities due to its relation to H. As the exogeneity of an instrument is not testable for the one-instrument case, we have to assume that the socio-emotional home resources (parental care or parental responsiveness) cause ability development. While parental care itself may depend on the availability of economic home resources, the latter do not have a direct impact on ability formation. This seems to be plausible and does not rule out that direct pathways from Y to some competencies exist, for instance social achievement and grades at school age. Furthermore, the choice for higher secondary education in adolescence directly depends on the availability of economic resources (compare section 2.5.3).

According to our data, the influence of Y on children's abilities is never significant in addition to H and the level of past abilities in equation 2.2. The associations are dominated by the variation of socio-emotional home resources and past abilities, and not by the inequality of per capita income in the family. Thus, under the assumption that financial resources have no direct impact on abilities, a comparison between OLS and 2SLS might be helpful to assess lower and upper bounds for the causal relationship between H and abilities.

A different, though related source of bias may stem from omitted variables, for example, unobserved abilities, that create correlations between abilities and the error term. To reduce the ability bias, we include all available lags of abilities in addition to the values of the past (one period lag) abilities into the equation 2.2 (Wooldridge, 2005). Further econometric approaches are discussed below.

2.4.2 Econometric results

Table 2.6 documents the estimates of the different econometric approaches for the IQ and P. There are columns for OLS results without and with additional lags and for 2SLS results without and with lags. Each equation contains the set of dummies from the initial risk matrix, R. Starting with age 4.5, this set of dummies was not jointly significant at the 5 percent level for cognitive and noncognitive abilities, and the estimates beginning at age 4.5 were performed without R.

Our first conclusion corresponds to motor abilities. Although the partial elasticity of MQ and H is always positive, it lacks statistical significance at the 5% level. Motor abilities strongly depend on early organic and psychosocial conditions (compare Table 2.1), and only weakly on socio-emotional home resources during childhood. In fact, there appears to be a high degree of stability in interpersonal differences in the MQ during the early life course. For reasons of clarity, we do not report the results for the MQ equation in Table 2.6, but rather in the Appendix, Table B.4.

The OLS estimates indicate that H is positively related to cognitive and noncognitive ability development at all developmental stages (Table 2.6). However, the role of socio-emotional home resources and the level of abilities from the past period for ability formation changes in a way that is specific to age and abilities. P is always significantly associated with H, with the estimated partial elasticity varying between 0.30 and 0.54. The highest values for the elasticity are estimated to occur at the ages of 4.5 and 8 years. This is consistent with findings reported in Cunha and Heckman (2008), who estimate parameters of the technology of skill formation for three stages, starting with stage 1, from age 6-7 to age 8-9, and ending with stage 3 from age 10-11 to 12-13. The IQ is positively related to H until the age of 4.5 years, with an estimated partial elasticity varying between 0.54 at three months and 0.38 at the age of 4.5 years. At school age, the elasticity drops to 0.19. Although this is still positive, it is no longer significant at the 5 percent level.

The estimated elasticity of the past abilities steadily increases during the early course of life. It is low until toddlerhood and increases thereafter. With increased levels of abilities, the child reaches higher levels of independence. During development, the socio-emotional home environment loses its strong relationship with abilities at preschool age. The more abilities children acquired during childhood, the higher the stock of cognitive abilities at school age will be, when the relationship to socio-emotional home resources decreases. Our stage-specific estimates at secondary school age (11 years) for the IQ at primary school age (8 years) varies around 0.9, a value which is comparable in magnitude with the findings from Cunha and Heckman (2008). However, our estimates of the parameters of past abilities are lower for the preschool period and for noncognitive abilities, P. For the preschool period, our results seem to be in line with Cunha and Heckman (2008), who studied the parameters of the technology of skill formation. Comparable to our results, self-productivity is low in early childhood and increases when children grow older, although in an ability specific way. Cunha and Heckman (2008) do not regard motor abilities in their research, but according to our study, self-productivity in motor abilities is already high in early childhood.

When significant, the 2SLS estimates for the IQ and P equation are higher compared to the OLS results (Table 2.6) (with one exception: at preschool age, the coefficient for the P equation is lower for the 2SLS estimate). In the third period (age 4.5 years), for example, the coefficient in the IQ equation is 0.50, compared to 0.38 for OLS. In infancy and toddlerhood, the difference is wider. If parents provide a higher H for their firstborn children with a higher IQ, OLS underestimates the partial elasticity as a result of reversed causality.

If the assumption applies, the socio-emotional home resources are even more important for child development than the OLS results suggest. Although this seems to be in line with evidence on the eminent role of early childhood, as discussed by Amor (2003); Heckhausen and Heckhausen (2008); Cunha and Heckman (2008), a caveat remains within our analyses. 2SLS estimates produce higher standard errors (for the year 4.5 and the IQ equation 2.2, the point estimate is 0.50 with a standard error of 0.18 compared to OLS: 0.38, 0.09). Therefore, the difference from the OLS is not well-determined from a statistical point of view. OLS results with lower standard errors may even be closer to the 'true' parameters of the technology of ability formation. Nevertheless, 2SLS estimates demonstrate that socio-emotional home resources might be more important for cognitive ability than OLS results suggest. Therefore, we regard the 2SLS results as an upper bound and the OLS results as a lower bound of the 'true' value of the elasticity. We will compare policy conclusions based on the upper and the lower bounds in section 2.6.

Table 2.6: Econometric results for ability formation, IQ and P

	IQ_t				P_t			
	OLS	OLS+lags	2SLS	2SLS+lags	OLS	OLS+lags	2SLS	2SLS+lags
	t=3 months							
H_t	0.54*		2.37*		0.30*		0.66	
	(0.14)		(0.98)		(0.14)	(0.73)		
Adj.R^2/F-test	0.10		2.54		0.02		1.15	
	t=2 years							
H_t	0.37*		1.57*		0.36*		1.33*	
	(0.08)		(0.45)		(0.11)		(0.58)	
IQ_{t-1}	0.23*		0.09		0.11		0.001	
	(0.06)		(0.10)		(0.08)		(0.11)	
P_{t-1}	0.13*		0.16*		-0.07		0.18*	
	(0.06)		(0.09)		(0.07)		(0.11)	
Adj.R^2/F-test	0.30		6.94		0.12		3.49	
	t=4.5 years							
H_t	0.38*	0.37*	0.50*	0.51*	0.54*	0.53*	0.04	-0.02
	(0.09)	(0.09)	(0.18)	(0.20)	(0.22)	(0.22)	(0.40)	(0.43)
IQ_{t-1}	0.53*	0.53*	0.50*	0.50*	0.55*	0.53*	0.67*	0.65*
	(0.06)	(0.06)	(0.07)	(0.07)	(0.12)	(0.12)	(0.14)	(0.14)
$P_t - 1$	0.02	0.02	0.008	0.01	0.16*	0.18*	0.19*	0.21*
	(0.03)	(0.03)	(0.03)	(0.03)	(0.06)	(0.06)	(0.07)	(0.07)
Adj.R^2/F-test	0.58	0.58	71.12	45.28	0.34	0.34	29.85	19.38
	t=8 years							
H_t	0.19	0.18	0.31	0.24	0.43*	0.38*	0.64	0.53
	(0.16)	(0.15)	(0.35)	(0.37)	(0.18)	(0.18)	(0.45)	(0.50)
IQ_{t-1}	0.84*	0.77*	0.82*	0.76*	0.27*	0.21*	0.24*	0.19
	(0.08)	(0.10)	(0.10)	(0.10)	(0.10)	(0.12)	(0.13)	(0.14)
P_{t-1}	0.09*	0.08*	0.08*	0.07	0.29*	0.28*	0.28*	0.27*
	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)
Adj.R^2/F-test	0.64	0.64	37.61	17.87	0.36	0.35	27.92	13.10
	t=11 years							
H_t	0.17	0.16	-0.59	-0.90	0.39*	0.38*	0.89	1.38*
	(0.15)	(0.15)	(0.51)	(0.59)	(0.18)	(0.19)	(0.61)	(0.70)
IQ_{t-1}	0.88*	0.75*	1.02*	0.89*	0.22*	0.32*	0.12	0.19
	(0.07)	(0.07)	(0.12)	(0.11)	(0.07)	(0.09)	(0.13)	(0.13)
P_{t-1}	0.11*	0.11*	0.15*	0.14*	0.29*	0.25*	0.26*	0.22*
	(0.05)	(0.05)	(0.06)	(0.06)	(0.05)	(0.05)	(0.06)	(0.07
Adj.R^2/F-test	0.76	0.78	49.14	19.28	0.36	0.39	25.68	9.19

Note: All variables in natural logarithm; estimates include a constant; MQ equation not reported here; the equations for 3 months and 2 years contain nine dummies for the cells in the risk matrix; lags: in column 2, 4, 6 and 8, all available lags of IQ, MQ and P are included, although the coefficients of the lags are not reported here; *indicates significance at the 5% level, heteroscedasticity robust standard errors are in parentheses; for OLS, the Adj.R^2 for 2SLS F-tests are reported; 364 observations.
Source: MARS 1986-2003. Own calculations.

Including all available lags in order to reduce an omitted variable bias for abilities only slightly changes the coefficient of the lagged abilities (one period lag) a great deal (Table 2.6, columns 2, 4, 6 and 8).

2.4.3 Further estimates

To account for reverse causality, a further set of regression analyses was performed including H_{t-1} instead of H_t in equation 2.2. In this case, the estimated coefficients for all abilities remain (almost) unchanged, while the estimated coefficients for the lagged socio-emotional home resources do not change much (results available upon request). The main reason for this finding is that the interpersonal variation of H remains fairly constant over time.

If a sex indicator is included in equation 2.2, the respective coefficients are significant (in Model 1) only in two of the five periods. The estimated difference varies around 0.02 and 0.04, if significant. All other coefficients remain unaffected. From a production function point of view, cognitive and noncognitive ability formation seems to be rather similar between boys and girls. If we additionally include height (and/or weight) the explanatory power of Model 1 does not increase, and the additional coefficients fail to reach significance. This is in line with research from Case and Paxson (2008b).

A set of quantile regressions was performed to examine differences for each quantile of the ability distribution, starting at the age of 2 years. The set of results for the IQ is reported in Table B.5. The quantile estimates suggest that the partial elasticity of H with respect to the IQ is slightly lower at the tails of the IQ distribution (or slightly higher in the middle area). For children with rather low or rather high cognitive abilities, H seems to be less important compared to children with medium abilities. At the age of 11 years and for the 50th and 60th percentile of the IQ distribution, the partial elasticity of H with respect to the IQ becomes significant (see Table B.5). We conclude that the production of abilities depends on the level of abilities, although the number of observations in our data is too low to quantify the differences more precisely. In the group of children with low or high IQ measures, socio-emotional home resources have a lower association with the IQ.

Table B.6 documents separate regression results for the verbal and the nonverbal IQ in order to investigate whether there is evidence for sensitive investment periods regarding the two dimensions of cognitive abilities. The partial elasticity of H with respect to the verbal IQ is higher in comparison to the nonverbal IQ at all developmental stages (Table B.6). We conclude that socio-emotional home resources have a closer relationship to the verbal than to the (more fundamental) figural reasoning and understanding. The window of ability formation by improved socio-emotional home resources seems to be smaller for the nonverbal aspects of cognitive ability, such as logical reasoning, and longer for the verbal and linguistic dimension of cognitive ability.

2.5 Abilities as predictors of competencies at school age

In this section, we proceed with the analysis of competence formation during the transition from preschool to primary and from primary to secondary school. We try to shed some light on complementarities between basic cognitive, motor and noncognitive abilities and social and school achievement during the early life course. We assess the magnitude of preschool factors for school achievement in order to further examine the childhood skill multiplier (Heckman, 2007). In addition, we analyze whether higher secondary school track does still improve cognitive and noncognitive abilities.

2.5.1 Abilities at preschool age as predictors of social competencies at primary school age

We present findings from regression models in order to explain four measures of social competencies at primary school age. On the right-hand side of the regression equation, home resources, H and Y, and the level of IQ, MQ and P measured at preschool age are included. The results from OLS estimates, documented in Table 2.7, demonstrate substantial complementarities between abilities acquired during childhood and social competencies which a child achieves at primary school age, and several differences between the four competencies.

Table 2.7: The partial elasticity of preschool abilities and home resources for social competencies at school age ($t = 8$ years)

	interest		*autonomy*		*peer relations:*			
					expert-rated		*self-rated*	
		lags		lags		lags		lags
H_t	1.44*	1.46*	0.07	0.10	0.76*	0.85*	0.27	0.30
Y_t	-0.00	-0.00	-0.04	-0.05	-0.00	-0.00	0.03	0.03
IQ_{t-1}	0.54*	0.49*	0.07	-0.23	0.12	0.06	0.13	0.12
MQ_{t-1}	0.21*	0.15*	0.65*	0.44*	0.29*	0.24*	0.05	0.04
P_{t-1}	0.13*	0.14*	-0.06	-0.09	0.21*	0.22*	0.05	0.07
Adj.R^2	0.61	0.62	0.24	0.30	0.30	0.32	0.05	0.08
Observations	364	364	364	364	363	363	352	352

Note: All variables in natural logarithm; coefficients from OLS regressions including a constant; heteroscedasticity robust standard errors; *significant at 5% level.
Source: MARS 1986-2003. Own calculations.

Cognitive, motor and noncognitive abilities at preschool age predict interests at primary school age, motor abilities predict autonomy, and motor and noncognitive abilities predict peer relations. There are significant associations between the indicator of social competence, peers, and H, the MQ_{t-1} and P_{t-1}. Interests are additionally associated with the IQ_{t-1} acquired until the previous stage. Autonomy, measuring maturity in everyday life, is solely linked to the past MQ. Contemporary H enhances both popularity among peers (peer relations), and the variety of actively followed interests (interests), according to expert ratings. The findings demonstrate complementarities in competence formation, indicating that higher basic cognitive, motor and noncognitive abilities acquired in childhood help children to perform better with regard to social competencies at school age. Children from adverse home environments suffer twofold, due to poor investments in their abilities until preschool age and due to insufficient support during primary school age.

Surprisingly, however, there is no significant association with the self-rated peer relations. None of our observations are related to the child's self-rating of social relationships and friendships (last column, Table 2.7). Findings from self-ratings differ from those of expert ratings for various reasons. This discrepancy might be caused, among other factors, by a self-protection mechanism employed by children at risk to cope with a situation in which emotional support continuously lacking. To overcome their misery, they rate their peer relationship as satisfactory. Another explanation is that children with lower levels of basic abilities are satisfied with a smaller variety in terms of their peer relationships and their interests.

2.5.2 Abilities at preschool age as predictors of grades at primary school age

Findings from linear regressions predicting school grades by preschool factors are summarized in Table 2.8. Grades for reading, spelling and math are evaluated in primary school at the age of 8 years, two years before ability tracking takes place in the German educational system. All grade equations include the current H, the current Y and the cognitive, motor and noncognitive abilities measured at the age of 4.5 years. In an additional model, the IQ is divided into the verbal and the nonverbal abilities, V-IQ and NV-IQ, respectively.

Note that a negative coefficient in Table 2.8 implies a better grade. The estimates can be interpreted in terms of partial elasticities since the (natural) logarithm has been used for all variables. The IQ and P at preschool age are significantly related to better grades in reading and spelling as well as in math, with similar coefficients, while the MQ is not (Table 2.8). Persistence is an important predictor for later achievement in school, which is in line with Duckworth and Seligman (2005). Interestingly, neither H nor Y is related to the grades received at age 8.

Considering two different dimensions of IQ, only the NV-IQ remains a significant predictor of better grades. Accordingly, the level of fundamental cognitive abilities, such as logical and figural reasoning and noncognitive abilities tends to be more important for predicting school achievement at the primary school level than verbal abilities. When interpreting this result, it has to be kept in mind that our sample included only children of German-speaking parents. However, if this result could be replicated in other samples, it would be of utmost importance for policies to foster human capital, since our results (see Table 2.6) point to a very short timeframe (until early childhood) for improving logical reasoning through improved socio-emotional home resources.

Table 2.8: The partial elasticity of abilities in $t-1$ and home resources in t for school grades at the age of $t = 8$ years

	reading		*spelling*		*math*	
	IQ	V-/NV-IQ	IQ	V-/NV-IQ	IQ	V-/NV-IQ
H_t	-0.10	-0.05	-0.64	-0.62	-0.49	-0.56
	(0.43)	(0.41)	(0.43)	(0.39)	(0.42)	(0.40)
Y_t	-0.02	-0.02	-0.06	-0.07	-0.04	-0.05
	(0.02)	(0.06)	(0.05)	(0.05)	(0.06)	(0.06)
IQ_{t-1}	-0.84*		-0.60*		-0.66*	
	(0.19)		(0.19)		(0.19)	
$NV\text{-}IQ_{t-1}$		-0.96*		-1.18*		-1.11
		(0.23)		(0.21)		(0.23)
$V\text{-}IQ_{t-1}$		-0.26		0.16		0.19
		(0.23)		(0.21)		(0.20)
MQ_{t-1}	-0.17	0.009	-0.21	0.001	-0.10	0.08
	(0.13)	(0.13)	(0.12)	(0.12)	(0.12)	(0.12)
P_{t-1}	-0.32*	-0.23	-0.29*	-0.19*	-0.25*	-0.17
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
R^2	0.21	0.25	0.21	0.28	0.17	0.22
Observations	327	327	322	322	327	327

Note: OLS regressions including a constant; heteroscedasticity robust standard errors are in parentheses; all variables in natural logarithm; *significant at 5% level.

Source: MARS 1986-2003. Own calculations.

2.5.3 Abilities at primary school age as predictors of higher-track school attendance

Findings from probit models predicting secondary school attendance are summarized in Table 2.9. All probit estimates for attending the Gymnasium include the stage-specific home resources H and Y and the cognitive, motor and noncognitive abilities. These are measured at primary school age (8 years), two years before tracking takes place. In a further specification, the total IQ is split into verbal and nonverbal abilities. In addition, all available lags of the three abilities are included in the probit equation to reduce a potential ability bias (Wooldridge, 2005).

IQ, MQ and P at primary school age are significantly related to the probability of attending the Gymnasium. The magnitude of P is lower compared to the IQ and higher compared to the MQ. If the verbal and the nonverbal IQ are considered separately, the NV-IQ tends to be slightly more important than the V-IQ.[11] Using all lags of ability (Table 2.9, column 3) reduces some of the coefficients in the probit equation without changing the conclusions. Home resources increase the probability of attending the Gymnasium. H is as important as the IQ, and, at this stage of transition from primary to secondary school, economic resources, Y, become relevant. If Y is 10% higher, the probability of attending the Gymnasium increases by 1.8%, all else being equal.

Table 2.9: Probit estimates for attending Gymnasium

	IQ		*IQ + lags*	
H_t	0.82*	(0.37)	0.60*	(0.38)
Y_t	0.15*	(0.05)	0.18*	(0.05)
IQ_{t-1}	1.03*	(0.15)	0.84*	(0.19)
MQ_{t-1}	0.37*	(0.15)	0.33*	(0.16)
P_{t-1}	0.49*	(0.12)	0.38*	(0.11)
R^2	0.29		0.32	
Observations	357		357	

Note: All variables in natural logarithm; column 3 contains all available lags in abilities, although not reported here: these lags are jointly significant; LR-tests: 86.18**, 71.35**: *significant at the 5% level; standard errors are in parentheses.
Source: MARS 1986-2003. Own calculations.

Basic cognitive, motor and noncognitive abilities are developed in the interaction with adequate socio-emotional home resources during the early life course. They predict school

[11] These results are not reported here, but available from the authors upon request.

achievement, help children to perform in terms of grades, and predict higher-track school attendance.

A numerical examination illustrates the importance of the stock of abilities and socio-emotional home resources (all values are taken from the estimation with all lags included) for higher-secondary school track. If the IQ at age 8 is 103.75 instead of 100 (i.e. is 10% higher), the average marginal probability of attending the Gymnasium would increases by 8.4%. If P at age 8 were 10% higher, the average marginal probability would increase by 3.8%. If H at age 11 were 10% higher, the average marginal probability would increase by 6%, and if Y at age 11 were to increase by 10%, the marginal increase in the probability would be 1.8%. This suggests the existence of some credit market constraints at the age of 10 years. Bright children from poor households have a lower chance of entering a higher-track secondary school. The magnitude is moderate in our data. Out of 1,000 children from poorer households, 18 will be constrained in the school transition, according to our estimates. This demonstrates that cognitive and noncognitive ability 'constraints' from lower socio-emotional home resources at preschool age and/or from initial organic and psychosocial conditions are more important than credit constraints in the period of transition from primary to secondary school.

2.6 Policies to improve competence development

What are the conclusions that can be drawn from our investigation for education policies? Assume that the government has two objectives: it intends to improve competencies at secondary school age and to increase the share of children entering the Gymnasium. Since ability formation is a cumulative and dynamic process, the government faces alternatives in the early life course that we would like to illustrate numerically. The government either helps children early in their life to overcome constraints through poor socio-emotional home resources, or it helps children later, at school age, to overcome credit constraints, or both.

Assume that the government is willing to raise Y for all households by 10% (i.e. an increase of 103 DEM (Deutsche Mark) per child on average in nominal terms of 1986/1987, 1^{st} wave, 151 DEM in nominal terms of 1997/1998, 5^{th} wave). A 10% increase in Y has no direct implication for the formation of cognitive, motor and noncognitive abilities during childhood. However, let us assume for the sake of simplicity that on average, it is related to a 1% increase in H. In order to help children acquire competencies it may be necessary to improve their access to parental stimulation and responsiveness or emotional resources. Although in social reality, low economic and poor socio-emotional home resources are often related, the child can profit directly only from improved socio-emotional home resources alone. Assuming a causal relationship, an improvement of H by 1%, would require a 10% increase in Y. Families either receive a direct 10% income support or H is increased by other means (for example, direct emotional support for the children).

We take all direct and indirect multiplier and accelerator effects from the age-dependent 1% increase in H into account. We regard the OLS estimates as a lower bound, and the 2SLS estimates as an upper bound of the policy effect. The impacts of age-dependent policies are summarized in Table B.7. Looking at the columns, Table B.7 documents the percentage point increases of a 1% increase in H at five developmental stages during the life course. Looking at the rows, Table B.7 documents the resulting effects at a specific developmental stage. From the lower and upper bound effects, a set of similar and a set of different policy implications can be derived. Both bounds indicate that the early childhood years are optimal for bolstering basic cognitive abilities, while the frame for improving noncognitive abilities broadens until adolescence. While both bounds clearly indicate that childhood is of utmost importance for competencies at secondary school age, the results for the upper bound suggest that infancy and toddlerhood are even more relevant than preschool age. Interestingly enough, the lower bound results indicate that policies during infancy, toddlerhood and preschool age have effects of similar magnitude. This can be concluded from the estimated high association between socio-emotional home resources and noncognitive abilities (P) at the ages of 4.5 and 8 years and the induced multiplier and accelerator effects.

However, the specification of the upper bound (2SLS) results needs to be further investigated based on populations with a higher number of observations. Note that standard errors of the 2SLS estimates are relatively high (see section 2.4). Therefore, the further policy analyses rests upon the OLS results. If the upper bound results had been taken instead, policies that are directed to earlier stages would have been even more effective.

If policy had successfully raised H by 1% at the age of three months (2 years, 4.5 years), then the IQ would have increased until the age of 11 years by 1.11% (1.06%, 1.10%), the

MQ by 0.56% (0.31%, 0.19%) and P by 0.60% (0.96%, 0.94%). The probability of entering the Gymnasium would be higher by an amount of 1.3% (1.3%, 1.1%). If H had been increased by 1% at each of the 3 developmental stages in childhood, the resulting effects on abilities could be added (for example the IQ would have increased by 1.11%+1.06%+1.10% =3.27%). Such a policy would increase the probability of entering Gymnasium by 3.7% in our sample.

We compare these policies for improving the socio-emotional home resources available in childhood with an increase in economic home resources during the transition to secondary school age. A 10% increase of Y implemented when the child is 11 years old would increase the probability of attending Gymnasium by 1.8%. Through an improvement of socio-emotional home resources at secondary school age, such a policy would also be helpful in further increasing noncognitive abilities, while it has no measurable impacts on cognitive and motor abilities. Both policy approaches (additional support in early childhood versus support at secondary school age) are successful in raising the probability of entering the Gymnasium. However, they differ in their success in improving competencies.

The policy of supporting children at secondary school age mainly reduces credit market constraints and, to some degree, improves noncognitive abilities. The policy of supporting students at preschool age or earlier would help to overcome a lack of socio-emotional home resources. Therefore, this policy is likely to be more effective in improving basic abilities. As a result of complementarities in development, higher social and school competencies will emerge. Indeed, a combination of both types of policies should be extended continuously for children who have been left behind. To help these children, support should be extended continuously during all developmental stages. It should be designed to overcome constraints in the availability of socio-emotional home resources in early childhood and credit market constraints in adolescence.

2.7 Conclusion of Chapter 2

This paper contributes to uncovering the relationship of early life adversity and home resources with competence formation in childhood as well as complementarities between children's early and later achievement. Using data taken from the MARS, an epidemiological cohort study from birth to adulthood, our findings demonstrate that socio-emotional home resources are significantly related to ability formation during child development. The strength of the association differs between abilities and over time, which is in line with Heckman (2007).

Advantages from favorable socio-emotional home resources and disadvantages from poor socio-emotional home resources cumulate across development. Starting life with risk and growing up in an unfavorable environment impedes the development of cognitive and motor abilities. The disadvantage continues during the early life cycle until school age, a stage particularly important for noncognitive ability formation (Heckman, 2000). Disadvantaged children are impeded once again when the transition to higher-track secondary school attendance takes place. At this stage, low economic home resources create an additional barrier.

We conclude that investment in better socio-emotional home resources during childhood is necessary for improving the development of cognitive and noncognitive abilities, as well as social and school competencies. Economic support at school age additionally increases the probability to enter Gymnasium because it reduces credit market constraints. Future research on competence formation based on economic models should focus on more specific characteristics of the early parent-child relationship and early child development. Nevertheless, we are still lacking information about the variety of parent-child interaction in infancy from representative data. Knowledge on early developmental risks, both from the organic and the psychosocial dimension, and on parental responsiveness is necessary in order to foster competencies. Better data are needed to improve the parent-child relationship as the cradle of lifelong action.

3 Initial Risk Matrix, Home Resources, Ability Development and Children's Achievement

Abstract:[1] This paper investigates the development of basic cognitive, motor and noncognitive abilities from infancy to adolescence. We analyse the predictive power of these abilities, initial risk conditions and home resources for children's achievement. Our data are taken from the Mannheim Study of Children at Risk (MARS), an epidemiological cohort study, which follows the long-term outcome of early risk factors. Results indicate that differences in abilities increase during childhood, while there is a remarkable stability in the distribution of the economic and socio-emotional home resources during childhood. Initial risk conditions trigger a cumulative effect. Cognitive, motor and noncognitive abilities acquired during preschool age contribute to the prediction of children's achievement at school age.

Keywords: initial conditions, home resources, cognitive and noncognitive abilities

JEL-classification: D87, I12, I21, J13

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[1]This chapter is a joint work by Dorothea Blomeyer, Katja Coneus, Manfred Laucht and Friedhelm Pfeiffer. It is published in the *Journal of European Economic Associations Papers and Proccedings* (2009), 7 (2-3), 638-648.

3.1 Introduction to Chapter 3

Economists and psychologists share a common interest in the research on ability and health development (Heckman (2007), Heckman (2008)). Deep-seated skills are formed in a dynamic interactive process starting in early childhood, and research that is based on only a subset of relevant factors may contain some bias. The relationship between initial risk conditions (both from the organic and the psychosocial perspective), investments and ability development is analysed to gain an understanding of the formation of abilities in childhood.

Our contribution to this burgeoning multidisciplinary literature on individual development is twofold. First, we present economic models of ability formation with unique data from a developmental psychological approach for the first time. The data are taken from the Mannheim Study of Children at Risk (MARS)[2], an epidemiological cohort study that follows 384 children from birth to adulthood (Laucht et al. (1997), Laucht et al. (2004)). MARS provides detailed psychometric and medical assessments as well as psychological expert ratings on various child outcome measures. We study data from infancy to adolescence with variables on initial risk conditions, on cognitive and motor abilities, as well as on persistence, a noncognitive ability. Second, we analyse the relationship between economic and socio-emotional home resources and the development of abilities, and investigate the predictive power of abilities acquired at preschool age for children's achievement at school age. This should deepen the understanding of competence formation from both an economic and a psychological perspective.

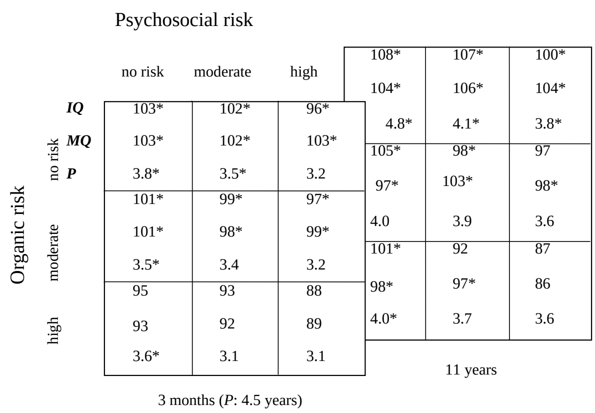
There is a significant degree of stability in the economic and socio-emotional home resources over time. This is presumably a major reason for the increase of inequality in development. Disadvantages from adverse home environments can trigger further disadvantages during the developmental stages. In early childhood, the formation of cognitive and motor abilities is hindered. As a consequence, the acquisition of noncognitive abilities at school age is impaired. Children are hindered once again during the transition to a higher-track secondary school, when low economic resources constitute an additional barrier.

[2]MARS has been derived from the German title: **MA**nnheimer **R**isikokinder **S**tudie

3.2 Data: initial risk matrix, home resources and children's achievement

MARS aims at following infants at risk for later developmental disorders in order to examine the impact of initial adverse conditions on the probability of negative health and socio-economic outcomes (Laucht et al., 2004). It includes firstborn infants growing up with German-speaking parents in a West German urban conglomeration (the Rhine-Neckar region) of medium size. Infants were rated according to the degree of 'organic' risk and the degree of 'psychosocial' risk. Each risk factor was scaled as no risk, moderate risk or high risk, as shown in Figure 3.1. Organic risk factors include conditions such as preterm birth or neonatal complications, while psychosocial risk factors refer to characteristics of adverse home environments, such as low-educated parents, early parenthood, or parents with a mental disorder. According to this rating, children were assigned to one of the nine groups resulting from the two-factor 3×3 design.[3] All groups have about equal size, with a slight oversampling in the high risk combinations and with sex distributed evenly in all subgroups.

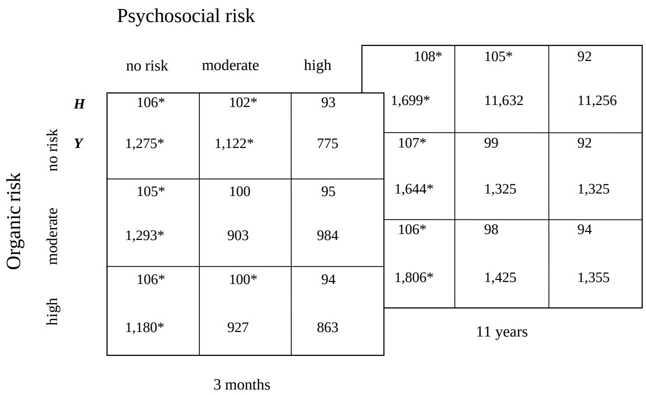
Figure 3.1: Initial risk matrix and means of abilities, 3 months and 11 years



Source: MARS 1986-2003. Own calculations.

[3]Details on the initial risk matrix, the psychometric assessments of abilities, competencies, as well as home resources are discussed in Blomeyer, Coneus, Laucht, and Pfeiffer (2008).

Figure 3.2: Initial risk matrix and means of H and Y, 3 months and 11 years



Source: MARS 1986-2003. Own calculations.

Psychometric assessments of cognitive (IQ) and motor abilities (MQ), were conducted at infancy (3 months), toddlerhood (2 years), preschool age (4.5 years), elementary school age (8 years) and secondary school age (11 years), representing significant stages of child development. Our main dimension of noncognitive abilities, persistence (P), is related to goal shielding in the presence of distractors and obstacles. Assessments are based on parent interviews and behavior observations by experts, starting at the age of 3 months. In addition, information on school achievement, such as grades at primary school age and the type of secondary school a child attends are taken into account. Figure 3.1 summarizes the means of the abilities IQ, MQ and P in the nine risk groups at the ages of 3 months and 11 years. Table 3.1 presents their first-order temporal correlations. In line with the literature on risk research (Kazdin et al., 1997) and previous findings from MARS, our results indicate that unfavorable consequences of initial organic and psychosocial risks persist until adolescence. Organic and psychosocial risks have cumulative effects. There is a monotonic decrease in IQ and MQ in both risk dimensions, with increasing differences between the ages of 3 months and 11 years. Organic and psychosocial risk factors exhibit equally negative effects, but are specific to the areas they affect. While psychosocial risks primarily influence cognitive and noncognitive functioning, the impact of early organic risks concentrates on motor and cognitive functioning. Average P decreases monotonically along the two dimensions. There is a 23% difference between the no risk and the highest risk group of children at the age of 4.5 years (3.8 vs. 3.1, see Figure 3.1).

Two types of home resources are considered, summarized into socio-emotional categories, H, and economic categories, measured as the monthly net equivalence income per household member, Y, in Figure 3.2 and Table 3.1. H was assessed using the Home Observation for Measurement of the Environment (HOME score, Bradley (1989)). The ratings indicate a considerable longitudinal stability of both home resources (Table 3.1). H declines steadily along the psychosocial risk dimension (Figure 3.2). For the group of children with high psychosocial risk, H is 87% compared to the no risk group, while the value of Y is on average 60% of the value for the no risk group. The partial elasticity of H with respect to Y varies between 0.06 and 0.11. If economic resources were doubled, H would be 6% to 11% higher.

Table 3.1: First-order temporal correlations in abilities and home resources

	2 years/3 months	4.5/ 2 years	8/4.5 years	11/8 years
	Abilities			
IQ	0.34	0.72	0.74	0.81
MQ	0.35	0.63	0.53	0.60
P	0.03	0.42	0.59	0.64
	Home resources			
H	0.78	0.75	0.88	0.93
Y	0.82	0.86	0.77	0.79

Note: Correlations from a regression model including a constant. All coefficients are significant at the 5% level. 364 observations.

Source: MARS 1986-2003. Own calculations.

3.3 The development of abilities

Abilities develop in a cumulative, dynamic process that has been referred to as the 'technology of skill formation' by Cunha and Heckman (2007). Initial conditions, both from the organic and the psychosocial perspective, together with the availability of specific home resources contribute to ability development. Experience in childhood may lay foundations for success or failure in school and for human capital formation in later life. Our epidemiological cohort data allow a detailed look at the initial risk conditions. Moreover, our study contains comprehensive psychometric assessments as well as medical and psychological expert ratings of abilities and specific home resources at significant stages in child development to estimate the parameters of ability development. The basic structure of the model of Cunha and Heckman (2007) is summarized in equation 3.1.

$$\Theta_t = f_t(I_t, \Theta_{t-1}, E) \tag{3.1}$$

IQ, MQ and P at stage t are combined in Θ. Note that the technology, f, may also vary depending on t. Other factors included in equation 3.1 are the initial conditions, E, and the economic and socio-emotional home resources, I. We are interested in the estimation of the formation process at the major stages of development. Assume that equation 3.1 can be represented in a Cobb Douglas form. Taking the natural logarithm yields equation 3.2:

$$\Theta^j_{t,i} = \alpha^{j,R}_{0,t} + \alpha^{h,j}_t h_{t,i} + \alpha^j_t \Theta^j_{t-1,i} + \alpha^{k,j}_t \Theta^k_{t-1,i} + \alpha^{1,j}_t \Theta^1_{t-1,i} + \epsilon^j_{t,i} \tag{3.2}$$

where j, k, l are indices for the three abilities *IQ, MQ* and P, and $i = 1, ..., N(364)$ is an index for the children. The variable R contains all nine cells of the two-dimensional risk matrix. All parameters can be interpreted as partial elasticity. We focus on the relationship between basic abilities in t with I in period t and the stock of basic abilities available from period $t-1$, taking the initial conditions into account.

The relationship between parental investments and children's abilities may be reciprocal (for a theoretical elaboration on optimal investment over the life cycle see Cunha and Heckman (2007)). Having a child with high cognitive or noncognitive abilities, for instance, is likely to increase H to bolster development. Having a child with low abilities may be a source of stress for the parents, which may even lead to a reduction of *H.* Reciprocity may create bias in the estimates. To address the issue of endogeneity of *H*, we compare OLS with Two Stage Least Square results (2SLS) and use the permanent Y as an instrument for H (see Table 3.2). Instead of *Y*, we calculate the permanent Y from the available waves, which is more attractive than a wave-specific measure of Y from an investment perspective. Y may contain some temporary fluctuations that are less relevant for investment decisions. Permanent Y is partially related to *H*, one necessary condition for an instrumental variable. We find significant partial correlations in each period (t_1=0.06, F-test=37.51; t_2=0.09, 43.68; t_3=0.11, 114.0; t_4=0.08, 82.09 and t_5=0.07, 102.74). The F-statistics indicate that there is no weak instrument problem.

A second condition for Y being a valid instrument is that it should only affect abilities through its relation with *H.* As the exogenous of an instrument is not testable for the one instrument case, we assume that the emotional environment of the child does not depend on economic resources, but is mainly driven by parents' attitudes towards the child's development (a direct pathway from Y to children's further achievement might become more relevant after the age of 10 years, see section 3.4). Indeed, the influence of Y on children's abilities is not significant when we include H in OLS estimates. However, H is significantly related to IQ and P until the age of 8 years, as is shown in Table 3.2.

Table 3.2: The partial elasticity of H and the stock of abilities

Ability	IQ_{t-1}	MQ_{t-1}	P_{t-1}	H_t	2SLS: Y
	t=11 years				
IQ_t	0.89**	0.13**	0.10**	0.17	-0.56
MQ_t	0.34**	0.66**	-0.01	0.13	0.46
P_t	0.31**	0.03	0.31**	0.28	0.83
	t=8 years				
IQ_t	0.84**	0.26**	0.07	0.19	0.43
MQ_t	0.00	0.42**	0.01	0.12	-0.77
P_t	0.27**	0.20**	0.29**	0.43**	0.65
	t=4.5 years				
IQ_t	0.53**	0.09**	0.02	0.38**	0.53**
MQ_t	0.26**	0.72**	0.11**	0.04	-0.18
P_t	0.61**	-0.04	0.18**	0.50**	-0.09
	t=2 years				
IQ_t	0.53**	0.09**	0.02	0.38**	1.52**
MQ_t	0.26**	0.72**	0.11**	0.00	0.48
P_t	0.61**	-0.04	0.18**	0.37**	1.27**
	t=3 months				
IQ_t	(0.12**,0.10**,0.04,0.11**,0.10**,0.02,0.07,0.09**)			0.55**	2.36**
MQ_t	(0.14**,0.11**,0.03,0.13**,0.08**,0.02,0.15**,0.10**)			0.16	-0.18
P_t	(0.02,0.07,0.06,0.06,0.09**,0.03,0.05,0.08)			0.29**	0.69

Note: All variables in natural logarithm; coefficients from OLS regressions including a constant and performed for each ability; heteroscedasticity robust standard errors; the equations for 2 years also contain variables indicating a cell in the initial risk matrix, as it is the case for the *MQ* equation at 8 and 11 years; describes the degree of organic and psychosocial risk: (0,0), (1,0), (2,0), (0,1), (1,1), (2,1), (0,2), (1,2), (2,2). **significant at 5% level. 364 observations.
Source: MARS 1986-2003. Own calculations.

The strength of the relationship differs between the three abilities and changes in a way specific to the developmental stage. 2SLS estimates for H are higher compared to the OLS estimates, specifically during childhood for the IQ. This finding suggests that children with higher (lower) cognitive abilities receive more (less) socio-emotional support from their parents. If this interpretation is appropriate, OLS would underestimate the partial elasticity of H due to simultaneity. H would be even more important than OLS results indicate.

However, there are two caveats. First, the 2SLS estimates produce high std.dev. (for the year 4.5 and the IQ equation the estimate is 0.53 with std.dev. 0.18 compared to OLS: 0.38, 0.7). Therefore, the difference to OLS is not always well determined. In fact, OLS results with low std.dev. may be closer to the 'true' parameters of the technology of ability formation. Second, identifying the channels through which interaction takes place in social reality remains a question for future research. In our data, the time variation of H and Y is lower compared to the time variation of the abilities. Therefore, the main direction will be from H to abilities, especially during childhood (the period that we are interested in). Furthermore, it seems that some parents try hard to compensate for low abilities. Section 3.2, for instance, indicated that for the group of children without any psychosocial risk, there is no difference in H with regard to organic risk. Parents seem to put effort into helping their children if these were exposed to organic risk during birth. The next section shows that this effort improves school achievement.

The goal of the current section is to estimate stage specific parameters of the technology of ability formation from birth until the age of 11, based on psychometric assessments. From the comparison discussed above and further regressions (available upon request, see Blomeyer et al. (2008) we conclude that the OLS estimates presented in Table 3.2 are robust. However, we refrain from interpreting the findings in a causal way, for reasons presented above.

In the following part, we concentrate on OLS results. Cognitive and noncognitive abilities are significantly related to the socio-emotional home resources, while the basic motor ability is not. P is significantly associated with H throughout developmental stages until age 8, with the estimated partial elasticity varying around 0.4. IQ, however, is positively related to H only until the age of 4.5 years, with an estimated partial elasticity varying around 0.4. At school age, the elasticity drops to 0.28 and is no longer significant. The partial elasticity of the past and the current IQ increases steadily. This indicates that self-productivity (a term introduced by Cunha and Heckman (2007)) increases steadily. In early childhood, the partial elasticity is still small (relative to the partial elasticity of H). At primary school age, the relationship between cumulative abilities and IQ is already high. Individual differences in IQ become stable or consolidate between the age of 5 and 8 years. At the age of 8 years, the estimate approaches 0.9, comparable to the results from Cunha and Heckman (2008).
The results for MQ are different. The partial elasticity of H with respect to motor abilities never reaches significance. The estimates of the partial elasticity of the past and

the current MQ are higher compared to those for IQ. MQ seems to solidify even faster. Moreover, initial risk conditions remain relevant for the level of MQ.

Note that the partial elasticity of the past and the current P shows a different pattern with lower values at all developmental stages. A confirmation of this finding is that the partial elasticity of H with respect to P also remains significant at primary and secondary school age. In other words, noncognitive abilities remain malleable during adolescence (Heckman (2007), Borghans, Duckworth, Heckman, and Weel (2008)). We find evidence for synergies in ability formation among P and IQ. Since the IQ seems to consolidate between the ages of 4.5 and 8 years, insufficient socio-emotional home resources in early childhood are particularly harmful for human capital formation.

3.4 Abilities as predictors of children's school achievement

Do abilities acquired during childhood predict children's achievement at school? In this section, we investigate the predictive power of abilities gained at preschool age for grades in maths in primary schools (at the age of 8). In addition, we examine the predictive power of abilities gained up to the age of 8 years with respect to the likelihood of attending a 'Gymnasium', the highest high school track in the German educational system (this is the academic track, a college/university entry requirement). The entry in a 'Gymnasium' takes place, as a rule, after the age of ten.

Our discussion starts with findings from the initial risk matrix. School achievement at the age of 8 years confirms the importance of the initial risk conditions. Average grades in maths vary with the cells of the risk matrix. In the group of children with high psychosocial and high organic risk, average grades in maths are 2.9 (in Germany, grades vary from 1: excellent, to 6: insufficient). The value is about one grade lower compared with the no risk group. Parental investments seem to compensate for some of these risks improving school achievement. The share of children attending the 'Gymnasium' differs in the initial risk matrix. Among children with high psychosocial and high organic risk, only 15% attend the Gymnasium compared to 74% in the group of children with no risk. There is no difference between the children born with no or only moderate psychosocial risk if they are not affected by organic risks.

Table 3.3 presents the findings from multivariate estimates of the determinants of grades in maths at the age of 8 and of the probability of attending the Gymnasium after the age of 10. In both equations, the stage-specific home resources H and Y are included. The results from two different estimates are presented. One of these includes all available lags of the abilities (columns 2 and 4) to reduce a potential omitted variables bias, the other (columns 1 and 3) does not. Using all lags slightly reduces our ability coefficients. Therefore, the bias from omitted variables seems to be rather small.

Table 3.3: Predicting grades in maths at the age of 8 and Gymnasium attendance after the age of 10

	grades in math at age 8		attending Gymnasium	
	basic	add lags	basic	add lags
Abilities				
H_t	-0.49	-0.44	0.82**	0.60**
Y_t	-0.04	-0.03	0.15**	0.18**
IQ_{t-1}	-0.66**	-0.59**	1.03**	0.84**
MQ_{t-1}	-0.10	-0.18	0.37**	0.33**
P_{t-1}	-0.25**	-0.22**	0.49**	0.38**
(Pseudo) R^2	0.17	0.32	0.29	0.32
Observations	327	327	357	357

Note: All variables in natural logarithm; lag specification contains all available lags in abilities: these lags are jointly significant; LR-tests: 86.18**, 71.35**: **significant at 5% level.
Source: MARS 1986-2003. Own calculations.

All variables have been transformed to natural logs allowing a partial elasticity interpretation. The estimates reveal that *IQ, MQ* and P significantly predict school achievement at the age of 8 and Gymnasium attendance after the age of 10. Cognitive abilities are more important than noncognitive abilities in both equations. Interestingly, neither H nor Y seems to significantly enhance grades in maths at primary school age. However, both home resources significantly increase the probability of attending the Gymnasium. For higher secondary school attendance, the economic resources Y now become relevant (in addition to H and the cumulated abilities).

We conclude the section with numerical assessments of the relative role of investments in early childhood and at school age for Gymnasium attendance based upon our estimates (Tables 3.2 and 3.3); for a theoretical analysis of optimal investment, see Cunha and Heckman (2007) and for an application over the life-cycle, see Pfeiffer and Reuss (2008). Assume that the government would like to improve children's abilities and increase the share of children entering the Gymnasium. The government is willing to raise Y for all households by 10% (that is 103 DEM in nominal terms 1986/1987, 1st wave, 151 DEM in nominal terms 1997/1998, 5th wave). We further assume that an increase in Y by 10% increases H by an average of 1% (see section 3.3 for the empirical relationship).

A 10% increase of Y implemented when the child is 11 years old would increase the probability of attending the Gymnasium by 1.8% (see Table 3.3, column 4), ignoring any relationship with abilities. If the improvement of economic home resources is performed earlier it would only work indirectly through H. In that case, (taking into account all direct and indirect multiplier and accelerator effects, with all abilities and throughout all waves, calculated from Table 3.2) the gain would be 1.18% if Y is increased at 3 months, 1.07% if at 2 years, 0.93% if at 4.5 years and 0.37% if at 8 years. If Y is increased each wave during childhood, (until the age of 4.5 years) the probability would increase by (1.18+1.07+0.93=) 3.18%. In addition, children's abilities would be higher. The *IQ*, for instance, would have increased on average by 3.86% until the age of 11 years. We conclude that investment during preschool age bolsters children's cognitive and noncognitive abilities and improves school achievement. Economic support at school age increases the probability to enter Gymnasium in addition.

3.5 Conclusion of Chapter 3

This paper analyses the development of abilities, starting in infancy, and their predictive power for children's achievement at school age. Our epidemiological cohort data, taken from the Mannheim Study of Children at Risk (MARS), allow for a detailed look at the initial risk conditions. In addition, the data contain comprehensive psychometric and medical assessments, as well as psycho-logical expert ratings of abilities and specific home resources at significant stages of child development.

Growing up in an unfavorable environment impedes the development of basic cognitive and motor abilities. The disadvantage continues until school age, an important stage for noncognitive ability formation. Disadvantaged children are impeded again when the transition to higher-track secondary school attendance takes place. At this stage, economic resources create an additional barrier. Future research on competence formation needs to focus on the variety of parental care and its interaction with individual development.

4 Maternal Employment and Child Care Decision

Abstract:[1] When estimating the determinants of child care participation, the simultaneity in mothers' decision to work and in the decision to use child care is a major challenge. We provide first evidence on the determinants of institutional child care use addressing the endogeneity of mothers' labor supply by applying an instrumental variables approach. This endogeneity has often been neglected in studies on child care choice, even though the decision to use child care outside the home is strongly connected to mothers' decision to work after childbirth and vice versa. Based on the German Socio-economic Panel (SOEP) from 1989 to 2006 we show that children living in West Germany have a higher probability to attend institutional care if their mothers increase their actual weekly working time. Estimating the determining factors of child care participation without addressing the simultaneity issue underestimates the influence of maternal working time.

Keywords: child care decision, kindergarten attendance, maternal employment

JEL-classification: I21, J13, J22

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[1]This chapter is a joint work by Katja Coneus, Kathrin Göggel and Grit Mühler. It is published in the *Oxford Economic Papers (2009), 61, 172-188.*

4.1 Introduction to Chapter 4

A working woman who becomes a mother has to decide whether she is willing to continue her employment, either part-time or full-time, and how her child will be cared for while she works. Each of the two decisions – whether or not to return into employment and whether or not to use non-parental care – depend on a broad range of determinants such as parental preferences, societal attitudes and country specific family policies. But more importantly: the two decisions are interdependent. Thus, the mother's employment decision is not exogenous to the child care decision. In the end, both child care and employment arrangement need to fall into place to re-enter the labor market. However, most of the studies which estimate the determinants of child care participation do not take into account the simultaneity of the employment and child care decision. The main goal of our study is to propose an instrumental variables approach which addresses the endogeneity of maternal labor supply on the use of institutional child care.

In their theoretical models e.g. Pungello and Kurtz-Costes (1999) or Wrohlich (2006) show that parental beliefs influence child care choices and choices do also influence parental beliefs. Consequently, there are two branches of the economic literature with an interest in either the effect of child care provision on female labor market participation or the effect of maternal work on child care choices.

Regarding the first branch, research in economics as well as in social sciences agrees upon the fact that mothers are more likely to return to the labor market if there is adequate provision of child care. Whilst high coverage rates permit to take up work, subsidized prices raise the net revenues from employment. Several studies attempt to estimate a causal effect of child care availability or prices on female labor market participation using structural models (e.g. Ribar, 1995; Powell, 2002) or exploiting reforms or regional variation (Gelbach, 2002; Simonsen, 2006; Lundin, Moerk, and Oeckert, 2008). In particular, availability, quality and price of child care drive the decision to return into part-time or full-time employment.

Regarding the second branch, empirical evidence is smaller and does often assume maternal labor force participation to be exogenous to the child care decision (see for Italy Del Boca *et al.* 2005; for the U.S. and Canada Michalopoulos and Robins, 2002; for Germany Ondrich and Spiess, 1998; Spiess *et al.*, 2002; Kreyenfeld 2009). Working mothers and single-parent households are more likely to use non-parental care, in particular when their children are younger and when working daytime shifts (Hofferth, Chaplin, Wissoker, and Robins, 1996; Peyton, Jacobs, O'Brien, and Roy, 2001). The same holds for highly educated parents and high income families (Singer, Fuller, Keiley, and Wolf, 1998; Huston, Eun Changa, and Gennetian, 2002). Conelly and Kimmel (2003) control for the endogeneity of the employment decision by including predicted employment status as a regressor but focus on the effect of child care prices on the mode of care. The focus of our analysis is to uncover several influences on child care choice which are observed within a household, e.g. parental education, marital status, or the existence of siblings. Pursuing research towards the determinants of child care participation seems especially promising as there is evidence that education in early childhood is crucial for the formation of skills later in life (for a summary see e.g. Cunha et al., 2006). A growing awareness for the importance of preschool education might – apart from the employment aspect – raise parents' use of institutional child care. Estimating the factors which determine child care choice is thus a policy relevant question when preschool skill formation is considered to be important for the later school and labor market career.

With this paper we contribute to the second branch of the literature. In contrast to the aforementioned papers, our study explicitly addresses the simultaneity of a mother's labor market decision with the decision for institutional child care. To tackle the endogeneity problem we use a binary response model approach with one continuous endogenous regressor (IV Probit) where the actual working time of the mother two years before the birth of the first child serves as an instrument for actual maternal labor supply. Data are drawn from the German Socio-Economic Panel Study (SOEP). The estimation sample is pooled over the years 1989–2006 and consists of 2,970 observations of mothers and their firstborn children. Our results show that without accounting for endogeneity, we find – in line with prior research – a positive correlation between child care use and maternal working time. Children have a higher probability to attend institutional care if the mother increases her weekly working time. However, estimating the effect using the working time two years before childbirth as an instrument reveals that the influence of the number of hours worked on the probability to use institutional child care is larger than predicted by the probit model. One explanation of this bias might be the existence of mothers who do not return to the labor market but nevertheless send their children to institutional child care. Thus parents might regard institutional child care as a key element for the education and socialization of young children. We therefore would interpret the observed downward bias as possibly reflecting social attitudes.

The remainder of this chapter is organized as follows. Section 4.2 outlines the institutional setting and summarizes data, sample as well as explanatory variables. Section 4.3 presents estimation strategy and identification. Results and discussion are shown in section 4.4 and section 4.5 concludes.

4.2 Institutional setting and descriptive statistics

As early childhood education and care services in Germany are mostly publicly provided, institutional child care is the dominant child care setting for German children. The type of center-based care and the share of German children attending them depend mainly on age. There are separate institutions for infants and toddlers up to the age of three (Kinderkrippe), others for children from age three to compulsory school age six (Kindergarten).[2] Attendance of each of these institutions is up to parents and not mandatory for the child. Parental costs for child care are low in international comparison and fee structure accounts for parental income. In the year 1996, Germany experienced a policy change, where a legal claim on a child care slot for children aged three to seven was introduced. Hence, parents are not constrained when requesting a half-time slot for their child in this age group. Consequently, that is what most German parents do (Hank and Kreyenfeld, 2003). Therefore, our analysis is carried out using participation in institutional child care between age three to seven as dependent variable.

As child care supply and habits in using child care are still significantly different in the five new federal states and the number of observations is rather small we exclude East Germany from our sample. The number of children aged zero to two in public day care is only a very small fraction. In East-Germany on average 39.8% of the children are in public child care, in West-Germany it is 8.0%. In the age group of three years to school entry, coverage rates are much higher as children from age three on are legally entitled to child care. In 2007 around 87% of children in this age group attended institutional child care or public day care in West Germany (Statistisches Bundesamt, 2007).

The analysis is based on longitudinal data from the German Socio Economic Panel Study (SOEP) at the German Institute for Economic Research (DIW), Berlin. The SOEP is an annual representative sample beginning in 1984 of approximately 12,000 private households whereof we use the years 1989 to 2006 because there are not enough observations in the years before. While drawing our sample on the child level, we use information on household characteristics, educational background and labor market participation of the parents as well as information concerning institutional child care. To control for the fact that once the decision to attend child care is made, there is high probability of continued kindergarten participation, we use clustered and robust standard errors in our pooled sample on the child level. Through this clustering we allow for serial correlation within a cluster but not between different clusters.

[2] Recently this separation into age specific institutions is sometimes given up in favor of age-mixed child care settings (Kindertagesstätten) which cover the whole age range.

Table 4.1: Descriptive statistics

Variable	Mean	Std.dev.	Min	Max
child care attendance	0.67	0.47	0	1
weekly working hours mother	10.99	14.72	0	80
share of mothers working	0.46			
share of mothers working before birth	0.85			
education mother (in years)	11.68	2.44	7	18
child's age 3	0.26	0.44	0	1
child's age 4	0.24	0.43	0	1
child's age 5	0.22	0.41	0	1
child's age 6	0.20	0.40	0	1
child's age 7	0.08	0.27	0	1
siblings	0.51	0.50	0	1
mother's age	31.73	4.49	22	54
single parent	0.10	0.30	0	1
(both) parent(s) German	0.77	0.42	0	1
city size	4.12	1.73	1	7

Note: 2.970 observations.

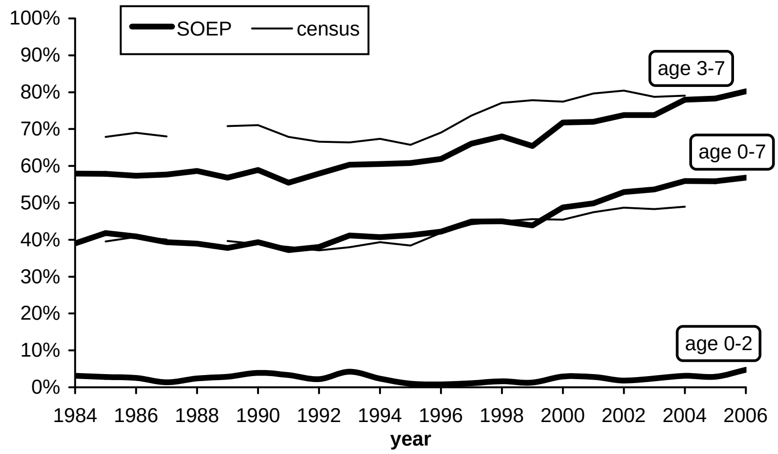
Source: SOEP 1989-2006. Own calculations.

Our sample contains only the firstborn child. We would expect that mothers' decisions to work after the firstborn child differ from the decisions to work after the second born child. For example, it is more likely that mothers reenter the labor market, if they have only one child in comparison to mothers with at least one child. In restricting the sample, we are able to estimate a much stronger first stage and obtain a more precisely estimated second stage coefficient. A further reason for only including firstborn children is our estimation strategy (see Section 4.3). As we use mother's working time two years before birth of the first child as an instrument, including all children would imply using the same instrument for every child of the same mother. Our final sample is pooled over the years 1989–2006 and contains 2,970 observations for West German firstborn children aged three to seven who do not attend school.

Two thirds of the children in our sample attend institutional child care (see Table 4.1). The numbers range from 15% for the three year olds to almost 90% for the elder children. In one of two cases the child has a younger sibling. Three quarters of the sample are children of parents with German nationality. The over-representation of immigrants in the sample is due to oversampling of foreigners in the SOEP. We observe 10% single-parents in our sample.

Figure 4.1 displays the development of child care attendance over the last 20 years and compares SOEP data to official census data. The SOEP data only slightly differs from representative data (Statistisches Bundesamt, 1984-2004). Furthermore, both data show an increase in participation rates of three to seven year olds from 1996 on.[3]

Figure 4.1: Children in institutional child care 1984–2006: SOEP and census data



Soure: SOEP 1984-2006, Mikrozensus 1984-2004 (missing information for the years 1984, 1988, 2005 and 2006). Own calculations.

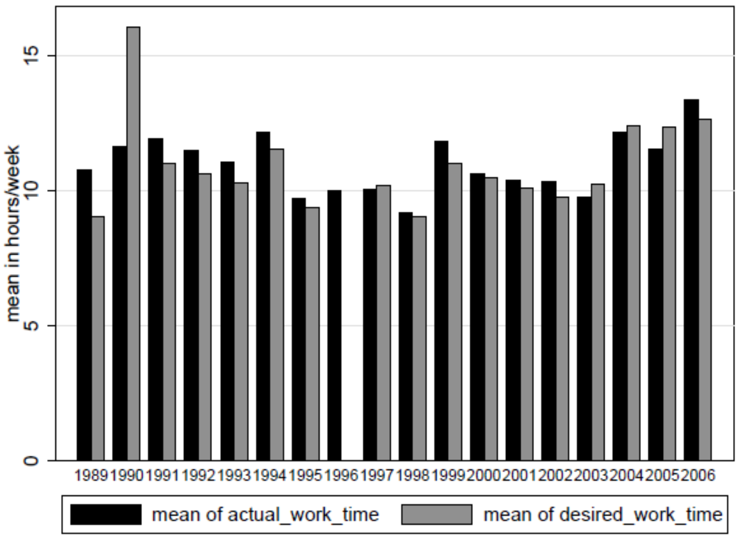
In our analysis the actual weekly working time of the mother is our main variable of interest. We use the actual working time rather than contractual working time as the last does not reflect the real time the mother has left for her child. Neither in mothers' actual working time nor in their desired working time we observe structural changes. Nevertheless the two variables stay close to each other over the years (see Figure 4.2).

The correlation coefficient between these two variables is 0.90 and a t-test yields no significant difference between mothers' desired and actual working time. We take this as an indicator that there is no problem of child care availability. Another implication out of this correlation is that there are minimal labor market restrictions for mothers. The share of mothers not working two years before birth of their first child is 15%, and is rising to 85% in the year after birth. With growing age of the child, the share of non-working mothers is diminishing until 48% at age seven (see Figure 4.3).

Relating these figures to the child care participation rates mentioned earlier, reveals that there is a substantial gap between the share of mothers working and the share of children

[3]This could be a result of the policy change in the year 1996. We observe an increase from 62% (1996) to 80% (2006) in the use of kindergarten for the relevant age group.

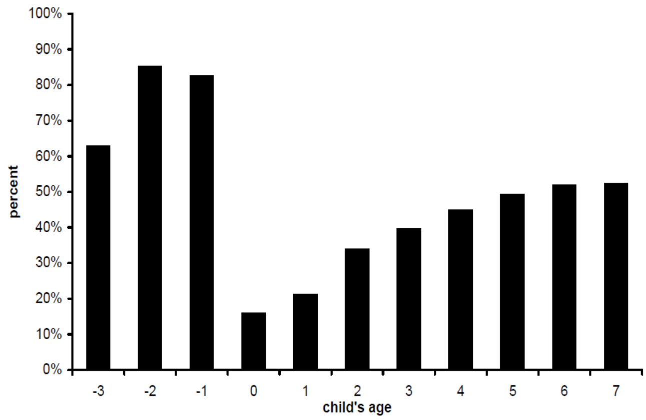
Figure 4.2: Desired vs. actual working time of mothers (in means) 1989-2006



Note: Mothers with working time equal to zero are included. Only mothers of children aged three to seven are included. 2.970 observations.

Source: SOEP 1989-2006. (Data for desired missing in 1996.) Own calculations.

Figure 4.3: Share of mothers working by first child's age



Note: Values of child's age below zero indicate the years before birth of the first child. 2.970 observations.
Source: SOEP 1989-2006. Own calculations.

in institutional child care. Parents with children under age three and parents in need for a full-time slot face supply side restrictions. This gap is covered by informal care arrangements, such as non-public daycare (grey market) or care by grandparents and relatives. In particular for the under three year olds these modes are important care settings. Around 13% of the children with full-time working mothers are cared for in informal day care, 42% of the children are taken care of by the grandparents (Bien, Rauschenbach, and Riedel, 2006, pp. 148, 181). Unfortunately our data does not allow to further investigate informal care settings.

4.3 Econometric framework

We estimate a probit model with one continuous endogenous regressor to assess the probability for a child to attend child care. The problem is then described in equation 4.1 and 4.2,

$$y_{1i}^* = y_{2i}\beta + x_{1i}\gamma + u_i \quad (4.1)$$

$$y_{2i} = x_{1i}\Pi_1 + x_{2i}\Pi_2 + v_i, \tag{4.2}$$

where $i = 1, ..., N$ and y_{2i} is a 1 x p vector of endogenous variables, x_{1i} is a 1 x k_1 vector of exogenous variables, and x_{2i} is a 1 x k_2 vector of additional instruments. Equation 4.2 describes the reduced form, where Π_1 and Π_2 are matrices of the reduced-form parameters. Rather than observing y^*_{1i}, we observe

$$y_{1i} \quad = \quad \begin{cases} 1 & \text{if } y^*_{1i} > 0 \\ 0 & \text{if } y^*_{1i} \leq 0 \end{cases}$$

The indicator variable y_{1i} describes child care attendance and turns 1 if the child attends child care and 0 otherwise. The latent (unobserved) continuous variable y^*_{1i} denotes hours of institutional child care demanded by the mother. Our main variable of interest is the actual working time of the mother. Other important parental determinants are education, age, nationality, and the family structure. We further control for the number of siblings in the household, the age of the child, year effects, city size (Gemeindegroesse) and federal state effects (Laender). All variables are described in Table C.1, Appendix. Under the assumption of an independent and normally distributed error term we are interested in the conditional expectation function. But the use of institutional child care and mothers' decision to return to the labor market after child birth constitutes an interdependent decision making process. In econometric terms, this means that there is a feedback relationship between both variables causing probit estimates of the probability to participate in institutional child care to be biased. As simultaneity is one source of endogeneity, one solution to that problem is to employ instrumental variables. A suitable instrument must fulfill two conditions. First, it needs to be correlated with the actual working time of the mother which is the endogenous variable. Second, it may not affect current child care attendance except through the endogenous variable. One source of exogenous variation in the maternal labor supply might be the actual working time of the mother two years before child birth of the firstborn child.[4] This lagged maternal labor supply is an indicator for

[4]Thus, we focus on the firstborn children in our analysis. We focus on working time two years before birth as this is not influenced by the (planned) pregnancy. Using the working time three years before birth yields to similar results. Including the siblings would enlarge the sample but would create multiple use of the same instrument (for one mother).

labor market attachment. We expect the working hours of the mother before child birth to be strongly correlated to actual working hours, as both reflect the attitudes and working preferences of the woman. Several studies have shown that positive state dependence is likely to occur for both, the decision to return itself and the hours of labor supplied (e.g. Geyer and Steiner, 2007; Haan, 2005).

Concerning the instrumental variable, the working hours of the mother two years before birth of the first child, we observe a significant correlation of 0.13 (see Table C.2) with the actual working hours. The F-test for the first stage regression gives a test-statistic of 18.50, thus we have no weak instrument (Stock, Wright, and Yogo, 2002). We performed overidentification tests of the instrument including a second instrument (see Appendix, Table C.3). Those indicated that at least one of the instruments was not correlated with the error term, i.e. exogenous. Although these tests cannot be performed in the single instrument case, this gives us some evidence for the zero-correlation between the error term and our instrument.

We observe variation in the working hours before birth (see Appendix Figure C.1) and no considerable state-dependence between the decision to work before and after birth of the firstborn child. The SOEP includes the question if pregnancy occurred rather planned or unplanned. 40% of the births in the SOEP 2003-6 occurred rather unplanned. If then women did not plan to get pregnant it is also very likely to be the case that they had no idea on the child care decision, neither. Using a dummy variable (worked/ worked not) instead of the continuous variable as instrument did not change the results.

Regarding the second condition, we assume that the working time two years before child birth does not influence current child care attendance through other channels than actual working hours. As we want to disentangle the simultaneity between the decision to work and the decision to use child care, former working hours are the best instrument available so far, as the decision is taken long before the decision for child care. However, education of the mother might affect both, former and current labor market supply. This is taken into account by inclusion of the years of education of the mother in the regression.

It is assumed that the error terms of equation 4.1 and 4.2 (u, v) are bivariate normally distributed with zero mean, a correlation ρ and variances 1 and σ_v^2, respectively (Wooldridge, 2002; Winkelmann and Boes, 2006).[5] Under the joint normal distribution of (u, v) with

[5] Note that there is no endogeneity problem if u and v are independent.

$var(u) = 1$ follows: $u = \theta v + \epsilon$, where $\theta = \frac{\eta}{\tau^2}$, $\eta = cov(u, v)$, $\tau^2 = var(v)$. The reduced-form equation for y_{1i}^* can be written as follows:

$$y_{1i}^* = (x_{1i}\Pi_1 + x_{2i}\Pi_2 + v_i)\beta + x_{1i}\gamma + u_i \tag{4.3}$$

To obtain consistent estimator for mother's working time we estimate the model using Maximum Likelihood.

4.4 Results

We estimate the determinants of the decision to use institutional child care for the sample of firstborn children living in West Germany that are between three and seven years old. The estimation results of the probit model (Probit) and the binary response model with one continuous and endogenous regressor (IV-Probit) are shown in Table 4.2. In line with other studies we find a positive and significant correlation of the mother's actual working time on the probability of the child to attend institutional child care (e.g. Ondrich and Spiess, 1998; Conelly and Kimmel, 2003). If the working time of the mother rises by ten hours a week, the probability of Kindergarten attendance increases by eleven percentage points. But surprisingly, in the binary response model with one continuous endogenous regressor (IV-Probit), the influence of the hours worked is larger than the estimates predicted by the probit model. Our estimation strategy illustrates an existing underestimation of the effect if not considering endogeneity in the decision process. We interpret the observed downward bias as possibly reflecting social norms. We define these as 1) work ethic (working as such is good and socially preferred), 2) mothers should stay at home, if their children are not yet attending school, and 3) children should attend institutional child care from the beginning of age three on. If these social norms exist in West Germany, it would imply that even if the mothers do not necessarily participate in the labor market, their children are still likely to attend institutional child care. And this is indeed what we observe. In our data 32% of the children are attending institutional child care while their mothers are not working.

There are several studies in the literature which support our explanation. First, Wernhart and Neuwirth (2007) perform a European comparison based on data from the International Social Survey Programme (ISSP) from 2002. Their results show that more than half of the West Germans think that preschool children suffer if their mothers work. With this rate, West Germany ranks among the first five countries in Europe. Furthermore, almost

Table 4.2: Kindergarten – average marginal effects

firstborn children (3-7 years)	**Probit**	**IV-Probit**
weekly working hours mother	0.004***	0.011**
	(0.001)	(0.005)
education mother (in years)	0.013**	0.005
	(0.005)	(0.007)
siblings	0.027	0.101*
	(0.026)	(0.057)
child's age 4	0.320***	0.307***
	(0.016)	(0.019)
child's age 5	0.432***	0.421***
	(0.016)	(0.017)
child's age 6	0.454***	0.443***
	(0.015)	(0.016)
child's age 7	0.306***	0.307***
	(0.014)	(0.015)
mother's age	0.004	0.004
	(0.003)	(0.003)
single parent	0.086***	0.067*
	(0.029)	(0.035)
(both) parent(s) German	0.092***	0.115***
	(0.031)	(0.035)
city size	0.014*	0.013*
	(0.007)	(0.007)
Berlin-West	0.131	0.124*
	(0.069)	(0.071)
North	0.027	0.013
	(0.033)	(0.034)
South	0.124***	0.109***
	(0.029)	(0.031)
year 1992-94	0.049*	0.054
	(0.036)	(0.036)
year 1995-97	0.042*	0.058
	(0.038)	(0.039)
year 1998-00	0.139***	0.149***
	(0.032)	(0.033)
year 2001-03	0.166***	0.179***
	(0.030)	(0.031)
year 2004-06	0.210***	0.217***
	(0.027)	(0.027)
N	2,970	2,970
χ^2	1138.57***	1209.32***

Note: See first-stage regression in Appendix Table C.2. Clustered standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level.

Source: SOEP 1989-2006. Own calculations.

90% of the Germans think, women should work when married but not when they have children. When having children under age 7, mothers should stay at home as stated by 50% of the West Germans. Only Poland, the United Kingdom and Slovakia have higher rates on this issue. Secondly, when studying the life satisfaction of mothers results point in a somewhat similar direction. E.g. Holst and Trzcinski (2003) show that German mothers who work part-time are the most, mothers who work full-time are the least satisfied with their lives.

Furthermore, we find several positive and significant determinants of the probability to give a child into institutional child care and can thus confirm most of the results of other studies (Singer et al., 1998; Huston et al., 2002; Spiess, Buechel, and Frick, 2002; Kreyenfeld, 2009). We observe no significant impact of the education of the mother on the probability of the child attending institutional child care.

If the child has siblings, the probability of attending kindergarten rises. At first, we would expect caring parents more frequently staying at home if they have more young children. But our result supports the idea that parents with more young children seek for institutional child care to have time for the babies (for them a child care slot cannot be claimed) and housework.[6] The age dummies are all significant and positive implying that the probability of a child attending kindergarten is rising with age. This is not surprising as descriptive statistics show that the attendance rate increases from 17% at age three to 93% at age seven in the sample.

There is a significant impact if one parent is raising the child alone. We conclude that single parents are different in their demand for child care. There seem to be a substantial difference between households with two parents or other relatives (such as grandparents) and single parent households. If both parents or the single parent are German, the probability of sending the child to kindergarten rises. The kindergarten attendance seems to be more frequent for Germans. This could be due to different cultural settings and as well to the higher number of persons in immigrant households providing more possibilities for informal child care. Children coming from larger cities are more frequently attending kindergarten. This last fact is not surprising as the supply of institutional child care slots increases with city size (Kreyenfeld, 2009). Although, the 1996 law assures a half-time slot for all children from age three on, parents in need for a full-time slot might face supply side restrictions, especially in rural areas. Furthermore, the labor attachment of mothers is higher in bigger cities and we suppose that informal child care settings are more frequent in

[6]In addition, in the institutional setting, the probability of getting a full-time child care slot rises with the number of children a family has.

rural areas. Grouped year dummies control for year-specific effects in the pooled sample, as well as grouped Laender dummies control for differences between West German federal states. We would expect that year effects capture supply side restrictions of institutional child care as well as to some extent the rather small differences across fee structures.

Including the education time of the father in addition to the mother's education time in the estimation results in a 'transfer' of the mother's education impact on the father's coefficient. It seems as if fathers' education is in general higher than mothers' and stronger correlated with the kindergarten decision. Including income variables, such as the equivalence income of the household or the hourly wage of the mother does not give any significant impact. The same is true for employment categories (blue-collar, white-collar, civil servant and self-employed) and education categories (instead of education in years). In addition we included more variables which could be relevant in the child care and labor market participation decision: the weekly working time of the father, the number of adults in the household (to capture effects of other persons helping with child care), and home ownership of the family. Including these variables one after the other and all together in our regression does not change results. All of these variables are not significant.

4.5 Conclusion of Chapter 4

Mobilizing the labor pool of non-working mothers is on the top of the political agenda of most OECD countries especially with regard to the consequences of the demographic transition during the next decades. An adequate provision of early childhood education and care which ensures availability, affordability and quality of child care is considered to be an important instrument for maternal labor force participation. In international comparison particularly the Nordic countries stand out with their high female participation and fertility rates – effects which are mainly attributed to the family-friendly policies in these countries (Datta Gupta, Smith, and Verner, 2008). Apart from labor market reasons, early educational stimulation of children constitutes a second reason for a country to invest into child care provision (OECD, 2006). Early skill formation might not only extend the period of investment in human capital but may also raise later returns to education. Both reasons are particularly important for Germany. Especially in West Germany, child care use for children under age three but also from ages three to seven is still low in comparison to other Western European countries. At the same time, Germany faces substantial school drop-out rates and a large group of low educated children. Investing into child care and understanding the determinants of parental child care choice is thus of political interest for both, employment and educational reasons. This paper contributes to the ongoing debate by estimating the determinants of child care choice with an emphasis on the effect of maternal labor supply.

By using a binary response model and by instrumenting the actual working time of the mother with her working hours two years before the birth of the first child we attempt to account for the endogeneity of the mother's decision to work. Our results show that the labor market status of the mother is an important predictor for the child being in institutional care or not. Without accounting for endogeneity, we find – in line with prior research – a positive correlation between child care use and maternal working time. Children have a higher probability to attend institutional care if the mother increases her weekly working time. Applying the instrument reveals that the influence of the number of hours worked on the probability to use institutional child care is larger than predicted by the probit model. Thus, estimating the probability to attend child care without addressing the simultaneity in the work and care decisions might underestimate the effect. One explanation of this bias might be the existence of mothers who do not return to the labor market but nevertheless send their children to institutional child care. Thus parents might regard institutional child care as a key element for the education and socialization of young children. We therefore would interpret this finding as possibly reflecting social norms.

As our analysis is limited to firstborn children aged between three to seven several questions are left for future research. First, it might be interesting to use an identification strategy relying on recent reforms in child care such as the reform of the parental leave benefit in 2007. Second, one could study how a mother's decision to work affects the decision of institutional child care for children under age three. Recent policy changes in Germany foster the supply of institutional child care for children under age three and provide a possibility for research in that area. More research on the attendance of different types of out-of home care and its effects on different families, e.g. families with migration background, might be a second interesting topic. The upcoming waves of the SOEP that among others focus on mothers and newborn children will provide a substantially larger database for future research on these questions.

5 The Intergenerational Transmission of Health in Early Childhood

Abstract:[1] The prevalence and importance of children's physical health problems have received increasing recognition in recent years. Such problems as obesity, motor impairment and chronic diseases cause high social costs. Furthermore, they can lead directly to physical health problems in adulthood, which incur additional social costs. This paper examines the intergenerational link and transmission of both maternal and paternal health to children's health in Germany. We investigate this issue using data from the German Socio-Economic Panel (SOEP), making particular use of the Mother and Child Questionnaires. These data allow us to capture a broad set of health measures: anthropometric, self-rated and self-reported health measures. We find significant relationships between parental and child health during the first six years of life. In order to take into account the endogeneity of parental health, we estimate fixed effects models. Overall, we find, controlling for parental income, education and family composition that parents who experience poor health have children with significantly poorer health in terms of anthropometric, self-reported and self-rated health measures.

Keywords: intergenerational transmission, child health, parental health, early childhood
JEL-classification: I1, I12, J13

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5.1 Introduction to Chapter 5

In recent years, there has been a growing concern about the children's health. A special health survey among children in Germany, for instance, showed that only 39.2% of the parents rate the health of their children as 'very good' (Kurth, Hoelling, and Schlack, 2008). Furthermore, they report that 7.5% of all girls and 10.3% of all boys between 11 and 17 years have 'hay fever', while 3.5% of all boys in this age group and 2.5% of all girls are reported to have asthma. Children's physical health problems such as obesity, bronchitis, vision and motor impairments cause social costs, primarily in the health sector. Moreover, children's health problems can lead directly to physical health problems in adulthood, which cause additional social costs.

In the economic literature, there are various research strands dealing with child health. One of these strands focuses on the association between child health and parental background factors, such as education and income (e.g. D. Thomas (1994), Currie and Stabile (2003), Case, Lubotsky, and Paxson (2002), Burgess, Propper, and Rigg (2004), Currie and Moretti (2003), Case and Paxson (2008a)). Most of these studies deal particulary with the child-health-income gradient. For a recent overview, see the essay by Currie (2009), which focuses on links between the parental socioeconomic status (e.g. education, income, occupation, or in some cases area of residence) and child health. However, while most of these studies find a strong relationship between various parental background measures and child health, there is little evidence that the relationships are causal.

A second strand of research attempts to quantify the effects of early infant health on a person's future health, education and social outcomes. This economic literature recognizes that physical health problems can impede children's human capital formation throughout the whole life cycle, see for example Almond et al. (2005), Currie and Lin (2007), Case, Fertig, and Paxson (2005), Miller, West, Brown, Sim, and Ganchoff (2005), Ding, Lehrer, Rosenquist, and McGovern-Audrain (2006), Currie and Hyerson (1999), Currie and Neidell (2005) or Black et al. (2007). Most of these studies focus on the correlation between low birth weight (LBW) and later outcomes. In developed countries, LBW is often considered as an indictor of poor health at birth. Aside from LBW, there has been little research on the long-term consequences of other specific health conditions. For one exception, see Currie and Stabile (2006), who examine the long-term consequences of Attention Deficit Hyperactivity Disorder (ADHD) on educational attainment and delinquency. For Germany, Salm and Schunk (2008) find that childhood health conditions explain 18% of the gap in cognitive ability and 65% of the gap in language ability. Altogether, this research shows that controlling for parental income, education and social class, children who experience poor health in childhood have significantly lower educational attainments, poorer health and a lower social status as adults (for a recent summary of this literature, see Currie (2009)).

Until now, studies investigating the intergenerational correlation between the physical health of the parents and the children's physical health, however, have received less explicit attention in the economic literature. This paper focuses on this issue, examining the intergenerational links and transmissions of health between parents and children in Germany.[2] There is little work in the economic literature exploring the importance of 'health' in the intergenerational transmission of socio-economic status. Parental health might influence child health either because parents and children share the same genetic endowments and/or through 'behavioral or environmental effects' (for a short discussion see Sacerdote (2007)).

We concentrate here on analysing the link and transmission process between parental health and children's health during their first six years of life. The early years are a crucial period for health and skill formation (Cunha et al., 2006). Recent empirical evidence has underscored the strong effect of early child health on skill formation (for recent data on Germany, see Cawley and Spiess (2008)).

Our paper expands on the results of previous health studies in the following ways: First, we focus on the intergenerational link and transmission of both maternal and paternal health and health behavior on children's health during their first six years of life. We account for various child, parent and household-specific characteristics during each period of childhood. Second, starting during pregnancy, we examine the relationship between various parental health measures on various children's health measures in different models. Differences in child health are apparent at birth. Our health measures are observable for three different points of time during childhood: at birth, at age 2-3 years (26-47 months) and at age 5-6 years (62-81 months). Finally, in order to take into account the endogeneity

[2]In contrast to other studies related to intergenerational processes of social outcomes, we explicitly distinguish between intergenerational links and intergenerational transmissions. The former simply means the association between parental and child health in a cross-sectional context. The latter refers to the causal relationship between parental and child health in the context of a fixed effects model.

of parental health, we apply fixed effects models.

The paper is organized as follows: after describing potential links and transmissions of health in more detail we summarize previous studies on these particular issues in section 5.2. Section 5.3 describes our data, variables and methods. Section 5.4 presents our results: first on the link between parental health and child health and then on the transmission of parental to child health. We conclude with a discussion and prospects for future research.

5.2 The intergenerational transmission of health

As it is summarized by (Ahlburg, 1998) studies on the intergenerational transmission of health have been carried out mainly in the field of genetic epidemiology, seeking associations between genes and specific diseases. Furthermore, estimates have been done of the intergenerational correlation in life expectancies, which can be considered the ultimate output of the health production function. Estimates of intergenerational health correlations over the life-cycle between generations have been used to support a strong genetic component of longevity (see for a summary and critical reflection on theses studies Ahlburg (1998)).

There are only few studies analysing the transmission of health between generations, before the children have reached adulthood. Apart from this, most studies on child health and its socio-economic determinants do not control for parental health (see for instance, D. Thomas (1994), Case et al. (2005), Black, Devereux, and Salvanes (2005)). This dearth of literature is due partly to the lack of data. Most surveys that collect information on child health do not contain information on parental health. Further difficulties can also arise because health is a multidimensional and time-variant measure, compared to other socio-economic measures such as education.

A close link may exist between parental health and child health for several reasons: First, health has a genetic dimension. Thus, it is important to observe different health dimensions of both maternal and paternal health. Second, there is an 'environmental effect', as children grow up in the same 'shared' and 'non-shared' environment as their parents. Parents have both a direct and an indirect influence on what their children obtain in terms of health care and medical treatment. They can invest directly in the health of their children through the use of health inputs such as nutrition and (medical) health care as well as by avoiding unhealthy behavior such as smoking and drinking alcohol (see, for example Sacerdote (2007)). These investments are strongly related to labor supply and household budget constraints. On the one hand, constrained families may be less able to provide medical care and nutritious food. On the other hand, parents who work full time and therefore have less financial constraints may spend less time with their children, which may also affect children's health.[3]

Apart from this, unhealthier parents may exhibit unhealthier behavior such as smoking or regular alcohol consumption, which can be detrimental to child health. In addition, poor parental health reduces the labor supply and reduces family income, and thus can have an indirect effect on child health. Moreover, unpredictable effects of parental health – for instance accidents – could affect the health of the children in that parents who are disabled due to an accident have less (financial and time) resources to invest in the health of their children. Finally, the health of parents and children might be affected by common but unmeasured environmental factors, resulting in a correlation between their health levels. Overall, it is obvious that there are various mechanisms involved in how parental health might be related to child health. The challenge lies in disentangling them.

Until now, there have been few economic studies that explicitly focus on the correlation between child and parental health.[4] The study by Currie and Lin (2007), for example, investigates the intergenerational transmission of birth weight in Western industrialized countries.[5] Based on the data on individual birth records from California, they show that there is a strong intergenerational correlation between the mother's and the children's birth weights using grandmother fixed effects models. They also show that the family income at the time of mother's birth is also a predictor of LBW and that there is an interaction between maternal LBW and poverty in the production of LBW. In sum, their findings suggest that intergenerational correlations in health could play a role in the intergenerational transmission of income: parental income affects child health and health at

[3] Mahler (2007) for instance, found that a higher maternal labor supply increases the probability of the child being obese.

[4] There have been some studies that control for parental health in regressions on child health (see Burgess et al. (2004)). However, the primary focus of these studies is on the income gradient of child health (for such studies, see section 5.1).

[5] Note that there are various studies on birth weight. However, to the best of our knowledge only this study looked at birth weight between generations.

birth affects future earnings.

Case et al. (2002) analyse parental health as a determinant of children's health. The authors use U.S. data from the National Health Interview Survey (NHIS) 1986-1995 and the Panel Study of Income Dynamics (PSID), which cover self-rated health measures rating the health of the children and the parents on a scale from 1=excellent to 5=poor. They find large effects of parents' health on children's health. If a child aged 0-3 has a mother in excellent health, his or her chance of also being in very good or excellent health increases by 27%. With both parents in excellent health, the corresponding increase is 16%. Moreover, maternal health is more strongly associated with child health than to paternal health, which is consistent with the idea that women in worse health bear less healthy children, or that women in poor health are less able caregivers. The study by Sacerdote (2007) is an example of a U.S. study that analyses various outcomes of parents and their biological and adopted children using health measures as part of the outcome measures. It shows, for instance, that the shared family environment explains 33% of the variation in drinking behavior, which can be regarded as a proxy for the health behavior. A very recent study by Goode, Mavromaras, and Smith (2008) investigates the possibility of intergenerational transmission of unhealthy eating habits from parents to adult children. Their regressions, which are based on the 2003 Scottish Health Survey, suggest that paternal history of eating habits has no impact on either sons or daughters and the maternal history of eating habits negatively influences the eating behavior of daughters. The intergenerational transmission of unhealthy eating habits appears to be stronger among individuals with lower household income.

The links and transmission between parental and child health have also been investigated in developing countries based on anthropometric health measures (e.g. height, weight or the body mass index (BMI)). Kebede (2005), for instance, uses data from rural Ethiopia in the period 1994-97 and takes height as a measure of long-term health to estimates fixed effects models on children's height. Beside other explanatory variables, parents' height is highly significant in all specifications. They conclude that the correlation between child and parental health is explained more through genetic inheritance rather than by behavior. Bhargava (1994) uses a data set from a specific region of the Philippines during the period 1984-85. As health measures he uses the height, weight and BMI of the child and the parents. Estimating dynamic health models show that parental - in particular maternal - health has large effects on child health.

Studies in other social science disciplines, such as psychology, epidemiology and medicine also contribute to the discussion of intergenerational health and health behavior respectively. These studies include earlier investigations of the intergenerational correlation of health compared to economic studies (for example, Tanner, Goldstein, and Whitehouse (1970)), various mainly psychological studies on the influence of the mothers' mental health on the child's health (for instance, Leiferman (2002)) as well as studies on the correlation between the child's and the parents' health behavior and beliefs (for instance, Rimal (2003) and Marshall, Jones, Ramchandani, Stein, and Bass (2007)).

5.3 Sample, variables and methods

5.3.1 Sample

The data used for this study is the German Socio-Economic Panel (SOEP). It is a representative national longitudinal data set that annually surveys households and all individuals 17 and over living in the household. The SOEP started in 1984 (Wagner et al., 2007). It provides an informative database with a rich set of indicators of both parent's and children's characteristics. Since 2003, detailed information on child health has been collected in an additional questionnaire given to the mothers of very young children (see below). The first Mother and Child Questionnaire, which was used for the first time in 2003, is addressed to all mothers who gave birth to a child in the year of survey or the year before, in which case the age of the child varies between 0 and 19 months. A second questionnaire is given to mothers with children aged two to three. It was firstly implemented in 2005. This second age-specific questionnaire gather health information on the 26-47 month old children. A third Mother and Child Questionnaire contains questions on five to six year olds. It was firstly implemented in 2008 and hence, only the birth-cohort 2002 is observable. At the time of the survey, the age of the children ranges between 62 and 81 months (for a more detailed description see Wagner et al. (2007)). The design of the sample is presented in Table 5.1.

Moreover, the SOEP contains information about the mother's as well as the father's health, education, age, family income, family composition, private health insurance, migration and municipality between 2002 and 2008. We merged the information from the Mother and Child Questionnaires with the parental information.

Table 5.1: The cross-section samples

sample	survey years	questionnaire	child's age (in months)	birth-cohorts	(pooled) observations
0-1 years old	2003-2008	Mother-Child (1)	0-19	2002-2008	925
2-3 years old	2005-2008	Mother-Child (2)	26-47	2002-2005	686
5-6 years old	2008	Mother-Child (3)	62-81	2002	143

Source: SOEP 2003-2008.

For our empirical analysis, we consider different samples (see Table 5.1): first, a pooled cross-sectional sample of children aged between 0-19 months. This sample contains 925 children born between 2002 and 2008. Second, we consider a cross-sectional sample of 686 26-47 month old children born between 2002 and 2005. Third, we consider a cross-sectional sample of 143 62-81 month old children who were born in 2002.[6] Finally, for the birth cohorts 2002-2005, we repeatedly observe their health conditions. The (unbalanced) panel data set comprises 642 children whose mothers have been successfully interviewed at least twice, in the first and in the third year of their child's life. For 143 children we can observe health measures three times: in the first year, the third year and the sixth year of life (see Table 5.1).

5.3.2 Health measures

Child health. Finding appropriate measures of a child's health status is a challenge. Health has many dimensions, such as mental, physical, chronic conditions, environmental conditions, nutrition and injuries. In developing countries, infant mortality rates, anthropometric measures and vaccination data are often used as benchmarks to estimate child health because they are easy to measure and highly correlated with the full health status. Studies on Western industrialized countries use LBW as an indicator of poor health at birth (see the studies cited in sections 5.1 and 5.2). Alternative measures of children's health are bed days and hospitalization episodes. As there is still no operational, global definition of child health, it might be useful to use various measures once they become available.

This is a crucial advantage of the data we used here. The SOEP allows us to observe different types of health measures for the children (for other SOEP-based studies using

[6]The sample size within one cross-section varies because of missing observations with regard to some health conditions.

similar child health measures, see for instance, Dunkelberg and Spiess (2009) and Cawley and Spiess (2008)). For all age cohorts, we observe anthropometric (health) measures such as weight and height of the child. Anthropometric health measures have the advantages that they are easy to administer and that potential measurement errors are more likely to be random (Kebede, 2005). Weight and height of the children are reported by the mother and not measured by an expert. Thus there might be reporting errors (see for instance, Strauss and Thomas (1996)), but we argue that the reporting error is low and random given the specific features of the German health care system. In Germany, preventive medical check-ups are offered to children on a regular basis form birth up to the age of five. They are free of charge. The weight and the height of the child are taken by experts at each check-up and documented in a medical record booklet that is kept by the family. 98% of SOEP children have had such regular check-ups. The average weight (height) at birth is 3338.39 gram (51.13 cm). Both measures increase with age. A 5-6 year old child has an average weight and height of about 21.46 kg and 116.57 cm (see Table 5.2).

Table 5.2: Descriptive statistics of children's and parental health measures

	0-19 months		26-47 months		62-81 months	
	mean	std.dev.	mean	std.dev.	mean	std.dev.
			child's health			
weight (in kg)	3.34	(0.60)	14.02	(2.53)	21.46	(4.07)
height (in cm)	51.13	(3.17)	93.25	(11.44)	116.57	(6.80)
disorder (1=yes)	0.05	(0.22)	0.46	(0.50)	0.42	(0.50)
worried about my child's health[1]	3.43	(0.77)	3.46	(0.76)		
			mother's health			
height (in cm)	167.26	(6.68)	167.36	(6.62)	167.95	(6.57)
weight (in kg)	68.36	(12.81)	68.16	(12.65)	69.82	(13.37)
self-rated health status[2] $(t-1)$	3.79	(0.75)	3.70	(0.80)	3.60	(0.74)
smoking	0.18	(0.38)	0.21	(0.41)	0.19	(0.39)
			father's health			
height (in cm)	180.48	(7.11)	180.36	(6.95)	180.74	(7.54)
weight (in kg)	84.06	(14.35)	85.16	(14.65)	86.35	(15.88)
self-rated health status[2] $(t-1)$	3.85	(0.75)	3.75	(0.80)	3.68	(0.82)
smoking	0.36	(0.48)	0.34	(0.48)	0.30	(0.46)

Note: Standard deviations are in parentheses. [1]worried about my child's health varies from 1=(applies fully), 2=(applies more), 3=(applies less) to 4=(does not apply); [2]Self-rated health status varies from 1=(bad), 2=(poor), 3=(satisfactory), 4=(good) to 5=(very good). For the 0-19 months old we observe the weight and height at birth.
Source: SOEP 2003-2008. Own calculations.

Moreover, in all cross-sectional samples, mothers were asked about any disorders their child had, for example, motor impairments or asthma (see Appendix Table D.1 for a detailed description). We compute a dummy variable instead of using all dimensions separately, because the share of children with any kind of a disorder at birth is quite low. It takes the value of one, if the child has at least one disorder and zero, if the child has no disorder. Again, we would expect that given the regular medical check-ups in Germany during the first five years of a child's life, measurement errors are low and random. Descriptive statistics in Table 5.2 show that among newborns, the share of children with any kind of a disorder is only 5%, at the age of 2-3 years nearly every second child has at least one disorder, while three years later, almost 60% of the children suffer from at least one disorder. The main disorders are asthma, bronchitis and middle-ear inflammations. Some aspects of this health measure also reflects common illnesses during early childhood and explain why the percentage of children with any kind of a disorder at the age of two and older is eight times higher than for newborns.

Apart from these 'self-reported health measures', we also use 'self-rated' health measures (in the strict sense these are mother-rated measures of the child health): The mothers in the SOEP were asked in the first and second Mother and Child Questionnaire whether they were worried about their child's health.[7] They could specify to what extent the statements apply, ranging from 'applies fully' (1) to 'does not apply' (4). For the newborns as well as for the 2-3 year olds, the share of mothers who assessed the health of their children as 'good' or 'very good' is about 90 percent.

The SOEP also contains data on the utilization of health care services. The mothers were asked for the number of doctor visits and hospital stays. However, it is difficult to disentangle whether both variables capture the health of the child or whether they simple reflect the health behavior or risk aversion of the mother. Thus, we do not apply models based on these variables.

Parental health. As far as parental health is concerned we also use different health measures (compare for such an approach based on the SOEP, Schwarze, Andersen, and Anger (2000)). First, the SOEP covers anthropometric health measures for all adults living in the household every two years. We consider the height and the weight of the parents: the former for the cross-sectional models, the latter for the panel models (Poskitt, 1995). Table 5.2 indicates that the height of the mother as well as the height of the father are stable over time, which is one indication that the reporting error of this self-reported health

[7] For 5-6 years old, this variable is no not available.

measure is quite low. The average height of the mothers is about 167.26 cm, while fathers are 13 cm taller on average. Regarding the weight of the mother, we do not observe a so-called pregnancy effect, as the weight only differs slightly between the three cross-sectional samples. In contrast, the weight of the father increases (slightly) over time.

The data also contain a self-rated health measure of the parents:[8] Parents were asked how they assess their own current health status, using a scale from 1=(bad), 2=(poor), 3=(satisfactory), 4=(good) to 5=(very good). One might argue that self-rated health is not a valid health measures. However, the empirical health literature has shown that self-rated health measures are highly correlated with 'self-reported health measures' (see for instance Singh-Manoux et al. (2007) or Schwarze et al. (2000)).[9] We use this indicator, because we would expect that is associated, at least to some extent, with the true health of the child. On average, the parents' self-rated health lies on the upper bound of the scale, but the average value slightly decreases between the three cross-sectional samples for mothers as well as for fathers. For all three periods, it seems as if fathers assessed their own health better than the mothers.

Finally, we observe aspects of the health behavior of the parents: every two years, they were asked whether they smoked or not. In general, mothers and fathers differ with respect to their smoking behavior. For the newborns we observe that the percentage of fathers who smoke is twice as high as the percentage of mothers who smoke. But the percentage of nonsmoking mothers with very young children is three percent lower than that of nonsmoking mothers with 2-3 year olds. It may be that mothers stop smoking and then start again when their children are slightly older.[10] Given this broad set of health measures, we do several estimations, using anthropometric and self-rated health measures as well as the information on any health disorders of the child.

Maternal reports of child health might depend on the mothers' own health. Healthier mothers, for example, might tend to overestimate their children's health. Given the problem of reverse causality between parental ratings of children's health and the self-rated

[8]In the main SOEP, self-rated health is measured by an internationally widely accepted scale.

[9]Our descriptive evidence indeed supports this hypothesis: self-rated health is significantly correlated with both the anthropometric health and the self-reported health.

[10]Furthermore it could be that older cohorts of mothers are more likely to smoke.

health of the parents, we use the self-rated health information of the parents one year before the health of the child was assessed.

5.3.3 Child and family characteristics

Descriptive statistics for child, parent and household characteristics that might also affect the child's health are reported in Table D.2. Among the child-related variables is the age of the child in months, the gender of the child, the share of children growing up with siblings and whether the child is firstborn. We control for age in months, since the children in our cross-sectional sample are aged between 0-19, 26-47 and 61-82 months, depending on the time of the survey. Moreover, we include a dummy for gender and for being the firstborn child. Other studies (for instance, D. Thomas (1994)) have shown that there are gender differences in the resource allocations to child health that might reflect both technological differences in child rearing and differences in the preferences of parents. Mothers allocate more resources to their daughters and fathers allocate more resources to their sons. It is unclear whether being the firstborn child on average correlates with higher or lower health. Firstborn children may benefit from more parental investment ceteris paribus but their parents have less experience.

Family characteristics cover the education of the parents, the age of the parents, the household income (€ 1,000), the household structure (single or non-single parent), if at least one parent has a migration background, if at least one parent has a private health insurance and a variable indicating the size of the municipality a household lives in. We distinguish three levels of parental education: no degree (reference category) occupational degree versus any university degree. For these variables, other studies have found differing effects (see for instance, Case and Paxson (2001) and Case et al. (2005)). Some find that maternal education is strongly associated with a better child health status, while fathers' school-leaving ages show no significant correlation with child health. We take into account whether the child is being raised by a single parent or not. A single parent cannot share child-rearing responsibilities with a partner, which might result in less time available to invest in the health of their children. Only one percent of the children are growing up in a single household. Furthermore, we control for the migration status of the parents, which might capture different cultural attitudes towards the investments in the health of children. The literature extensively examined the effect of income as one of the important economic variables affecting child health (see for instance, the recent analysis by Case and Paxson (2008a)). First, income levels affect the amount of resources spent in households for nurturing children. Second, health-related behavior of people (like smoking, alcohol consumption, health care) is usually systematically correlated with levels of income. Third, in addition to the absolute levels of income, health is affected by income inequality - particularly in industrialized countries. Lower ranks in the distribution of income probably increase the psychosocial stress that negatively affects endocrine processes and immunity. Although we control for smoking, we can not disentangle all these various income effects. For a detailed study on the effects of income on child health, see the analysis by Case et al. (2002).[11] A dummy variable, indicating whether either the mother or the father or both have a private health insurance or not, does allow us on the one hand to test whether children with access to higher-quality care might be better in health.[12] Although all children in Germany have some kind of health insurance, it might be argued that given the German framework, children who have private health insurance through their parents have access to higher-quality care; since private health insurances in Germany generally covers the cost of treatment by the head physician. On the other hand, these variables might capture the effect that parents with private health insurance go to the doctor more frequently since their insurance covers more types of costs. This might affect their self-rated health.[13]

Furthermore, municipality size should on the one hand cover the effect that families living in larger municipalities have better access to relevant health infrastructure. On the other hand, it might be that children living in rural areas live in a less polluted environment. As has been shown by Currie and Neidell (2005), this affects child health as well. Which effect is stronger is an empirical question, however.[14]

[11]Apart from this, we do not control for the employment status of the mother, as this might be endogenous to child health. As has been shown in various studies, the employment status of mothers might influence child health as the mothers have more financial resources to invest in child health. This effect is covered by the income variable we use, which covers total household income. Apart from this, employed mothers might have less time to invest in the health of their children: or conversely, mothers might have to reduce working hours or quit work due to the illness or disability of their child. For a German study on this issue, see for instance, (Dunkelberg and Spiess, 2009).

[12]For such an approach in the U.S. context, see Case et al. (2002).

[13]For a description of the German health insurance system, see http://www.bmg.bund.de.

[14]Another potentially valid argument is that one should control for possible genetic ties. Case et al. (2002), for instance use the information whether the child is adopted or biological to test the hypothesis on genetic ties. Their results cast doubt on a simple genetic hypothesis. In our study, there are only four adopted children. But if we exclude individuals with missing values from the analysis, we have no longer adopted children in our sample.

5.3.4 Econometric model

Our goal is to assess the role of parental health measures in the health of children at very young ages. Given the variety of health measures in our sample, we group them and test the link and transmission between parental and child health.

Parental health measures are known to depend on family characteristics and investments in children's health. A number of factors that influence parental health and health behavior will affect the health of the children. It is obvious that unobserved factors such as the unobserved parental health behavior, genetic components and time preferences may affect both parents' and their children's health. We attempt to account for the endogeneity of parental health by following two approaches. First, we consider how the effect of maternal health on the health of the children changes once we control for paternal health and paternal characteristics. Then, we try to obtain more direct evidence on the effect of the parental health on the child's health by estimating fixed effects models.

We first estimate a model for the health of the child i at a certain age between birth and six years of age, only including the measures of maternal health and maternal characteristics:

Equation 5.1 presents the link between the health of the mother and the health of the children:

$$Health_i = \beta_1 + \beta_2 Health_{mi} + X'_{mi}\gamma + Y'_i\lambda + u_i. \tag{5.1}$$

where $Health_i$ is a measure of child i's health in early childhood, which covers anthropometric, self-reported and self-rated health. $Health_{mi}$ denotes child i mother's (m) health (it also includes mother's health behavior). X_{mi} is a vector of mother characteristics that includes education, household income, family status, private health insurance, age, nationality and municipality size. Y_i is a vector of children characteristics that includes sex, siblings, parity and age. This specification yields an upper bound estimate of the extent to which health is passed from mother to child.

In order to reduce unobserved heterogeneity likely to affect $Health_{mi}$, we include measures of paternal health and paternal characteristics to the equation 5.1.

Equation 5.2 presents the link between the health of the parents and health of the children:

$$Health_i = \beta_1 + \beta_2 Health_{mi} + \beta_3 Health_{fi} + X'_{m,fi}\gamma + Y'_i\lambda + u_i. \tag{5.2}$$

We estimate equations 5.1 and 5.2 for all age groups and all different health measures of the child, as well as for girls and boys, respectively.[15]

The health status of the parents and of the child may be correlated with unobserved factors, even after including the father's health and the father's characteristics and even if we control for various child, parent and household characteristics in the OLS regression. One way to account for the endogeneity is to apply instrumental variable approaches. Usually, the instruments that find the strongest support result from natural experiment or from institutional changes affecting otherwise similar populations in a different ways. In our data, we do not observe such instruments. Another difficulty is that we have to deal with more than one potentially endogenous variable (health and health behavior of mothers and fathers). Thus in this analysis we are not able to apply instrumental variable approaches.

An alternative way to use the instrumental variables in tackling the problem of causal inference is to study the health status of children over time during the first six (three) years of a child's life. We try to identify the intergenerational transmission coefficient of health by exploiting variation in health measures over time.

Equation 5.3 presents the transmission between health of the parents and health of the children:

$$Health_{it} = \alpha + \beta Health_{jit} + X'_{jit}\delta + Y'_{it}\gamma + f_i + u_{it}. \tag{5.3}$$

In equation 5.3, we explicitly take into account an individual fixed effect f_i. $Health_{it}$ denotes the health of the child i in t, $Health_{jit}$ denotes the vector of health measures of both mothers and fathers, X_{jit} is a vector which includes all family characteristics and Y_{it} includes all controls at the child's level i. If f_i is constant over time, the model will recover an asymptotically unbiased estimate. Within this model, we analyse the

[15]The standard errors are clustered at the family level.

intergenerational transmission of the parent's health on the child health, conditional on time-variant family background variables, captured in X_{jit}. The coefficient on parental health β is our parameter of interest. The parameter can be used to test a variety of hypotheses. First, β provides information on whether the children of parents with poor health also experience poor health in early childhood. Second, the coefficient β can be interpreted as a health gradient. A high coefficient indicates a strong transmission of health characteristics from parents to children. Finally, the coefficient β can be decomposed into the impact of mother's health and father's health on the child's health. We apply within-transformation to eliminate f_i. The identifying assumption is that parental health across children is uncorrelated with the unobserved determinants of the child's health.

$$\Delta health_{it} = \beta \Delta health_{jit} + \Delta X_{jit}\delta + \Delta Y_{it}\gamma + \Delta u_{it}. \tag{5.4}$$

After eliminating f_i, we assume that the conditional mean independence assumption holds (equation 5.5). Conditional mean independence

$$E(\Delta u_{it}|\Delta health_{jit}, \Delta X_{jit}, \Delta Y_{it}) = 0 \quad \forall t = 1, 2. \tag{5.5}$$

implies:

$$E(\Delta u_{it}|\Delta health_{jit}, \Delta X_{jit}, \Delta Y_{it}) = 0 \quad s \leq t. \tag{5.6}$$

This implies that the error terms are uncorrelated with $\Delta health_{jit}, \Delta X_{jit}, \Delta Y_{it}$ within one period (equation 5.5) and are uncorrelated between different periods (equation 5.6).

In the following, we first estimate cross-sectional models with anthropometric health measures for children, mothers and fathers. Second, we distinguish between models with self-reported health measures and self-rated health measures for the children and self-rated health measures of the parents. All models include a measure of parental health behavior, namely whether or not a parent smokes. Finally, we estimate fixed effects models for different health measures.

5.4 Results of the health regression

5.4.1 Cross-sectional results

We first present cross-sectional estimation results at a certain age and different model specifications. For all models presented in columns 1, 3 and 5, we control for income (€1,000), a dummy whether the child has private health insurance, the mother's education, the mother's age, child's age in months, birth order, the number of children in the household, gender, single parenthood, migration and municipality, while for all models presented in columns 2, 4 and 6, we additionally control for the father's health, education and age.

Anthropometric health measures: For the health of the children in terms of weight and height at birth, we observe a strong effect of mother's height for all models presented in Table 5.3, which is most pronounced among boys. Introducing the father's health and the father's characteristics reduces the effect of maternal height on child weight and height somewhat. When observing parental health behavior, we find that maternal smoking significantly reduces the weight and the height of the girls, while paternal smoking significantly reduces the weight of boys.

In respect to the control variables one can summarize that the results show a positive correlation between the child's weight and with the mother's education, especially for boys, see Appendix Table D.3. If at least one parent has a private health insurance, children tend to be lighter and smaller at birth - especially the girls - on average. Moreover, firstborn and girls are lighter. The children of single parents have significantly shorter girls.

The intergenerational correlation between anthropometric health measures increases continuously with age (see Tables 5.4 and 5.5).[16] The link between mother's height and child's weight, for example, increases from 15.60 at birth to 68.72 at 2-3 years and is 98.98 at 5-6 years. The pattern of the correlation over ages remains the same for the child's height. The steadily increasing correlation may operate through sharing the same genetic endowment and sharing the same behavioral environment. We interpret this effect as reflecting changes in the relationship between both channels. At birth, the influence of both the genetic endowment and the shared environment are important. However, at older ages, the importance of the environmental effects, such as nutrition or health care, steadily increases, while the influence of the genetic endowment remains unchanged.

[16] All the models covering all control variables are available from the authors upon request.

Table 5.3: Intergenerational links between parents' height and child's weight and height at birth

	all children		girls		boys	
	weight					
	mother	parents	mother	parents	mother	parents
Mother's height	15.60***	14.97***	14.48***	13.32***	16.26***	14.91***
	(3.26)	(3.64)	(4.08)	(4.28)	(4.79)	(5.55)
Father's height		3.03		3.03		2.93
		(3.73)		(4.29)		(5.62)
Mother smoking	-114.74**	-108.80*	-152.12**	-227.89***	-72.85	-26.11
	(55.84)	(60.17)	(76.44)	(82.32)	(81.06)	(85.21)
Father smoking		-13.82		139.02**		-138.82**
		(50.65)		(64.02)		(69.20)
Observations	925	925	472	472	453	453
	height					
Mother's height	0.08***	0.077***	0.07***	0.06***	0.09***	0.08**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.036)
Father's height		0.02		0.02		0.03
		(0.02)		(0.02)		(0.04)
Mother smoking	-0.69**	-0.80**	-1.10***	-1.65***	-0.22	-0.08
	(0.29)	(0.32)	(0.37)	(0.40)	(0.46)	(0.49)
Father smoking		0.23		1.04***		-0.40
		(0.26)		(0.31)		(0.39)
Observations	924	924	471	471	453	453

Note: Clustering-robust standard errors (at the family level) are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models for parents (mothers) include birth order, the number of siblings in the household, gender, income (€1000), a dummy whether one of the parent has private insurance, the (mother's) and the father's education, the (mother's) age, the father's age, single parenthood, migration and municipality.
Source: SOEP 2003-2008. Own calculations.

In accordance with the argumentation, we see that at birth parental health is passed to child's health through maternal health, while from age of two on, the fathers' health is linked to the child's health as well.[17] This result might reflect that in addition to the genetic endowment the broader 'shared environment' of mothers and children in terms of smoking, nutrition, alcohol use and medical checkups plays a role, while there seems to be no influence of paternal behavior during pregnancy.

Children's 'mother-rated' health and parents' self-rated health: In this section we investigate the link between the child's health disorders and parental self-rated health reported in one year previous to the assessment of the child's disorder.

[17] At age 5-6, the sample size is rather small and therefore our estimates are less precise.

Table 5.4: Intergenerational links between parents' height and child's weight and height at 26-47 months

	all children		girls		boys	
	weight					
	mother	parents	mother	parents	mother	parents
Mother's height	68.72***	60.13***	77.06***	82.99***	57.65***	45.47**
	(14.30)	(15.11)	(21.63)	(19.99)	(20.55)	(21.18)
Father's height		34.30**		19.80		47.82**
		(13.82)		(19.13)		(21.31)
Mother smoking	42.97	48.14	150.60	52.82	1.89	-66.38
	(252.57)	(286.27)	(423.67)	(347.85)	(339.49)	(368.15)
Father smoking		52.86		-319.22		368.15
		(220.56)		(342.10)		(279.89)
Observations	686	686	352	352	334	334
	height					
Mother's height	0.20**	0.15**	0.31***	0.25***	0.09	0.06
	(0.08)	(0.075)	(0.08)	(0.07)	(0.14)	(0.13)
Father's height		0.18***		0.29***		0.08
		(0.07)		(0.08)		(0.10)
Mother smoking	0.0001	-0.42	-1.99	-2.98	2.28*	2.37
	(1.02)	(1.26)	(1.41)	(1.86)	(1.18)	(1.47)
Father smoking		1.29		2.31*		-0.03
		(0.90)		(1.27)		(1.19)
Observations	675	675	349	349	326	326

Note: Clustering-robust standard errors (at the family level) are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models for parents (mothers) include the child's age in months, the number of siblings in the household, gender, income (€1000), a dummy whether one of the parent has private insurance, the (mother's) and the father's education, the (mother's) age, the father's age, single parenthood, migration and municipality.
Source: SOEP 2003-2008. Own calculations.

Our estimates (see Table 5.6) show that there is a strong link between the mother's self-rated health and the child's disorders. During the first three years of a child's life, healthier mothers are more likely to have healthier children. At age five, the average partial effects have the expected size; however, they are mostly insignificant due to the small sample size. For the newborns, the results suggest that there is not an intergenerational correlation of health among girls, but that there is a strong correlation among boys. Two years later, the link between maternal health and child health also appears for girls, however, the effect remains stronger among boys.

Table 5.5: Intergenerational links between parents' height and child's weight and height at 62-81 months

	all children		girls		boys	
	weight					
	mother	parents	mother	parents	mother	parents
Mother's height	98.98*	77.06	5.60	-1.48	188.76**	113.12
	(59.34)	(64.50)	(96.18)	(114.97)	(74.69)	(93.47)
Father's height		36.76		-50.94		150.39**
		(61.86)		(91.73)		(68.09)
Mother smoking	1642.09*	1421.17	2068.6	1457.68	1633.86	2003.71*
	(839.67)	(969.05)	(1271.21)	(1399.51)	(1116.14)	(1026.44)
Father smoking		739.51		1380.79		-139.14
		(1053.14)		(1611.27)		(1398.54)
Observations	138	138	67	67	71	71
	height					
Mother's height	0.29***	0.30***	0.19	0.17	0.39**	0.42**
	(0.11)	(0.11)	(0.15)	(0.15)	(0.16)	(0.18)
Father's height		0.08		0.06		0.05
		(0.09)		(0.11)		(0.12)
Mother smoking	1.13	1.85	1.14	1.60	2.21	2.32
	(1.60)	(1.77)	(2.29)	(2.58)	(2.17)	(2.07)
Father smoking		-1.55		-0.05		-1.26
		(1.52)		(2.44)		(2.65)
Observations	134	134	67	67	67	67

Note: Clustering-robust standard errors (at the family level) are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models for parents (mothers) include the child's age in months, the number of siblings in the household, gender, income (€1000), a dummy whether one of the parent has private insurance, the (mother's) and the father's education, the (mother's) age, the father's age, single parenthood, migration and municipality.
Source: SOEP 2003-2008. Own calculations.

Introducing the father's current health status and characteristics in columns 2, 4 and 6 in Table 5.6 slightly reduces the effect of the mother's current health on the probability of the child having any disorder. The link between paternal health and child health becomes even more significant at older ages. At ages 2-3, we find that if both mothers and fathers assess their current health as very good, it reduces the probability of a child's disorders by 0.06 percentage points. The intergenerational correlation between father and daughter is even larger than to the intergenerational correlation between mother and daughter (see Table 5.6 column 4). Parental smoking seems to have no influence on the probability of a child's disorders. In these models we cannot compare the effects over age groups because the child health variable includes a different set of disorders in each period. The probability of a child's disorder significantly increases with age (for the effect of other child,

Table 5.6: Intergenerational links between parents' self-rated health and child's disorders

	all children		girls		boys	
	0-19 months					
	mother	parents	mother	parents	mother	parents
Mother's self-rated	-0.017**	-0.016*	-0.005	-0.005	-0.019***	-0.016***
health $(t-1)$	(0.008)	(0.008)	(0.014)	(0.014)	(0.007)	(0.006)
Father's self-rated		-0.004		0.003		-0.007
health $(t-1)$		(0.008)		(0.01)		(0.007)
Mother smoking	0.003	-0.003	0.009	0.005	-0.006	-0.009
	(0.017)	(0.015)	(0.03)	(0.03)	(0.01)	(0.009)
Father smoking		0.008		0.01		-0.003
		(0.01)		(0.02)		(0.01)
Observations	837	837	423	423	414	414
	26-47 months					
Mother's self-rated	-0.076***	-0.06**	-0.07**	-0.06*	-0.086**	-0.08**
health $(t-1)$	(0.026)	(0.026)	(0.03)	(0.035)	(0.038)	(0.039)
Father's self-rated		-0.06**		-0.09**		-0.03
health $(t-1)$		(0.026)		(0.037)		(0.037)
Mother smoking	0.065	0.09	0.09	0.14*	0.03	0.047
	(0.05)	(0.056)	(0.07)	(0.07)	(0.08)	(0.08)
Father smoking		-0.06		-0.09		-0.016
		(0.05)		(0.065)		(0.07)
Observations	673	673	344	344	329	329
	62-81 months					
Mother's self-rated	-0.07	-0.05	-0.145	-0.09	-0.02	-0.02
health $(t-1)$	(0.06)	(0.06)	(0.10)	(0.10)	(0.08)	(0.09)
Father's self-rated		-0.09		-0.33***		-0.03
health $(t-1)$		(0.06)		(0.10)		(0.08)
Mother smoking	-0.13	-0.12	-0.40	-0.18	-0.09	-0.02
	(0.11)	(0.11)	(0.41)	(0.16)	(0.16)	(0.18)
Father smoking		0.08		0.07		-0.008
		(0.11)		(0.15)		(0.18)
Observations	143	143	69	69	72	72

Note: Clustering-robust standard errors (at the family level) are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models for parents (mothers) include birth order, the number of siblings in the household, gender, income (€1000), a dummy whether one of the parent has private insurance, the (mother's) and the father's education, the (mother's) age, the father's age, single parenthood, migration and municipality.

Source: SOEP 2003-2008. Own calculations.

parent and household characteristics, see Appendix Table D.4.)

The children's 'mother-rated' health: Our main results in estimating the intergenerational correlation between the parents' self-rated health and the child's 'self-rated' (that is 'mother-rated') health are shown in Table 5.7. To deal with the problem that mothers who are in poor health are more likely to report that their children are in poor health, regardless of the 'true' health status of the child, we use, in line with the previous investigation, the lagged self-rated health of the parents. Using self-reported health of the children involves an additional problem, because it is difficult to disentangle whether it reflects merely perception or actual knowledge (Strauss and Thomas, 1996). The relationship between perceptions and knowledge might depend on the socio-economic status, for example, less-educated mothers might tend to overestimate the health of the child than better-educated parents, who may tend to underestimate their child's health.[18]

With respect to the control variables, it is shown that the mothers rate the health of their firstborn higher than that of subsequent children, and the more children they have, the higher they rate the health of the first child. This s particularly true for boys.

When observing the 'mother-rated' health of the child, we do not find an intergenerational correlation between the father's health and the child's health, either for the newborn or for the 2-3-year olds. Surprisingly, the effect of the mother's health on the child's health remains unchanged in all models presented in Table 5.7, even if we control for paternal health and paternal characteristics. It seems to be likely that both findings result from the problem mentioned above. But for the analysis of health transmissions, the 'true' health is difficult to measure. We regard this finding as evidence of how different aspects of health might be passed on from one generation to the next.

While a mother's health is positively linked to her daughter's health, we find no correlation between a mother's health and her son's. In accordance to the results above, the influence of parents' health on the children's health becomes more important with age. Among girls, for example, the intergenerational correlation increases from 0.12 in the newborn sample to 0.15 for the 2-3-year olds. Finally, parental tobacco consumption seems to have no influence on the health of their children at least in terms of the child's self-rated health.

[18]However, mean differences in the child's 'mother-rated' health are insignificant for the mother's education.

Table 5.7: Intergenerational links between parents' self-rated health and child's self-rated health

	all children		girls		boys	
	0-19 months					
	mother	parents	mother	parents	mother	parents
Mother's self-rated	0.10***	0.10***	0.12**	0.12**	0.07	0.07
health $(t-1)$	(0.037)	(0.037)	(0.056)	(0.055)	(0.05)	(0.05)
Father's self-rated		-0.005		-0.02		0.004
health $(t-1)$		(0.03)		(0.04)		(0.05)
Mother smoking	0.06	0.02	0.06	-0.02	0.08	0.06
	(0.08)	(0.09)	(0.09)	(0.10)	(0.12)	(0.12)
Father smoking		0.10		0.12		0.09
		(0.07)		(0.08)		(0.09)
Observations	840	840	426	426	414	414
	26-47 months					
Mother's self-rated	0.11***	0.11***	0.15***	0.15***	0.06	0.08
health $(t-1)$	(0.04)	(0.04)	(0.05)	(0.06)	(0.06)	(0.06)
Father's self-rated		-0.03		0.01		-0.08
health $(t-1)$		(0.04)		(0.04)		(0.05)
Mother smoking	-0.08	-0.08	-0.05	-0.04	-0.13	-0.14
	(0.08)	(0.09)	(0.10)	(0.10)	(0.13)	(0.14)
Father smoking		-0.016		-0.07		0.035
		(0.07)		(0.10)		(0.10)
Observations	671	671	343	343	328	328

Note: Clustering-robust standard errors (at the family level) are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models for parents (mothers) include birth order, the number of siblings in the household, gender, income (€1000), a dummy whether one of the parent has private insurance, the (mother's) and the father's education, the (mother's) age, the father's age, single parenthood, migration and municipality.

Source: SOEP 2003-2008. Own calculations.

5.4.2 Fixed effects results

With the fixed effects models, we try to obtain more causal inference when exploiting variation over time. We repeatedly observe three health measures of the children for at least two periods: the child's weight, height and the self-rated health (see Tables 5.8 and 5.9). It is possible to follow children from birth until six years, at least for the youngest birth cohorts. Obviously, the variation over this short time period might be rather small, see Table 5.8. However, the child's weight and height in particular strongly increase over time.[19]

Table 5.8: Within variation in health measures

	mean	within-std.dev.	min	max
		child's health		
weight (in kg)	15.36	2.237	3.86	26.86
height (in cm)	97.37	6.44	71.37	123.37
worried about my child's health	3.46	0.40	1.96	4.96
		mother's health		
weight (in kg)	68.58	1.64	57.58	79.58
self-rated health status $(t-1)$	3.77	0.41	1.77	5.77
		father's health		
weight (in kg)	85.56	1.55	76.56	94.56
self-rated health status $(t-1)$	3.81	0.36	2.31	5.31

Source: SOEP 2003-2008. Own calculations.

When investigating the intergenerational transmission between anthropometric health measures, we cannot compare cross-sectional findings with fixed effects findings, because the height of the parents is a time-invariant measure. For this reason, we apply panel data models with parents' weight.[20] Since the mother's weight might be distorted due to pregnancy, we focus on changes in a child's anthropometric health starting at the age of two.[21] We exclude our health behavior measure in all panel models, because first differencing (for the birth cohort 2002 within transformation) leads to removing both good (interrupt smoking) and bad variations (starts smoking again)(Angrist and Pischke, 2009).

[19]Within families (sibling models), we observe almost no variation in observable health characteristics.

[20]Using the BMI instead of the weight might also reflect changes in weight rather than changes in height.

[21]When we estimate fixed effects models for these health measures, in some cases we observe significant negative effects of mother's weight, which might be reflected by a higher weight at birth.

Table 5.9: Intergenerational transmission between parent's weight and child's weight, height and self-rated health: fixed effects results

	all children	girls	boys
	child's weight		
Mother's weight	0.076	0.086	0.06
	(0.12)	(0.22)	(0.12)
Father's weight	0.32**	0.34	0.31**
	(0.13)	(0.24)	(0.13)
Observations	589	295	294
	child's height		
Mother's weight	0.267	0.179	0.29
	(0.38)	(0.61)	(0.47)
Father's weight	1.07***	0.95	1.16**
	(0.398)	(0.67)	(0.47)
Observations	579	293	286
	child's self-rated health		
Mother's self-rated health $(t-1)$	0.13***	0.11*	0.136**
	(0.045)	(0.06)	(0.06)
Father's self-rated health $(t-1)$	-0.06	-0.046	-0.08
	(0.05)	(0.077)	(0.07)
Observations	642	325	318

Note: Standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models for parents (mothers) include the number of siblings in the household, income (€1000), a dummy whether one of the parent has private insurance, single parenthood and municipality. *Source:* SOEP 2003-2008. Own calculations.

In Table 5.9,[22] we observe a strong intergenerational effect between the father's weight and the child's weight and height in the overall sample as well as for boys. The effect is only significant between fathers and their sons, while we observe no intergenerational transmission between mothers and their children, for girls or for boys.

Finally, we investigate the intergenerational transmission of health in terms of self-rated health status (see Table 5.9). When we account for unobserved time-invariant factors, the intergenerational correlation is slightly higher in the overall sample than in the cross-sectional findings. However, in contrast to the cross-sectional results, we observe a stronger intergenerational correlation among boys. In line with the cross-sectional findings, we observe no intergenerational correlation between father's health and the child's health in

[22]Since our self-rated health measures are only observable for the newborns and the 2-3 year olds, our fixed effects approach is equivalent to first-differencing.

terms of the self-rated health.

Among the time-variant control variables, we find that the number of children living in the household increases child health (see Tables D.6 - D.8 in the Appendix). The higher the number of children in the family, the taller and heavier the children are on average.

Finally, we tried to draw causal inferences by using sibling fixed effects models. However, the within-sibling variation in health outcomes is smaller than the variation in health outcomes across families. Thus it is not possible to identify the health gradient. Moreover, applying sibling models in this context might be not appropriate because it is assumed that all relevant omitted variables are the same for all members of the sibling pair. In case of the genetic endowments, for example, this is even true when comparing identical twins.

5.5 Conclusion of Chapter 5

This paper contributes to the literature on the intergenerational transmission of health between parents and their children by providing new evidence on the association between various health measures for very young children and parents. Our cross-sectional analyses show that there are significant correlations between child health and parental health in terms of anthropometric measures, self-reported measures and self-rated health. In particular, we find for most of the models that parental health is passed to child through both the mother's as well as the father's health. The intergenerational correlation is still significant even if we control for a set of child, parent and household characteristics. Across model specifications, the health gradient seems to increase with the child's age. When we account for unobserved heterogeneity, the intergenerational transmission also remains significant.

Our findings are significant because health is an important pathway for the acquisition of skills in early life and it facilitates the acquisition of additional capabilities at later ages (Heckman, 2007). Given this association, one of the strengths of the present study is that it analysis health in early childhood: first, the health of children at the age of 0 and 19 months, second between 26 and 47 months of age, and third between 62 and 81 months of age. Given the challenge of finding appropriate health measures, another advantage of this study is that we can use three groups of health measures, anthropometric, self-reported and self-rated ones. Moreover, we have a measure of health behavior, namely the smoking behavior of mothers and fathers. All these health measures are observable for both mothers and fathers. To our knowledge, this is the only study based on a representative sample using so many alternative health measures for children, mothers and fathers. Furthermore, our analysis allows us to draw causal inferences for at least for some models: given the panel character of our data, we can estimate fixed effects models. Thus the results can be interpreted as clear evidence of the intergenerational transmissions of health and not just of intergenerational links between paternal and child health.

Nevertheless, the study has limitations: The child health measures are rated by the mother rather than by professionals. Weight, height and all other paternal health indicators are reported by the mother or the father. Although several studies conclude that, for instance, parental reports of child weight are sufficiently accurate to be used in research (for example, Goodman, Hinden, and Khandelwal (2000)), and although a maternal reporting error of child weight is expected to be small in the SOEP because virtually all children had recent medical check-ups, such reporting error is likely to bias coefficient estimates.

Besides, our results do not allow us to disentangle the effects involved in an intergenerational transmission of health in a strict sense. We cannot separate 'biological programming' from 'environmental effects'. However, given the intergenerational links between parental and child health in the first years of a child's life, there is some evidence that biological issues play the dominant role since the 'environmental effects' have literally not had as much time to unfold as with older children. However, the links do increase with age, which speak against this argument if they are driven by environmental and biological factors themselves. Independent of this, further research on biometric measures might help to disentangle such effects.

Given the results on the intergenerational transmission of health, our results underline the importance of both maternal and paternal health in child health. From a policy point of view, one could certainly argue that improving parental health and health behavior would be an effective strategy if the political goal is to improve child health.

6 The Effect of Early Noncognitive Skills on Social Outcomes in Adolescence

Abstract:[1] This paper investigates the impact of early noncognitive skills on social outcomes in adolescence. The child's attention span, approach, prevailing mood and distractibility in early childhood may be crucial predictors for school achievements, health risk behavior, delinquency and autonomy as adolescent. We investigate this issue using a longitudinal epidemiological cohort study of 384 children at risk from the Rhine-Neckar Region in Germany. Our results indicate that noncognitive skills in early childhood are important predictors of educational success, tobacco and alcohol use, delinquency and autonomy in adolescence. In particular, the attention span has emerged as a dominant factor among noncognitive skills regarding educational performance, health behavior and delinquency in our study. Further, we find that boys with low noncognitive skills have significantly lower social outcomes compared to girls.

Keywords: noncognitive skills, early childhood, risk factors, social outcomes
JEL-classification: I20, J13, J24

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6.1 Introduction to Chapter 6

Differences in a child's noncognitive skills become already apparent at birth. A few years ago it was still assumed that noncognitive skills were mainly driven by biological endowment. However, the traditional assumption that genetic influences are most pronounced in early life has proven incorrect. Recent research findings by psychologists have shown that children are born with self-organized incentive-response systems, which adapt during their development. Individuals begin at different starting points with the reactivity within these systems (Kagan and Snideman, 2004). These starting points differ due to variations in genotype and variations in the prenatal environment. Thus, noncognitive skills are partly heritable but change in interaction with a child's environment.

However, although noncognitive skills are more malleable over the whole life cycle than cognitive skills, the stock of noncognitive skills which was built in early childhood increases monotonically from early childhood to adulthood. Different noncognitive skills develop during the life cycle, but to different extents and at different stages in life. Therefore, some noncognitive skills are relatively stable in childhood such as conscientiousness, while others reach only stability in late adulthood. For example, inhibited toddlers are unlikely to become exuberant children (Kagan and Snideman, 1999). Thus, the early years lay the foundation for the acquisition of noncognitive skills over the life cycle, see for example Heckman, Stixrud, and Urzua (2006) and Borghans et al. (2008).

Understanding the effects of early noncognitive skill formation has important implications in terms of educational policy. In recent years, a number of economic studies have demonstrated the importance of noncognitive skills for school as well as for labor market success, for example, the studies by Bowles, Gintis, and Osborne (2001), Duncan et al. (2007), Claessens, Duncan, and Engel (2009), Carneiro, Crawford, and Goodman (2007) or Cunha et al. (2006). Duckworth and Seligman (2005) examined the role of noncognitive skills in improving educational attainment, showing that self-discipline outdoes IQ as a predictor for final grades. The study by Duncan et al. (2007) focused on school readiness at school entry and on later school achievements. Besides math and reading (cognitive skills), the authors find that attention skills (noncognitive skills) are the best predictors for educational attainment. This result is based on six different longitudinal studies of children in the U.S., U.K. and Canada. Seminal work by Martin, Olejnik, and Gaddies (1994) even found that the different dimensions of temperament are five times better predictors for school success than a person's IQ.

Apart from economic returns on noncognitive skills in terms of school achievements and wages, there might be additional noneconomic returns to noncognitive skills. These returns may come from healthier behavior, reduced criminality and greater subjective well-being, compare Shiner and Caspi (2003). Heckman et al. (2006), for example, examined the effect of noncognitive skills on a wide variety of risk behaviors. They conclude that noncognitive skills strongly influence tobacco and marihuana use as well as delinquency in adolescence. The study by Shirley, Shen, Lowers, and Locke (2000) suggests that, beyond adverse family and genetic effects, a high extraversion in childhood predicts an earlier onset of alcohol consumption. Besides school and family effects, the individual's ability to build good peer contacts protects against criminality. Currie and Stabile (2006) and Currie and Stabile (2007) investigate the relationship between attention-deficit hyperactivity disorder (ADHD) and special education as well as delinquent behavior, using sibling fixed effects models for children living in the U.S. and Canada. They show that children with high scores on the ADHD screener had much higher probabilities of being in special education and being delinquent. Currie (2009) concludes that these measures of noncognitive skills seem to partly reflect aspects of mental health problems. The study of Shiner, Masten, and Roberts (2003), who tracked children aged 8 to 12 years until adulthood, reveals that four traits of childhood personality, including motivation (which is related to attention skills), conscientiousness, surgency (which is related to the initial reaction) and agreeableness (which is related to mood) predict adult autonomy two decades later. In addition, the study of Deal, Halverson, Havill, and Martin (2005) found that the temperament in early and middle childhood accounted for an average of 32% of the variance in personality in late adolescence and early adulthood.

Our paper expends on the results of previous work in the following ways: First, in this paper we use a longitudinal data set to investigate the effect of early noncognitive skills at the age between three months and two years on educational performance (grades in math and German), health risk behavior (tobacco and alcohol use), juvenile delinquency and autonomy in adolescence. We use four different dimensions of the child's temperament as noncognitive skills in early childhood, attention span, approach, prevailing mood and distractibility. Our empirical analysis is based on the Mannheim Study of Children at Risk, which follows individuals from birth until adolescence. The study is called 'at risk' because children suffering from organic or psychosocial risks at birth are oversampled. Derived from the design of the study we can separate the children into three different samples;

the organic risk sample; the psychosocial risk sample and a 'representative' sample (for a detailed explanation, see section 6.2). The data provides detailed psychometric assessments as well as medical and psychological expert ratings for a child's noncognitive skills. Tracking children from early childhood until adolescence provides longer term evidence, including educational achievements, health risk behavior, delinquency and autonomy.

Second, we analyse the influence of each noncognitive skill on each social outcome, taking into account a nonlinear association between early noncognitive skills and social outcomes. Due to the fact that unobserved time-invariant factors may influence both early noncognitive skills and social outcomes, we estimate fixed effects (F.E.) models on a child level. We calculated models for five different samples, OLS using the total sample, F.E. using the total sample, F.E. using the representative sample as well as F.E. models for boys and girls, separately. In each model, we control for family background variables.

Finally, we are able to examine how the relationship between early noncognitive skills and our outcome measures change when we estimate F.E. models for the psychosocial and organic risk sample. Using both subsamples we are able to disentangle both risk factors compared to the total sample, but we risk that our estimates are statistically insignificant due to a smaller sample size.

Our fixed effects results indicate that early noncognitive skills are crucial for the development of noncognitive skills and social outcomes in later life. Infants with low noncognitive skills may experience difficulties in adolescence in terms of educational performance, health behavior patterns, delinquency and autonomy. It is essential that different noncognitive skills are important for different outcomes. In particular, the attention span has emerged as a dominant factor for noncognitive skills regarding educational performance, health behavior and delinquency in our study. In addition, the child's initial reaction within the first two years of life is associated with most social outcomes. For a child's mood and a child's sensitivity in early childhood, we find, except for tobacco use, that only the lowest categories reduce the child's social outcomes, while differences between the middle against the highest category are not significant. We also find that boys with low noncognitive skills in early childhood have significantly lower social outcomes in comparison to girls. These gender differences arise for nearly all outcomes used in the study.

The rest of the chapter is organized as follows: In section 6.2 we describe our selection of noncognitive skills and social outcomes. In section 6.3 we explain our data set and present descriptive statistics. Section 6.4 presents the empirical methods. Section 6.5 analyzes the effects of early noncognitive skills on social outcomes. Section 6.6 concludes.

6.2 Noncognitive skills and social outcomes

Noncognitive skills

The temperament is an all-embracing term which constitutes the fundament for the development of personality traits in later life. In the psychological literature individual characteristics shown during childhood and adolescence are variously described as temperament (traits) or as personality traits. In accordance to the economic literature, we use the term 'noncognitive skills' throughout the paper.

Most data on noncognitive skills are based on self-reported measures and not on expert ratings or even on experimental observations. In our data, a child's noncognitive skills were assessed in two ways: on the one hand, the assessment was based on standardized parent interviews, on the other hand, it was based on structured observations in four standardized settings on two different days in both familiar (home) and unfamiliar (laboratory) surroundings. All ratings were made by trained judges in the subject on 5-point rating scales adapted from the New York Longitudinal Study NYLS (A. Thomas, Chess, and Birch, 1968). A measure for the quality of judgements is the interrater reliability which is defined as the correlation between assessments of the child's noncognitive skills for each interviewer. A high correlation indicates that the different assessments of the experts for each child's noncognitive skills are (very) similar.[2] We use four dimensions of a child's personality: attention span, approach, prevailing mood and distractibility assessed at the ages of three months and two years. We focus on the child's noncognitive skills that are more easily distinguishable from cognitive skills (IQ). Most of these measures are only weakly correlated with IQ. The reported correlations are of order $r = 0.19$, $r = 0.21$, $r = 0.10$ and $r = 0.14$ for attention span, approach, prevailing mood and distractibility.

[2]At the ages of 3 months and 2 years, the interrater reliability was measured in a preliminary study of 30 children. Satisfactory interrater agreement was obtained between two raters (3 months: mean $\kappa = 0.68$, range 0.51 - 0.84; 2 years: mean $\kappa = 0.82$, range 0.52 - 1.00).

Attention span refers to the child's ability to concentrate on a particular activity and to continue it in the face of obstacles. The items include aspects on *how attentive* the child is in different situations, for example the attention to a new plaything, or to a strange person. It also refers to whether or not a child can concentrate on a particular activity for a relatively long time. The attention span is related to task persistence and self-regulation which are both assumed to have a positive impact on the amount of time spent on homework and on a child's participation. In accordance with A. Thomas et al. (1968) we distinguish between a 'low attention span', a 'mid attention span' and a 'high attention span'.

Approach describes *how* the child *reacts* to new (strange) persons or environments, either in a positive or a negative way. For example, a child who is bold will tend to approach things or persons quickly as if without thinking. In contrast, a child who is cautious typically prefers to watch for a while before opening itself to new experiences. The scale varies between 'the child reacts sometimes' versus 'the child shows clear interest and smiles'.

Prevailing mood refers to the child's general tendency towards good or bad temper. The prevailing mood is an overall assessment of a child's mood in different situations, e.g. a child's mood when he or she goes to sleep or during eating. Infants who smile all the time can be considered as cheerful, while infants who cry all the time can be considered as stormy. Mood lies on a continuum between 'bad temper', 'satisfaction' and 'good temper' in accordance to the classification by A. Thomas et al. (1968).

Distractibility describes if and how a child is disturbed by changes in his/her environment. Is the child bothered by external stimuli such as noises or lights or does the child simply ignore them? A child who is difficult to calm will be easily distracted and will not be able to remain concentrated and vice versa. The scale ranges between 'difficult to calm', 'adequate to calm' and 'easy to calm', see A. Thomas et al. (1968).

Social outcomes in adolescence

We focus on six different kinds of social outcomes: grades in math and German, delinquency, tobacco and alcohol use and autonomy between 8 and 19 years.

Grades in math and German We use grades in math and German as measures of school performance. Grades in math and German were repeatedly observed at 11 and 15 years. They vary from 1, 1.1, 1.2,..., 5.9 to 6.

Delinquency Adolescents completed a questionnaire which asked individuals at age 15 and 19 what illicit things they had ever done in their life, for example dodging the fare, bunking off or using drugs, even if these things were not known to parents or to the police.

It is the unproven delinquency, instead of the proven delinquency. In our sample the scale ranges between 0 and 32 'criminal' activities.

Smoking Adolescents were asked at age 15 and 19 whether they currently smoked. For our empirical analysis we use a dummy variable which takes the value one if individuals consume tobacco and zero otherwise.

Alcohol consumption Adolescents were administered a substance use questionnaire assessing the average alcohol consumption in the last month at age 15 and 19. The average alcohol use is measured as the number of standard alcohol drinks[3] such as beer (0.33 l) or a glass of wine (0.125 l) or a longdrink/cocktail with 40 ml spirits. The measure varies between 0 and 204 standard drinks per month.[4]

Autonomy This measure is derived from a seven-step four dimensional assessment scale. The goal of this scale is to assess the level of functioning of a child or an adolescent independent from his psychiatric disorder (Marcus et al., 1993). The four dimensions of the scale include family, performances, peer relationships, interest and autonomy. In our paper, we focus on autonomy. It describes the extent of autonomy with regard to age-dependent tasks or problems, for example sleeping alone over night at their relatives' home or defining one's own positions. Autonomy was rated at the ages of 8 and 11 by trained raters (Marcus et al., 1993). The level of the functioning scale varies between 1 (total dependent) - 7 (total independent).

6.3 Data

The Mannheim Study of Children at Risk (MARS)[5] follows children at risk, born with different organic and psychosocial adversities, from birth until adolescence. The initial sample comprises children born in the Rhine-Neckar Region of Germany between February 1986 and February 1988. In order to distinguish between the independent and combined effects of organic and psychosocial risks on child development, the children were selected according to a combination of these two risk factors (see Figure 6.1).

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[3]A standard alcohol drink consists of 8-12 g alcohol per drink.

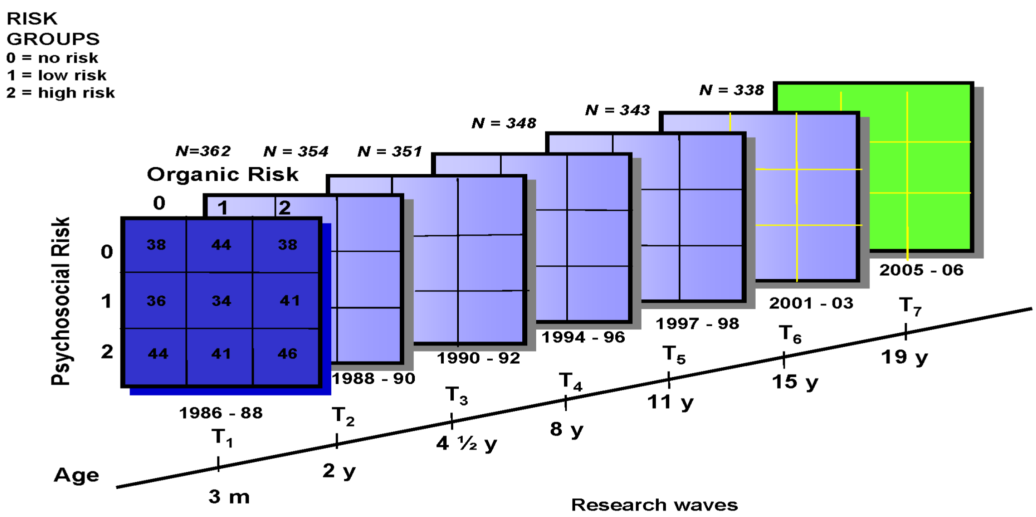
[4]Data concerning the tobacco and alcohol consumption were assessed via the Substance Use Questionnaire designed by Müller and Abbet (1991) in collaboration with the World Health Organization (WHO).

[5]MARS is derived from the German title **MA**nnheimer **R**isikokinder **S**tudie.

Organic risks are pregnancy or delivery complications, e.g. if a child is born with low birth weight (LBW) or is born preterm, while psychosocial risks are related to the family background, for example a low educational level of the parents, early parenthood or single-parent families.[6]

Both risk factors were divided into 'no', 'moderate' and 'high' risk, respectively. According to this rating, children were assigned to one of the nine groups resulting from the two-factorial design. All groups are of equal size with a slight oversampling in the high-risk combinations and have about the same share of females and males.

Figure 6.1: The Mannheim Study of Children at Risk (3 month - 19 years)



Source: Mannheim Study of Children at Risk (1986-2006).

To control for confounding effects of the family environment and infant medical status, only firstborn children of German speaking parents took part in the study. Multiple births were not considered, either. Furthermore, children with severe physical handicaps, obvious genetic defects or metabolic diseases at birth were excluded. The participants were primarily of European descent. The initial sample amounts to 384 children. Among them, the first 110 children were randomly selected. 274 children were systematically selected

[6]The psychosocial risk factors are based on the family adversity index proposed by Rutter and Quinton (1977).

by risk status to ensure that all of the nine risk combinations are equally distributed. Due to small sample size, we constitute a so-called ‘representative sample’ based on these 110 randomly selected children. Each of the 110 individual has a probability (weight) to be in one of the nine resulting groups. Based on the weights, we calculate a representative sample.

Medical and psychological examinations of the research waves took place when the children were 3 months, 2, 4.5, 8, 11, 15 and 19 years old and have continued since then.[7] For a more detailed overview of the study design, (see for instance Laucht et al. (2004), Laucht, Esser, and Schmidt (2001) or Laucht et al. (1997)).

Descriptive statistics: Table E.1 presents descriptive statistics of the child’s noncognitive skills in early childhood which we used in our study: attention span, approach, prevailing mood and distractibility.[8] Means and standard deviations for these measures are shown for the total sample, the high risk subsample, the no risk subsample, for girls as well as for boys. The share of children with a low attention span is 10% in the total sample. In the high risk subsample, the share of children with a low attention span is more than twice as large compared to the no risk combination. The proportion of boys with a low attention span is twice as large compared to girls.

Children without risk show a greater interest towards new persons and objects compared to those of the total and high risk subsample. Differences between boys and girls regarding the initial reaction are rather small. In the high risk sample, the percentage of children having a bad temper is 34%. The share of boys having a bad temper is ten percent higher compared to girls. Finally, the share of children who tend to be unsensitive to an external stimuli is 6% higher in the high risk sample compared to the no risk samples. In line with other dimension of a child’s temperament, boys have lower noncognitive skills compared to girls, at least regarding early childhood.

The stability of the temperament in early childhood is rather weak. Correlation analyses of all four noncognitive skills between three months and two years show only weak associations which is in line with the psychological literature (Nigg, 2006). The highest (lowest)

[7] Participants with severe handicaps, IQ<70, MQ<70 or neurological disorder were excluded from the original sample.

[8] We calculated joint means and standard deviations for both ages, three months and two years.

correlation is 0.17 (0.01) for distractibility (for prevailing mood).[9]

Table E.2 reports educational outcomes, delinquency, tobacco and alcohol consumption and autonomy of the adolescents. In accordance with the descriptive statistics of the early noncognitive skills, we regard these outcomes for all five samples. Depending on the social outcome, we repeatedly observe this information when individuals are between 8-19 years old.

Differences between the high risk and the no risk sample are quite large for most of the outcomes. For all samples, educational performance is on average higher for grades in German than for grades in math, where higher means imply worse achievements. Grades in maths are better for boys, while grades in German are better for girls.

The number of ‘criminal’ activities is on average twice as large among adolescents in the high risk sample compared to the no risk sample. The result indicates that individuals growing up with less educated parents or even with delinquent parents are more likely to become delinquent themselves. Boys are on average nearly more than twice as often ‘criminal’ than girls.

For the health risk behavior in terms of tobacco and alcohol use, we find that adolescents who were born with two risk factors have a worse health behavior compared to children born with no risk. The average alcohol consumption in terms of average standard alcohol drinks, for example, is more than twice as large among boys in comparison to girls. Finally, autonomy seems to be higher for girls compared to boys in our data.

6.4 Empirical methods

This section will discuss our framework for identifying the medium-term effects of early noncognitive skills. Let be

[9] However, agreement exists to consider temperament as something which develops very early and as biologically rooted differences in behavioral tendencies that are relative stable during lifetime (Pitzer, Esser, Schmidt, and Laucht, 2007).

$$Y_{it} = \alpha + \beta NC_{is} + X'_{jit}\lambda + f_i + u_{it} \tag{6.1}$$

where Y_{it} denotes the social outcomes (school achievement, health behavior, delinquency and autonomy) of individual i in t (during the age between 8 and 19 years), NC_{is} represents the child's i early noncognitive skills in s (at the age of 3 months and 2 years), X_{jit} is a vector of parental characteristics j at t, including a dummy variable indicating whether the adolescent lives in a single parent household, a set of dummies for the family size and family changes until adolescence of the child i. All variables captured in X_{jit} refer to the period when children are between 8 and 19 years old. Given the study design, we do not have to control for the birth order and migration background due to the fact that only the firstborn child and only singleton births from German speaking parents were considered in the study. As mentioned above, we do not have to take into account birth cohort effects or regional effects since all individuals were born between 1986 and 1988 in the Rhine-Neckar Region. u_{it} is the individual specific idiosyncratic error term, assumed to be independent of all observable and unobservable factors.

Finally, f_i describes the unobserved individual effect. This effect can cover features of an individual such as genetic endowment or parental motivation towards the upbringing of their child that are given and assumed to not change over time. Contrary to initial theories of temperament, new findings show that heritability plays a substantial role in the development of major traits during early childhood. For example, dopamine genes may influence to some extent temperament but may also be related to a range of other abilities and functions e.g. cognitive abilities, learning abilities or motor control (Nigg, 2006).

Our central parameter of interest is β and its magnitude is relevant for policy implications. If β has large and positive impacts on social outcomes, one might expect substantial benefits from interventions that improve early noncognitive skills. A cross-sectional estimation of equation 6.1 without considering f_i will lead to biased estimates of β, because unobserved time-invariant and individual specific elements of f_i might influence both early noncognitive skills and outcomes in adolescence. Thus, even if there is a strong correlation between social outcomes and early noncognitive skills, the strength of the correlation could be driven by the correlation between early noncognitive skills and unobservable genetic factors captured in f_i.[10]

Identification strategy: We observe social outcomes in adolescence at two different ages (from 8 to 19 years). Noncognitive skills in early childhood are also observed at two different ages (at 3 months and at 2 years). We exploit cross-variation in individual-specific one-period changes in regressors and individual specific one period changes in the dependent variables to identify β. Lagging equation 6.1 by one period yields:

$$Y_{it-1} = \alpha + \beta NC_{is-1} + X'_{jit-1}\lambda + f_i + u_{it-1} \tag{6.2}$$

Subtracting equation 6.2 from equation 6.1 yields the first-differences model:

$$(Y_{it} - Y_{it-1}) = \beta(NC_{is} - NC_{is-1}) + (X_{jit} - X_{jit-1})'\lambda + (u_{it} - u_{it-1}) \tag{6.3}$$

Under the assumption that u_{it} is uncorrelated with NC_{is}, the fixed effects estimator $\beta_{F.E.}$ is unbiased for β.[11] ΔNC_{is} denotes the change between noncognitive skills at three months and two years. The identification of β also depends on the degree of the within-variation between noncognitive skills and social outcomes. We present the variation for all noncognitive skills as categories as well as continuous measures and social outcomes in Table E.3. At the age of three months, these skills can be regarded as the result of genetic endowment, while noncognitive skills at the age of two years are the result of early parent-child interactions. The difference in noncognitive skills can therefore be regarded as parental investment in noncognitive skills.

We estimate different fixed effects models on the child level for each outcome.[12]

[10] A second problem can be reverse causality. This is especially problematic if outcomes may influence noncognitive skills and vice versa. Since we observe noncognitive skills during early childhood and social outcomes at least six years later, this source of endogeneity is not problematic in this study.

[11] Since we observe each social outcome only for two different ages, the first-differences estimator is equivalent to the within estimator.

[12] This is due to the fact that social outcomes differ in duration and age when they are assessed for the first time.

Models for grades in math and German:

$$(Y_{i15} - Y_{i11}) = \beta(NC_{is} - NC_{is-1}) + (X_{ji15} - X_{ji11})'\lambda + (u_{i15} - u_{i11}) \quad (6.4)$$

In equation 6.4 we are interested in how an increase in early noncognitive skills leads to an increase in school performance during the age between 11 and 15 years.
Models for delinquency, smoking and alcohol consumption refer to later points in time:

$$(Y_{i19} - Y_{i15}) = \beta(NC_{is} - NC_{is-1}) + (X_{ji19} - X_{ji15})'\lambda + (u_{i19} - u_{i15}) \quad (6.5)$$

Parental investment reduces health risk behavior and reduces criminal activities and therefore we would expect that β is negative.
Model for autonomy:

$$(Y_{i11} - Y_{i8}) = \beta(NC_{is} - NC_{is-1}) + (X_{ji11} - X_{ji8})'\lambda + (u_{i11} - u_{i8}) \quad (6.6)$$

In equation 6.6, we are interested in how an increase in early noncognitive skills leads to an increase in a child's autonomy during the age between 8 and 11 years.

For each skill, we compute categories (dummy variables) to estimate possible non-linear effects of early noncognitive skills. For example, differences in health behavior or school attainment may appear only for the fraction with a low attention span. In this case, a linear regression would not adequately capture this relationship.
As for the attention span, we estimate noncognitive skill effects in early childhood by comparing a 'low' attention or a 'mid' attention to a 'high' attention span (baseline category). For approach, we distinguish between two groups: whether the child reacts sometimes to a strange (new) person and whether the child shows a 'high interest' toward a strange person (reference group). As for the third noncognitive skill, we compare 'bad' temper and 'satisfied' with 'good' temper (baseline category). Regarding the fourth skill in early childhood, we compare 'difficult' to calm and 'adequate' to calm to the reference category 'easy' to calm.[13]

One limitation of our estimation strategy is that we cannot observe the effect of time-invariant measures on social outcomes. In particular, we cannot identify the effect of cognitive skills at t (IQ, nonverbal IQ or verbal IQ), because the rank order stability of cognitive skills emerge by middle of childhood (until age 8)(Borghans et al., 2008).[14]

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[13]We re-estimate all models using linear specifications. The results are similar. They are available from the authors upon request.

[14]Calculating differences in IQ scores between t and $t-1$ lead to zero within variations in our data.

For each noncognitive skill in early childhood, we estimate five different models: OLS using the total sample;[15] F.E. using the total sample; F.E. using the representative sample; and F.E. models for girls and boys, separately.

6.5 Results

Table E.4 shows the effects of early noncognitive skills on grades in math. Column 1 displays the OLS coefficients of all noncognitive skills for the total sample. The second column reports the FE results for the same sample. Columns 3-5 present F.E. results for the weighted (representative) sample, for boys and for girls. All models include a dummy variable which indicates whether a child lives in a single household, a dummy variable for the number of household members (from two to more than 5 members) and a dummy variable which takes the value one if the family composition has not changed until now. All subsequent tables present estimation results for other outcomes but have the same structure.[16]

The results in Table E.4 show that children with a low or mid attention span have significantly lower grades in math than those with a high attention span. This relationship holds in all models. The estimated coefficient between the total sample and the representative sample remains virtually unchanged. The relatively higher association between the attention span and grades in math is smaller for those with a mid attention span. A low attention span might indicate attention problems in early childhood, which is one symptom of ADHD (Nigg, Goldsmith, and Sachek, 2004). ADHD symptoms lead to lower reading and math test scores (Currie and Stabile, 2006). Nigg et al. (2004) find that early attention problems remain fairly stable over time, which might reduce learning opportunities. Finally, boys with a low attention span have lower school achievements compared to girls.

[15] This estimation strategy allows us to compare the OLS coefficient in the total sample to the F.E. coefficient in the total sample.

[16] Disabled persons are observed until age 11. Thus, for school grades and autonomy, we have observed their outcomes, however, for reasons of comparison we exclude all disabled persons from our analysis (3 observations).

The second part of Table E.4 presents the same results but uses approach instead of attention categories. Children who 'react sometimes' have on average 0.23 lower grades in math than those with a 'high interest'. The fact whether a child had a bad temper, was satisfied or was in a good temper in early childhood seems to have no impact on grades in maths.

The last results in Table E.4 indicate that children who were difficult to calm within the second year of life have significantly poorer grades in math. Interestingly, β is quite equal in the total (risk) sample and in the total (representative) sample. Moreover, these results show that only children who were difficult to calm perform more poorly in school in later life, while the association is insignificant for the category 'adequate to calm'.[17]

Table E.5 displays the estimation results for the influence of all early noncognitive skills on grades in German between the age of 11 and 15 years. In accordance to the results presented before, a low attention span in early childhood ceteris paribus causes lower school performance in terms of grades in German. The effect is stronger for the lowest attention category in comparison to children having at least a mid attention span. In comparison to grades in math, the attention span seems to be less important for explaining differences regarding grades in German. Both, the results for grades in math and in German, are in line with previous studies which found links between attention abilities and later achievement. For example, the study of Duncan et al. (2007) shows that the attention span is an important predictor for school reading and math achievements. Further, while a low attention span for boys is associated with worse grades in German, a low attention span for girls does not matter for grades in German (see Table E.5). This result is in line with a most recent study by Freudenthaler, Spinath, and Neubauer (2008).

Children who showed a high interest at the beginning of life towards a strange person have significantly better grades in German than children who reacted only sometimes to a new person or a new object.

For a child's mood in early childhood, columns 1, 2 and 4 suggest a correlation between early noncognitive skills and grades in German. However, these associations cannot be observed in the representative sample and they cannot be observed for girls. In line with

[17]For all models presented in Table E.4, OLS estimate are rather similar to F.E. estimates.

previous results, only the extremely low mood category leads to adverse impacts on grades in German, except for boys.

Surprisingly, if we estimate models 1-5 in Table E.5 using grades in German instead of grades in math, only the OLS model shows a significant association between early noncognitive skills and grades in German. A significant relationship between early noncognitive skills and school outcomes in our sample neither exists for the total sample (column 2) nor for the total representative sample (column 3). This suggests that different school outcomes require different aspects of early noncognitive skills. Altogether, comparing grades in math with grades in German, noncognitive skills seems to be more important for grades in math, while they seem to be less important for grades in German.[18]

'Criminal' activities during adolescence can be the result of various possible behavioral aspects, one is the early temperament (Loeber, 1990). Table E.6 shows that the attention span during early childhood is a very important noncognitive skill for explaining the differences in delinquency of the 15-19 year olds: on average, children with a low attention span and children with a mid attention span during early childhood will become more often delinquent in comparison to children with a high attention span, accounting for family background variables. Previous research has reported that ADHD is a risk factor for later delinquency in adolescence (Herrenkohl et al., 2000). This finding holds for all models presented at the top of Table E.6, except for girls. Children who had a low attention span between the age of 3 months and 2 years commit on average 3.11 more criminal activities than children of the high attention group. The significant association holds also for the category 'mid' attention span, but the extent is smaller compared to children with a low attention span. Boys who had a low and mid attention span during early childhood behave more delinquent than girls. Some studies have shown that gender is itself a risk factor for delinquent behavior (Pardini, Obradovic, and Loeber, 2006).

Table E.6 provides estimates of how the dimension 'approach' in early childhood impacts delinquent behavior in juveniles. Children who had a poor initial reaction in early childhood are more often 'criminal' than children who were more interested in strange objects

[18]We re-examined our main estimation for grades in math and German taking into account that a good grade at the highest school track indicates a higher school performance than a good grade at the lowest school track. Yet, for the (total) risk sample, the results are much stronger for the lowest skill category and become often insignificant for the mid against the highest skill category. The results are not reported here, but available from the authors upon request.

and persons. Boys who react only sometimes commit on average 2.30 ‘criminal’ activities, while for girls we find no significant influence.

The fact whether a child was in a good or bad temper in his first years of life seems to have no consequences with regard to delinquency in adolescence. This is true for all models presented in Table E.6. Simple Chi^2-tests also do not indicate any significant influence of early noncognitive skills on later delinquency. The child’s mood in early childhood is rather instable over time, which might explain why there is no association between early mood and delinquency in adolescence.

Finally, the facts are similar when we turn to distractibility. For some models, we find that children who were difficult to calm during early childhood commit on average 1.80 more crimes during adolescence than children who were easy to calm. However, these effects are only significant at the 10% level. The impact is more than twice as large for boys. The tendency to withdraw from unknown and dangerous situations is considered to be one aspect of a difficult child temperament, however, this will increase conduct problems (Frick and Morris, 2004).

Tables E.7 and E.8 present the relationship between early noncognitive skills and a risky health behavior in adolescence. Several studies suggest that the strong link between the use of tobacco and alcohol could be partly explained by personality traits for example, Cloninger, Sigvardsson, and Bohmann (1988) and Conway, Swendsen, and Rounsaville (2002). Table E.7 shows the estimated effects of early noncognitive skills on the probability of smoking between the age of 15 and 19 years.

Except for girls (column 5), all F.E. and OLS results indicate a substantial relationship between attention problems in early childhood and the probability of smoking in adolescence. Adolescents have a 15 percentage point higher probability of smoking if they had only a low attention span in their first years of life. The effect of smoking is, on average twice as high for boys at the age of 15 and 19 years compared to the representative sample.

The effects of ‘approach’ at the ages of three months and two years on smoking in adolescence are significant in the OLS specification, stronger in the FE specification in the full risk sample as well as in the representative sample, but insignificant for girls. The F.E.

results in column 2 and 3 indicate a significant relationship between early noncognitive skills and smoking in adolescence. The estimated effect is equal in both samples.

A young adult who often had a bad temper in early childhood has a 16 percentage points higher probability of smoking than his or her counterpart with a good temper during early childhood. Interestingly, the probability of smoking is even 26% higher for young girls with a bad temper in early childhood. No model presented in Table E.7 shows significant differences between satisfied children and children with a good temper in terms of smoking in adolescence.

The distractibility results within the F.E. context show no significant differences in all models between those children who were difficult to calm and those children who were easy to calm in early childhood. In contrast, children who were adequate to calm have a significantly lower probability of smoking at the age of 15-19 years in the total risk sample, in the representative sample and for girls compared to children who were easy to calm.

The results in Table E.8 indicate that early noncognitive skills are also associated with a risky health behavior in terms of alcohol consumption between 15 and 19 years. Children who had a low attention span or a mid attention span in early childhood consume significantly more alcohol on average compared to those with a high attention span. For example, the average number of alcoholic drinks is 22.77 times higher per months in the group of children having a low attention span compared to children who had a high attention span in early childhood. For children who had a middle attention span, it is 11.30 times higher per month compared to children who had a high attention span. Gender differences are quite large. Boys with a low attention span consume on average four times more alcoholic drinks than girls with a low attentions span.

The average alcohol consumption is higher for children who had low noncognitive skills in early childhood in terms of 'approach'. For all samples we find that children who reacted only sometimes to new (strange) persons in early childhood drink significantly more alcohol in adolescence than their counterparts.

In our data, mood in early childhood does not matter for the average monthly alcohol consumption in adolescence. We find neither a significant difference between children who had a bad temper during early childhood compared to satisfied children nor between satisfied children and children with a good temper in any model specification.

While a child's distractibility has no lasting impact on the smoking behavior as an adolescent, it has substantial effects on the average monthly alcohol consumption as adolescent. Differences are only quite large between the two extreme categories 'difficult to calm' and 'easy to calm', while differences between 'adequate to calm' and 'easy to calm' are not significant. Bobo and Husten (2000) found that the majority of tobacco smokers also consumed alcohol, whereas only half of the current alcohol users also smoked. Their investigation showed that the concurrent user group could be distinguished from the users of alcohol by higher novelty seeking scores. Finally, the positive relationship between high noncognitive skills and healthier behavior is most pronounced for boys.

We find that for most noncognitive skills, boys with the same stock of noncognitive skills (attention span, approach, distractibility) have a significantly higher alcohol consumption than girls. The risk-taking tendency may be more common among males than among females (Haas, 2004).

We conclude our analysis by considering how early noncognitive skills influence autonomy. The results in Table E.9 indicate that in contrast to the substantial effect of the early attention span on later school performance, health risk behavior and delinquency, there is no impact on a child's autonomy at the age between 8 and 11 years. This holds for each category relative to the baseline category and for all F.E. model specifications. Further, the null hypothesis of no impact of early noncognitive skills on a child's autonomy cannot be rejected.

In contrast to the attention span the dimension 'approach' in early childhood contributes to the development of autonomy. For the development of autonomy, the initial reaction to (strange) persons in early childhood matters. Our results are in contrast with our prior expectations that infants who reacted only in some cases to strange persons and objects might be considered as less open and withdrawn which in turn later manifests itself in low autonomy at the age between 8 and 11 years.

Children who had a bad temper during early childhood are significantly less independent when they are older compared to children who were at least satisfied. The result holds for all models, except for boys (column 4). The association between mood in early childhood and autonomy between the age of 8 and 11 years is most pronounced among girls. An infant's distractibility does not contribute to the development of autonomy between the age of 8-11 years, except for girls. Girls who are easy to calm become more independent as adolescents compared to boys.

Robustness: Our results are subject to one major limitation regarding the representatives due to the oversampling of risk children. However, one advantage of the study design is that we can examine which of the risk factors (psychosocial or organic) has more detrimental effects in terms of outcomes in adolescence. Using both subsamples, we are able to disentangle both risk factors compared to the total sample, but we risk that our estimates are statistically insignificant due to a smaller sample size. In Tables E.10 - E.12 we split up the total (risk) sample into the psychosocial and organic risk sample, which means that individuals with an organic risk are excluded from the former and individuals with psychosocial risk are excluded from the latter subsample (see Figure 6.2). In both samples, we exclude individuals with no risks.

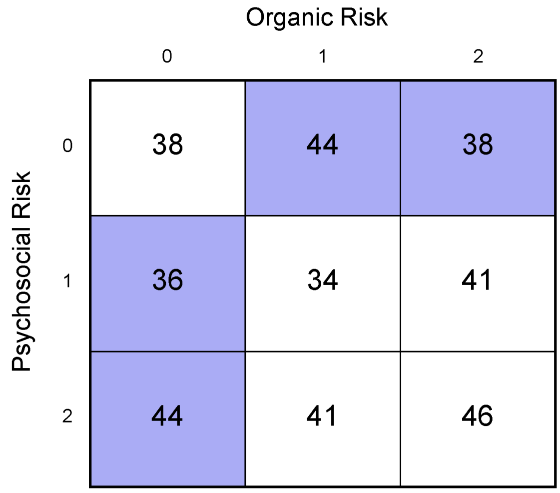
In the following, we restrict the interpretation of the findings to main differences between the samples. First, after separating the full sample, the estimated coefficient in the psychosocial (organic) risk sample falls (rises) from 0.57 to 0.48 (1.07).[19] Children born with a low attention span and (born) with pre- or neonatal complications face worse grades in math and German than children with a low attention span and no organic risk. This result supports earlier findings on the effects of poor infant health on school achievements, for example Currie and Hyerson (1999), Black et al. (2007) and Oreopoulos et al. (2008).

In contrast, using the psychosocial and organic subsample, however, we find no significant relationship between noncognitive skills in terms of approach, prevailing mood and distractibility and grades in math and German up to age of 15 at least at the five percent level.

The results in Table E.11 indicate that the relationship between noncognitive skills in early childhood and health risk behavior (tobacco and alcohol consumption) in adoles-

[19]Note that the coefficients are measured less precisely.

Figure 6.2: Risk subsamples



Source: Mannheim Study of Children at Risk (1986-2006).

cence is more pronounced among children born with psychosocial risk. This suggests that psychosocial risks and low noncognitive skills at birth amplify the adverse impact of the probability of tobacco and alcohol use. The impact of the quality of family environment on later tobacco and alcohol consumption seems to be cumulative (Anda et al., 1999).

Finally, we find a slightly higher risk of becoming delinquent in the psychosocial subsample compared to the organic risk subsample.

6.6 Conclusion of Chapter 6

The paper contributes to the recent discussion on the relevance of early noncognitive skills for human capital accumulation. We use a longitudinal epidemiological cohort study of 384 children at risk from the Rhine-Neckar Region in Germany to examine the medium-term consequences of noncognitive skills. Using four different measures of a child's noncognitive skills, attention span, approach, prevailing mood and distractibility assessed at the age of three months and two years, we find that noncognitive skills are significantly associated with most social outcomes observed in the study. These results hold for the full (risk) sample, the representative sample as well as for the organic and psychosocial risk sample. Most noncognitive skills in early childhood are important predictors of educational performance, health risk behavior, delinquency and autonomy in adolescence.

Especially the attention span has emerged as a dominant factor of noncognitive skills regarding educational performance, health risk behavior and delinquency in our study. Moreover, the child's initial reaction within the first two years of life is also associated with most social outcomes in adolescence. The child's attention span and the child's approach appear to be stronger predictors than a child's mood and a child's distractibility in the models for health risk behavior and juvenile delinquency. For a child's mood and a child's distractibility in early childhood, we find, except for tobacco use, that only the extremely low categories reduce the child's social outcomes in adolescence, while differences between the middle against the highest category are not significant.

Further, gender differences can be observed for nearly all outcomes used in the study. Boys with low noncognitive skills in early childhood have significantly lower social outcomes in comparison to girls in adolescence. Finally, we find for most social outcomes that low noncognitive skills in either the organic or psychosocial risk group have additionally adverse effects. In particular, for children born with organic risk, the association between low noncognitive skills in early childhood and poor school achievements during adolescence is stronger compared to children born with psychosocial risks. In contrast, for children born with psychosocial risks, the association between low noncognitive skills in early childhood and alcohol consumption as adolescent is higher compared to children born in the other risk group.

Our evidence supports the importance of noncognitive skills in early childhood as a predictor of a variety of social outcomes in adolescence. The enhancement of children's noncognitive skills will affect later skills which in turn affect a variety of economic and noneconomic outcomes (Heckman et al., 2006). This confirms earlier findings that much of the effectiveness of early childhood interventions comes from the promotion of noncognitive skills, such as self-esteem, learning abilities, peer interaction and the ability to overcome shyness (Blau and Currie, 2005).

Although noncognitive skills are malleable until the early 20s (Dahl, 2006), interventions in a period of relatively high malleability are more likely to succeed than interventions in a period of reduced malleability. Therefore, economic and noneconomic returns of early investments are higher.

Conclusion

While studies related to the economics of education traditionally focused on institutional aspects of education mostly started with school entry age, only a few studies have so far expanded the economic discussion by also taking education for the early years into account. This thesis empirically investigates different aspects of early childhood education in Germany starting at birth. However, recognizing the importance of the early years of childhood for human capital formation over the whole life cycle is not enough. In order to design policy implications, it is also essential to identify the links between different skills and different outcomes. As has been highlighted in the preceding chapters, improving the level of cognitive and noncognitive skills and improving health in early childhood is a complex task for both families and policy makers. Nevertheless, some results provide evidence for the direction for policy and family. This thesis ends by summarizing our response to the research questions posed in each chapter.

Chapter 1, 2 and 3 show how cognitive skills and noncognitive skills are affected by parental investment from birth until the end of (early) childhood. As we have seen in the first three chapters, the timing of parental investment and also the kind of investment are important for the development of a child's cognitive and noncognitive skills. Regarding some skills during (early) childhood, more non-economic resources seem to improve the development of a child's skills, while the development of other skills requires more 'economic' resources. The stock of skills acquired at previous periods is important for the formation of skills at later stages. This result explains why initial inequality ceteris paribus increases over time. Our main finding of chapter 2 and 3, which are designed to investigate the skill development over a longer time period, is that rank order stability of cognitive skills emerges much earlier during childhood than the rank order stability of noncognitive skills. These findings indicate that more attention should be directed toward the timing of investment during (early) childhood. Inefficient resource allocation can lead to high inequality in skill formation at later stages. This applies particularly for children from disadvantaged families.

Chapter 4 provides a methodical contribution regarding the determinants of institutional child care in Germany. The underlying consideration was to identify whether institutional child care can be regarded as one source of 'education' before schooling or whether the kindergarten is still and only a source of 'care'. In contrast to other studies, we addressed the endogeneity of the mother's labor supply by using an instrumental variable approach. Estimating a probit model against an IV probit model, the estimated effect of maternal employment on institutional child care is significant larger when taking the endogeneity of maternal labor market participation into account. The difference in estimates could reflect social attitudes in the sense that there is a share of mothers who do not return to the labor market but nevertheless send their children to institutional child care. We argue that parents might regard institutional child care as a key element for education and socialization of children before entering school. This point leads to important lessons for the recent policy change in Germany which plans to increase the supply of institutional child care for children younger than three years. A topic not addressed in this chapter is how institutional child care can contribute to the development of cognitive and noncognitive skills before children enter school. This might be an important research question especially when regarding the share of migrant families, single parenthood and the share of children who grow up without siblings in Germany.

In chapter 5, we focus on health as one dimension in and for the human capital formation over the life cycle. The child's health plays an important role for mainly two reasons: First, health in childhood has a lasting impact on the health in adulthood; second, health itself is linked to the acquisition of skills and education over the whole life cycle. The health in childhood depends on the genetic endowment, but most importantly on the health investments in terms of (health) inputs and (health) behavior of the family. As we have seen in chapter 5, the health of the parents as well as the health behavior of the parents play an important role for the health of their child. This finding holds for different health dimensions like anthropometric and self-rated health and for different models, even if we controlled for many family background information and for unobserved time-invariant factors. However, our results do not allow to disentangle the effects behind the intergenerational transmission process in early childhood, which means that we cannot separate biological programming from environmental effects. It is a challenge for future research on covering biometric health measures to disentangle these effects. In terms of policy implication, one can argue that in order to improve health in childhood it is effective to support the parents' self-rated health and their health behavior starting during pregnancy.

In chapter 6, we have shed some light on the importance of noncognitive skills in early childhood for a variety of social outcomes in adolescence. The inequality in noncognitive skills across individuals starts at birth, and parental efforts during the first years of life have strong effects on the stock of a child's noncognitive skills, including a child's attention span, approach, prevailing mood and distractibility. As chapter 6 shows, in the case of most early noncognitive skills, there is a positive relationship regarding school performance, reduced crime, health behavior and autonomy. The attention span has emerged as most important noncognitive skill regarding these outcomes at adolescence in our data. Moreover, a low stock of noncognitive skills in early childhood leads to cumulative adverse effects on all social outcomes at adolescence. This is the case when children are born with organic or psychosocial risk. For example, children born with psychosocial risks tend to consume significantly more alcohol ceteris paribus than children born with organic risks, while children who were born with organic risk significantly perform worse regarding school achievements compared to children who were born with psychosocial risk. Our evidence, along with the growing body of literature in the field of early childhood education, confirms the importance of the first years in life as a predictor for a variety of medium term outcomes. In conclusion, investigating differences across families and between boys and girls, helping to inform public policy makers about the mechanism of a child's skill development are effective ways to improve a child's noncognitive skills and hence future outcomes.

A Appendix for Chapter 1

Table A.1: The child's noncognitive skills at the second and the third stage

4-19 month Statements	26-47 month Statements
My child's health concerns me	I am worried about my child's health
My child is generally happy and satisfied	My child is usually happy and content
My child is easily irritated and cries frequently	My child is easily irritated and cries frequently
My child is difficult to console	My child is difficult to comfort when crying
My child is curious and active	My child is curious and active

Source: SOEP 2003-2007, Mother-Child Questionnaire (1) and (2).

Table A.2: The child's skills based on the Vineland scale

Skills	Statements
verbal	Understands brief instructions such as 'go get your shoes'
	Forms sentences with at least two words
	Speaks in full sentences (with four or more words)
	Listens attentively to a story for five minutes or longer
	Passes on simple messages such as 'dinner is ready'
motor	Walks forwards down the stairs
	Opens doors with the door handle
	Climbs up playground climbing equipment and other high playgrounds structures
	Cuts paper with scissors
	Paints/draws recognizable shapes on paper
social	Calls familiar people by name, for example, says 'mommy' and 'daddy'
	Participates in games with other children
	Gets involved in role-playing games ('playing pretend')
	Shows a special liking for particular playmates or friends
	Calls his/her own feelings by name, e.g. 'sad','happy', 'scared'
everyday	Uses a spoon to eat, without assistance and without dripping
	Blows his/her nose without assistance
	Uses the toilet to do 'number two'
	Puts on pants and underpants the right way around
	Brushes his/her teeth without assistance

Source: SOEP 2005-2007, Mother-Child Questionnaire (2).

Table A.3: The child's health conditions

4-19 months	26-47 months
Sensory (sight, hearing)	Asthma
Motor functions (grabbing, crawling, walking)	Motor impairments
Neurological disorder (including convulsions)	Spastic/acute bronchitis
Speech (pronunciation, speech acquisition disorder)	Pseudocroup/Croup syndrome
Regulatory system (inconsolable crying, continuous sleeping)	Middle-ear inflammation
Chronic illness	Hay fever
Physical disability	Neurodermatitis
Mental disability	Vision impairment (e.g. crossed eyes)
	Hearing impairments
	Nutritional disorder
	Chronic bronchitis
	Other impairments

Source: SOEP 2003-2007, Mother-Child Questionnaire (1) and (2).

Table A.4: Parental activities at the third stage

Statements	Daily	Several times per week	At least once a week	Never
Singing children's songs with or to the child	52.49	25.91	13.63	7.97
Taking walks outdoors	65.23	28.15	5.63	0.99
Painting or doing arts and crafts	25.33	45.34	24.33	5.00
Reading or telling stories	62.25	23.84	9.27	4.64
Looking at picture books	70.10	24.92	4.32	0.66
Going to the playground	12.67	40.00	29.33	18.00
Visiting other families with children	2.32	28.81	55.62	13.25
Going shopping with the child	8.97	46.18	39.20	5.65
Watching television or video with the child	28.67	32.00	20.33	19.00

Source: SOEP 2005-2007, Mother-Child Questionnaire (2). Own calculations.

Table A.5: Descriptive statistics - pooled sample

First stage (birth)	mean	std.dev.	**Second stage (4-19 months)**	mean	std.dev.	**Third stage (26-47 months)**	mean	std.dev.
			Skill indicator S_t					
Birth weight	3308.46	(600.55)	Noncognitive skills	18.07	(1.84)	Noncognitive skills	17.64	(1.82)
Fetal growth	84.61	(13.51)				Verbal skills	13.95	(1.52)
						Motor skills	13.13	(1.74)
						Social skills	13.81	(1.55)
						Everyday skills	11.30	(2.38)
						Vineland scale	52.22	(5.49)
			Skill indicator S_{t-1}					
			Birth weight	3297.28	(599.34)	Noncognitive skills	17.95	(1.92)
			Fetal growth	84.44	(13.42)			
			Investments I_t					
Mother smoked during pregnancy	0.20	(0.40)	Strong father's support	0.30	(0.45)	Parental activity	29.55	(4.21)
Good fetal environment	0.18	(0.38)	Good post-fetal environment	0.14	(0.35)	Institutional child care	0.42	(0.49)
Mother's education			Mother's education			Mother's education		
'No school degree'	0.16	(0.36)	'No school degree'	0.16	(0.37)	'No school degree'	0.14	(0.35)
'Vocational degree'	0.60	(0.49)	'Vocational degree'	0.59	(0.49)	'Vocational degree'	0.63	(0.48)
'University'	0.22	(0.41)	'University degree'	0.23	(0.42)	'University degree'	0.22	(0.41)
Mother's age	30.41	(5.45)				Single parent household	0.16	(0.36)
Mother's BMI	23.45	(4.10)				Only German spoken to child	0.81	(0.39)
Mother's health status	2.20	(0.77)				Mother not employed	0.51	(0.50)
			Controls C_t in %					
Boys	0.50	(0.50)	Boys	0.50	(0.50)	Boys	0.49	(0.50)
Twins	0.04	(0.19)	Twins	0.04	(0.19)	Twins	0.02	(0.12)
Firstborn	0.45	(0.50)	Firstborn	0.48	(0.50)	Firstborn	0.46	(0.50)
Mother German	0.90	(0.30)	Mother German	0.90	(0.30)	Mother German	0.91	(0.28)
			Child's age (4-9 months)	0.65	(0.48)	Child's age (26-31 months)	0.32	(0.47)
			Child's age (10-14 months)	0.33	(0.47)	Child's age (32-37 months)	0.53	(0.50)
			Child's age (15-19 months)	0.02	(0.14)	Child's age (38-47 months)	0.15	(0.35)
			Child's disorders	0.08	(0.56)	Child's disorders	0.46	(0.50)
Observations	1066			901			606	

Note: Fetal growth in gram/week. Good (post) fetal environment is a dummy variable which takes the value 1 if mothers have a very good mental and physical health status three months before (after) birth. Mother's health status varies from 1 (very good) to 5 (bad). Standard deviations are in parentheses.

Source: SOEP 2003-2007. Own calculations.

Table A.6: Descriptive statistics - sibling sample

First stage (birth)			Second stage (4-19 months)			Third stage (26-47 months)		
	mean	std.dev.		mean	std.dev.		mean	std.dev.
			Skill indicator S_t					
Birth weight	3261.10	(624.66)	Noncognitive skills	17.95	(1.88)	Noncognitive skills	17.55	(1.92)
Fetal growth	83.10	(13.88)				Verbal skills	13.94	(1.53)
						Motor skills	13.21	(1.67)
						Social skills	13.81	(1.54)
						Everyday skills	11.29	(2.38)
						Vineland scale	52.27	(5.27)
			Skill indicator S_{t-1}					
			Birth weight	3244.69	(625.13)	Noncognitive skills	17.90	(1.92)
			Fetal growth	82.89	(13.70)			
			Investments I_t					
Mother smoked during pregnancy	0.19	(0.39)	Father's support	0.28	(0.45)	Parental activity	29.71	(4.0)
Good fetal environment	0.15	(0.36)	Good post-fetal environment	0.13	(0.34)	Institutional child care	0.41	(0.49)
Mother's age	30.17	(5.22)				Mother not employed	0.58	(0.49)
Mother's BMI	24.33	(4.34)						
Mother's health status	2.20	(0.76)						
			Controls C_t					
Boys	0.50	(0.50)	Boys	0.51	(0.50)	Boys	0.48	(0.50)
Twins	0.08	(0.28)	Twins	0.09	(0.28)	Twins	0.03	(0.18)
Firstborn	0.38	(0.49)	Firstborn	0.40	(0.49)	Firstborn	0.53	(0.50)
			Child's age (4-9 months)	0.65	(0.48)	Child's age (26-31 months)	0.31	(0.46)
			Child's age (10-14 months)	0.32	(0.47)	Child's age (32-37 months)	0.56	(0.50)
			Child's age (15-19 months)	0.02	(0.15)	Child's age (38-47 months)	0.13	(0.34)
			Child disorders	0.08	(0.27)	Child disorders	0.48	(0.50)
Observations	460			401			267	

Note: Fetal growth in gram/week. Good (post) fetal environment is a dummy variable which takes the value 1 if mothers have a very good mental and physical health status three months before (after) birth. Mother's health status varies from 1 (very good) to 5 (bad). Standard deviations are in parentheses.
Source: SOEP 2003-2007. Own calculations.

Table A.7: Pooled OLS and siblings fixed effects estimates of birth outcomes

	Birth weight			Fetal growth		
	pooled OLS	siblings OLS	siblings F.E.	pooled OLS	siblings OLS	siblings F.E.
	‘Investments’ I_1					
Mother smoked during	-169.0***	-171.24**	-308.18**	-3.20***	-2.88*	-8.12***
pregnancy	(43.26)	(72.44)	(126.09)	(0.99)	(1.62)	(2.98)
Good fetal environment	81.77**	162.01**	48.43	0.86	2.61	-0.57
	(39.92)	(75.07)	(99.42)	(0.89)	(1.69)	(2.35)
Mother’s BMI	8.98**	10.98	16.90	0.17*	0.17	0.52*
	(4.26)	(6.79)	(11.62)	(0.10)	(0.15)	(0.28)
Mother’s health status	-22.60	-52.81	-90.77	-0.38	-0.85	-1.95
	(22.40)	(36.63)	(56.23)	(0.53)	(0.82)	(1.33)
Mother ‘vocational degree’	153.83***	153.52*		2.72**	3.44*	
	(51.29)	(82.59)		(1.18)	(1.86)	
Mother ‘university degree’	154.46**	185.55*		3.02**	4.20*	
	(67.0)	(104.44)		(1.48)	(2.35)	
Mother’s age	-60.51*	-74.22		-1.38*	-1.71	
	(34.80)	(48.70)		(0.79)	(1.09)	
Mother’s age square	0.95*	1.19		0.02*	0.03	
	(0.57)	(0.78)		(0.01)	(0.02)	
Mother is German	-29.57	-130.35		-1.56	-4.19*	
	(53.03)	(99.48)		(1.23)	(2.24)	
	Child’s ‘characteristics’					
Boys	88.83***	119.75**	172.24***	2.22***	3.14***	4.29***
	(33.99)	(52.5)	(63.11)	(0.77)	(1.18)	(1.50)
Twins	-997.11***	-967.44***	-930.16***	-21.79***	-20.54***	-21.40***
	(110.99)	(94.48)	(213.25)	(2.25)	(2.12)	(5.05)
Firstborn	-141.78***	-81.79	-55.63	-3.62***	-2.06	-1.41
	(37.25)	(58.91)	(60.0)	(0.85)	(1.32)	(1.41)
Constant	4061.25***	4288.18***	3111.39***	103.76***	109.42***	76.43**
	(532.93)	(761.36)	(294.17)	(12.12)	(17.12)	(6.96)
R^2	0.1451	0.2394	0.2236	0.1328	0.2161	0.1800
Observations	1066	465	460	1066	465	460

Note: Clustering-robust standard errors (taking account of correlated error terms within families) are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. We do not control for birth years and birth months because t-tests show that there are no significant differences in birth outcomes between birth cohorts.

Source: SOEP 2003-2007. Own calculations.

Table A.8: Pooled OLS and siblings fixed effects estimates of noncognitive skills at the second stage

	Noncognitive skills					
	pooled OLS	siblings OLS	siblings F.E.	pooled OLS	siblings OLS	siblings F.E.
	Birth weight			Fetal growth		
Skill S_1	0.09**	0.10*	0.19***	0.08**	0.10*	0.19***
	(0.038)	0.057	(0.07)	(0.038)	(0.059)	(0.07)
	'Investment' I_2					
Strong father's support	0.19***	0.21*	0.15	0.19***	0.21*	0.15
	(0.07)	(0.11)	(0.16)	(0.07)	(0.11)	(0.16)
Good post-fetal environment	0.39***	0.42***	0.16	0.40***	0.43***	0.19
	(0.07)	(0.10)	(0.18)	(0.07)	(0.10)	(0.18)
Mother 'vocational degree'	0.13	0.30*		0.14	0.30*	
	(0.09)	(0.16)		(0.09)	(0.16)	
Mother 'university degree'	0.18*	0.28		0.18*	0.29	
	(0.10)	(0.18)		(0.11)	(0.18)	
Mother is German	0.08	0.02		0.09	0.03	
	(0.11)	(0.22)		(0.11)	(0.22)	
	Child's 'characteristics'					
Boys	-0.16**	-0.06	-0.18	-0.15**	-0.06	-0.18
	(0.06)	(0.10)	(0.12)	(0.06)	(0.10)	(0.12)
Twins	-0.31	-0.25	1.18	-0.32*	-0.26	0.61
	(0.20)	(0.21)	(0.88)	(0.20)	(0.20)	(0.45)
Firstborn	0.03	0.13	0.03	0.03	0.13	0.03
	(0.06)	(0.09)	(0.14)	(0.06)	(0.09)	(0.14)
Child's age (4-9 months)	-0.45**	-0.34	-0.19	-0.46**	-0.34	-0.22
	(0.21)	(0.36)	(0.39)	(0.21)	(0.36)	(0.39)
Child's age (10-14 months)	-0.33	-0.23	-0.03	-0.33	-0.23	-0.07
	(0.21)	(0.36)	(0.40)	(0.21)	(0.36)	(0.40)
Child's disorders	-0.08	-0.44*	-0.08	-0.08	-0.44**	-0.07
	(0.09)	(0.23)	(0.25)	(0.09)	(0.23)	(0.25)
Constant	-0.19	-0.80	-0.78	-0.20	-0.81	-0.70
	(0.47)	(0.66)	(0.85)	(0.47)	(0.67)	(0.85)
R^2	0.0831	0.1269	0.0172	0.0817	0.1261	0.0142
Observations	901	391	401	901	391	401

Note: Clustering-robust standard errors (taking account of correlated error terms within families) are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. Birth weight, fetal growth and noncognitive skills are standardized into mean of 0 points and standard deviation of 1 points. All models control for birth years.

Source: SOEP 2003-2007. Own calculations.

Table A.9: Pooled OLS and siblings fixed effects estimates of noncognitive skills and Vineland skills at the third stage

	Noncognitive skills			Vineland skills		
	pooled OLS	siblings OLS	siblings F.E.	pooled OLS	siblings OLS	siblings F.E.
			Noncognitive skills			
Skill S_2	0.32***	0.45***	0.49***	0.10**	0.13***	0.37***
	(0.04)	(0.06)	(0.12)	(0.04)	(0.05)	(0.12)
			‘Investment’ I_3			
Parental activity	0.11**	0.15**	-0.01	0.21***	0.21***	0.15
	(0.04)	(0.06)	(0.11)	(0.05)	(0.07)	(0.11)
Institutional child care	-0.11	-0.10	-0.17	0.25***	0.20*	0.38
	(0.08)	(0.12)	(0.30)	(0.07)	(0.12)	(0.31)
Mother not employed	-0.05	-0.08	-0.48**	-0.22***	-0.16	-0.16
	(0.08)	(0.11)	(0.22)	(0.08)	(0.11)	(0.23)
Mother ‘vocational degree’	0.32**	0.19		0.03	-0.16	
	(0.14)	(0.21)		(0.16)	(0.17)	
Mother ‘university degree’	0.47***	0.44*		0.07	-0.20	
	(0.15)	(0.21)		(0.23)	(0.19)	
Single parent household	-0.13	-0.13		-0.02	-0.12	
	(0.12)	(0.19)		(0.09)	(0.17)	
Only German spoken	0.08	0.02		0.09	0.29	
to child	(0.14)	(0.20)		(0.13)	(0.22)	
Mother is German	-0.15	-0.08		0.22	0.21	
	(0.19)	(0.35)		(0.18)	(0.33)	
			Child’s ‘characteristics’			
Boys	-0.06	-0.17	-0.24	-0.34***	-0.40***	-0.38*
	(0.08)	(0.13)	(0.19)	(0.07)	(0.12)	(0.20)
Twins	-0.24	0.12	0.89	-0.03	0.19	1.26
	(0.19)	(0.25)	(1.00)	(0.31)	(0.38)	(1.02)
Firstborn	-0.03	0.10	0.50***	-0.11	0.10	-0.21
	(0.08)	(0.12)	(0.19)	(0.08)	(0.12)	(0.19)
Child’s age (26-31 months)	0.24	0.11	0.33	-0.47***	-0.27	-0.72**
	(0.17)	(0.21)	(0.33)	(0.16)	(0.21)	(0.34)
Child’s age (32-37 months)	0.08	0.23	0.23	-0.16	-0.08	-0.10
	(0.14)	(0.21)	(0.29)	(0.11)	(0.17)	(0.30)
Child’s disorder	-0.28***	-0.35***	-0.50**	-0.08	0.03	-0.33*
	(0.08)	(0.12)	(0.19)	(0.07)	(0.11)	(0.19)
Constant	-0.27	-0.17	0.17	-0.25	-0.38	0.60
	(0.27)	(0.40)	(0.37)	(0.25)	(0.32)	(0.38)
R^2	0.1884	0.3549	0.1830	0.2898	0.2725	0.0839
Observations	603	262	266	600	261	264

Note: Clustering-robust standard errors (taking account of correlated error terms within families) are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All skills in $t = 2$ and $t = 3$ and parental investments are standardized into mean of 0 points and standard deviation of 1 points. In all cross-section models we control for birth months.

Source: SOEP 2003-2007. Own calculations.

Table A.10: Pooled OLS and siblings fixed effects estimates of verbal and motor skills at the third stage

	Verbal skills			Motor skills		
	pooled OLS	siblings OLS	siblings F.E.	pooled OLS	siblings OLS	siblings F.E.
	Noncognitive skills					
Skill S_2	0.08*	0.08	0.23*	0.09**	0.17***	0.45***
	(0.04)	(0.06)	(0.13)	(0.04)	(0.06)	(0.12)
	'Investment' I_3					
Parental activity	0.23***	0.26***	0.24*	0.18***	0.18***	0.04
	(0.04)	(0.08)	(0.12)	(0.04)	(0.06)	(0.30)
Institutional child care	0.19**	0.11	0.19	0.02	-0.05	0.04
	(0.08)	(0.13)	(0.34)	(0.08)	(0.12)	(0.12)
Mother not employed	-0.16**	-0.12	-0.34	-0.17**	-0.14	-0.11
	(0.07)	(0.12)	(0.25)	(0.08)	(0.12)	(0.23)
Mother 'vocational degree'	0.26**	0.18		0.07	-0.14	
	(0.13)	(0.19)		(0.14)	(0.15)	
Mother 'university degree'	0.35**	0.18		0.28*	0.12	
	(0.15)	(0.22)		(0.15)	(0.18)	
Single parent household	-0.28***	-0.44**		0.04	-0.11	
	(0.10)	(0.19)		(0.10)	(0.17)	
Only German spoken	0.21*	0.39*		0.15	0.32	
to child	(0.13)	(0.23)		(0.13)	(0.21)	
Mother is German	0.19	0.33		0.06	-0.23	
	(0.19)	(0.37)		(0.16)	(0.25)	
	Child's 'characteristics'					
Boys	-0.12*	-0.23**	-0.44**	-0.09	-0.06	-0.05
	(0.07)	(0.12)	(0.22)	(0.08)	(0.12)	(0.20)
Twins	0.48	0.68*	0.67	0.03	0.17	0.75
	(0.21)	(0.40)	(1.11)	(0.19)	(0.23)	(1.03)
Firstborn	0.04	0.21*	-0.01	-0.21***	-0.17	-0.27
	(0.08)	(0.12)	(0.21)	(0.08)	(0.11)	(0.19)
Child's age (26-31 months)	-0.33**	-0.19	-0.38	-0.45***	-0.45**	-0.56*
	(0.14)	(0.21)	(0.38)	(0.17)	(0.21)	(0.34)
Child's age (32-37 months)	-0.12	0.02	0.06	-0.15	-0.23	-0.05
	(0.10)	(0.19)	(0.33)	(0.12)	(0.16)	(0.30)
Child's disorder	-0.14*	-0.02	-0.59***	-0.07	-0.09	-0.02
	(0.076)	(0.12)	(0.21)	(0.08)	(0.11)	(0.20)
Constant	-2.38***	-0.90***	0.65	-0.09	0.47	0.32
	(0.39)	(0.34)	(0.42)	(0.28)	(0.32)	(0.38)
R^2	0.2433	0.2432	0.0472	0.1825	0.1999	0.0483
Observations	606	263	266	604	262	265

Note: Clustering-robust standard errors (taking account of correlated error terms within families) are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All skills in $t = 2$ and $t = 3$ and parental investments are standardized into mean of 0 points and standard deviation of 1 points. In all cross-section models we control for birth months.

Source: SOEP 2003-2007. Own calculations.

Table A.11: Pooled OLS and siblings fixed effects estimates of social, everyday and noncognitive skills at the third stage

	Social skills			Everyday skills		
	pooled OLS	siblings OLS	siblings F.E.	pooled OLS	siblings OLS	siblings F.E.
	Noncognitive skills					
Skill S_2	0.05	0.08	0.36***	0.08**	0.09*	0.08
	(0.04)	(0.05)	(0.13)	(0.04)	(0.05)	(0.12)
	‘Investment’ I_3					
Parental activity	0.15***	0.15**	0.13*	0.12***	0.11*	0.06
	(0.04)	(0.07)	(0.12)	(0.04)	(0.069)	(0.11)
Institutional child care	0.31***	0.23*	0.73**	0.22***	0.24**	0.10
	(0.08)	(0.13)	(0.33)	(0.08)	(0.12)	(0.30)
Mother not employed	-0.14*	-0.10	0.04	-0.18**	-0.08	-0.11
	(0.08)	(0.13)	(0.24)	(0.08)	(0.12)	(0.22)
Mother ‘vocational degree’	0.11	0.03		-0.21*	-0.33**	
	(0.13)	(0.17)		(0.12)	(0.17)	
Mother ‘university degree’	0.13	-0.14		-0.33**	-0.54***	
	(0.15)	(0.19)		(0.14)	(0.20)	
Single parent household	-0.09	-0.19		0.15	0.22	
	(0.11)	(0.20)		(0.10)	(0.16)	
Only German spoken	0.14	0.19		-0.13	0.05	
to child	(0.13)	(0.21)		(0.12)	(0.18)	
Mother is German	-0.02	0.27		0.36**	0.23	
	(0.19)	(0.34)		(0.16)	(0.30)	
	Child’s ‘characteristics’					
Boys	-0.32***	-0.30**	-0.33	-0.40***	-0.48***	-0.34*
	(0.08)	(0.13)	(0.21)	(0.07)	(0.11)	(0.19)
Twins	0.09	0.28	2.82***	-0.45	-0.33	-0.11
	(0.40)	(0.46)	(1.08)	(0.34)	(0.38)	(0.99)
Firstborn	-0.03	0.19*	-0.23	-0.12	0.02	-0.07
	(0.08)	(0.11)	(0.20)	(0.07)	(0.12)	(0.19)
Child’s age (26-31 months)	-0.18	-0.07	0.29	-0.46***	-0.23	-1.07***
	(0.16)	(0.23)	(0.36)	(0.17)	(0.28)	(0.33)
Child’s age (32-37 months)	-0.05	0.25	0.71**	-0.13	-0.18	-0.63**
	(0.12)	(0.20)	(0.31)	(0.12)	(0.18)	(0.29)
Child’s disorder	0.03	0.18	-0.26	-0.07	0.0002	-0.14
	(0.08)	(0.12)	(0.21)	(0.07)	(0.11)	(0.19)
Constant	-0.25	-0.75*	-0.50	0.14	-0.008	0.96***
	(0.26)	(0.40)	(0.40)	(0.23)	(0.34)	(0.37)
R^2	0.1397	0.1789	0.0034	0.2538	0.2618	0.1080
Observations	607	264	267	607	264	267

Note: Clustering-robust standard errors (taking account of correlated error terms within families) are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All skills in $t = 2$ and $t = 3$ and parental investments are standardized into mean of 0 points and standard deviation of 1 points. In all cross-section models we control for birth months.

Source: SOEP 2003-2007. Own calculations.

B Appendix for Chapter 2

Table B.1: Definition of organic risk

	Items of the Index	Definition	N
		Non-risk group	
1	normal birth weight	2.500 - 4.200 g	118
2	normal gestational age	38 - 42 weeks	118
3	no signs of asphyxia	pH $\geq$ 7.2	118
		lactic acid $\leq$ 3.5 mmol/l	
		CTG score $\geq$ 8	
4	no surgical delivery	except elective	118
		Moderate-risk group	
5	EPH gestosis	edema	53
		proteinuria	
		hypertonia	
6	preterm birth	$\leq$ 37 weeks	151
7	signs of risk of preterm birth	preterm labor	43
		tocolytic treatment	
		cerclage	
		High-risk group	
8	very low birth weight	$\leq$ 1.500 g	46
9	clear case of asphyxia	pH $\leq$ 7.10	38
		lactic acid $\geq$ 8.00 mmol/l	
		CTG-score $\leq$4	
		treated neonatally for $\geq$ 7 days	
10	neonatal complications	seizures	83
		respiratory therapy	
		sepsis	

Note: The pH value measures an acid or basic effect of a hydrous solution. For individuals, a low pH value and lactic acid are indicators of low blood oxygen. A CTG (cardiotocograph) measures the child's heartbeat during pregnancy and labor, and through this, pathological values also indicate a lack of blood oxygen. An edema, also known as hydropsy, is the increase of interstitial fluid in any organ during swelling. Proteinuria is an indicator of possible severe damage to the metabolism or of kidney disease. Hypertonia is an indicator of a possible disease of the blood vessel system. Cerclage is an operative sealing of the cervix to prevent premature birth.

Table B.2: Definition of psychosocial risk

	Items of the Index	Explanation	N
1	low educational level of the parents	parent without completed school education or without skilled job training	74
2	overcrowding	more than 1.0 person per room or size of housing $\leq 50\ m^2$	34
3	parental psychiatric disorder	moderate to severe axis I or II disorder according to DSM-III-R criteria (interviewer rating, kappa =.98)	76
4	history of parental broken home or delinquency	institutional care of a parent/more than two changes of parental figures until the age of 18 or history of parental delinquency	74
5	marital discord	low quality of partnership in two out of three areas (harmony, communication, emotional warmth) (interviewer rating, kappa = 1.00)	43
6	early parenthood	age of a parent $\leq$ 18 years at child birth or relationship between parents lasting less than 6 months at time of conception	93
7	one-parent family	at child birth	38
8	unwanted pregnancy	an abortion was seriously considered	57
9	poor social integration and support of parents	lack of friends and lack of help in child care (interviewer rating, kappa = .71)	14
10	severe chronic difficulties	affecting a parent lasting more than one year, such as unemployment, chronic disease (interviewer rating, kappa = .93)	104
11	lack of coping skills	inadequate coping with stressful events of the past year e.g. denial of obvious problems, withdrawal, resignation, over-dramatization (interviewer rating, kappa = .67)	146

Note: The DSM-III-R is the Diagnostic and Statistical Manual of Mental Disorder, third edition, revised form.

Table B.3: Measurement of IQ and MQ

age	description
3 months	Cognitive abilities, IQ, were measured using the Mental Developmental Index (MDI) of the Bayley Scales of Infant Development (Bayley, 1969). The fine and gross motor abilities, MQ (called the motor quotient), were assessed by the Psychomotor Developmental Index (PDI) of the Bayley Scales.
2 years	The IQ was derived from the Mental Developmental Index (MDI) of the Bayley Scales of infant development. A differentiation is made between verbal abilities, V-IQ, and nonverbal cognitive abilities, NV-IQ. The verbal ability score is derived from the items of the Bayley Scales indicating language development, in combination with the expressive and the receptive language scales of the Münchener Funktionale Entwicklungsdiagnostik (MFED) (Köhler and Egelkraut, 1984). The nonverbal cognitive abilities are derived from the nonverbal items of the Bayley Scales, indicating basic, general abilities such as perception and logical and figural reasoning. The MQ was assessed by the Psychomotor Developmental Index (PDI) of the Bayley Scales.
4.5 years	The composite score of the IQ contained the Columbia Mental Maturity Scale (CMMS) (Burgmeister, Blum, and Lorge, 1972) and the subtest 'sentence completion' of the Illinois Test of Psycholinguistic Abilities (ITPA), (Kirk, McCarthy, and Kirk, 1968); for the German version, see Angermeier (1974). From these, a differentiation is made between V-IQ, language-dependent abilities and NV-IQ, indicating nonverbal abilities. The MQ was derived from the Test of Motor Abilities (MOT) 4-6 (Zimmer and Volkamer, 1984).
8 years	The composite score of the IQ was assessed by the Culture Fair Test (CFT) 1 (Weiss and Osterland, 1977), measuring nonverbal skills, such as the ability to perceive and integrate complex relationships in new situations, and the subtest 'sentence completion' of the ITPA, mentioned above, indicating verbal reasoning (V-IQ). The MQ was assessed with the body coordination test for children (KTK) (Kiphard and Schilling, 1974).
11 years	The IQ was measured with the CFT 20 (Cattell, 1960); for the German version see Weiss (1987) and a vocabulary test of the CFT 20, again allowing verbal, V-IQ, and nonverbal abilities, NV-IQ, to be distinguished. The MQ at age 11 years was assessed by means of a short version of the body coordination test for children (KTK).

Table B.4: Econometric results for ability formation, MQ

Ability	H_t	IQ_{t-1}	MQ_{t-1}	P_{t-1}	Adj.R^2
		11 years			
MQ_t	0.13	0.34*	0.66*	-0.01	0.56
		8 years			
MQ_t	0.12	0.00	0.42*	0.00	038
		4.5 years			
MQ_t	0.04	0.26*	0.72*	0.10*	0.56
		2 years			
MQ_t	0.00	0.07	0.31*	0.15*	0.23
		3 months			
MQ_t	0.16				0.11

Note: All variables in natural logarithm; coefficients from OLS regressions, including a constant and performed for each ability; heteroscedasticity robust standard errors; the equation contains additional indicator variables for belonging to a cell in the initial risk matrix: *significant at the 5% level. 364 observations.

Source: MARS 1986-2003. Own calculations.

Table B.5: Quantile regression for the IQ

Quantile	10	20	30	40	50	60	70	80	90
					2 years				
H_t	0.49*	0.50*	0.49*	0.55*	0.52*	0.57*	0.54*	0.46*	0.23*
	(0.16)	(0.10)	(0.14)	(0.09)	(0.12)	(0.08)	(0.10)	(0.07)	(0.02)
IQ_{t-1}	0.36*	0.32*	0.31*	0.30*	0.25*	0.19*	0.19*	0.04	0.03
	(0.14)	(0.08)	(0.11)	(0.07)	(0.09)	(0.06)	(0.07)	(0.06)	(0.02)
					4.5 years				
H_t	0.34*	0.39*	0.53*	0.47*	0.48*	0.40*	0.27*	0.27*	0.33*
	(0.16)	(0.11)	(0.08)	(0.07)	(0.08)	(0.08)	(0.06)	(0.05)	(0.09)
IQ_{t-1}	0.70*	0.60*	0.47*	0.48*	0.47*	0.43*	0.38*	0.38*	0.23*
	(0.10)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.03)	(0.07)
					8 years				
H_t	0.08	0.31	0.29	0.19	0.18	0.19	0.20*	0.05	0.01
	(0.16)	(0.16)	(0.16)	(0.11)	(0.13)	(0.13)	(0.10)	(0.11)	(0.18)
IQ_{t-1}	1.2*	1.0*	0.99*	0.72*	0.76*	0.74*	0.73*	0.71*	1.03*
	(0.09)	(0.09)	(0.09)	(0.06)	(0.07)	(0.07)	(0.05)	(0.06)	(0.08)
					11 years				
H_t	0.04	0.14	0.10	0.22	0.26*	0.20*	0.04	0.08	0.17
	(0.29)	(0.11)	(0.10)	(0.12)	(0.11)	(0.10)	(0.07)	(0.09)	(0.11)
IQ_{t-1}	1.0*	0.97*	0.93*	0.87*	0.81*	0.74*	0.72*	0.67*	0.53*
	(0.11)	(0.06)	(0.05)	(0.06)	(0.05)	(0.04)	(0.04)	(0.05)	(0.06)

Note: All regression models include a constant; all variables in natural logarithm; *significant at 5% level; standard errors are in parentheses. All regression models also contain MQ_{t-1}, P_{t-1}; the resulting coefficients are not reported here, because results do not differ (much) from the results presented in Table 2.6; 364 observations.

Source: MARS 1986-2003. Own calculations.

Table B.6: The partial elasticity of H on NV-IQ and V-IQ

ability	2 years	4.5 years	8 years	11 years
NV-IQ	0.22	0.29*	-0.06	0.21*
	(0.16)	(0.08)	(0.12)	(0.10)
V-IQ	0.42*	0.44*	0.30*	0.24*
	(0.07)	(0.07)	(0.11)	(0.10)
IQ	0.38*	0.38*	0.19	0.17
	(0.07)	(0.07)	(0.13)	(0.10)

Note: All regression models include a constant; all variables in natural logarithm; *significant at 5% level; standard errors are in parentheses. All regression models also contain MQ_{t-1}, P_{t-1}; the resulting coefficients are not reported here, because results do not differ (much) from the results presented in Table 2.6; 364 observations.
Source: MARS 1986-2003. Own calculations.

Table B.7: The estimated childhood multiplier: direct and indirect effects of a one percent increase in H (in %)

		One percent gain in H (in %)			
increase at		3 months	2 years	4.5 years	8 years
3 months	IQ (OLS)	0.55			
	IQ (2SLS)	2.37			
	MQ (OLS)	0.15			
	P (OLS)	0.28			
2 years	IQ (OLS)	0.72	0.38		
	IQ (2SLS)	2.66	1.58		
	MQ (OLS)	0.29	0.00		
	P (OLS)	0.34	0.37		
4.5 years	IQ (OLS)	0.83	0.59	0.38	
	IQ (2SLS)	2.83	2.44	0.50	
	MQ (OLS)	0.44	0.14	0.04	
	P (OLS)	0.46	0.67	0.50	
8 years	IQ (OLS)	0.96	0.82	0.74	0.19
	IQ (2SLS)	3.02	3.50	0.88	0.31
	MQ (OLS)	0.50	0.19	0.06	0.12
	P (OLS)	0.55	0.84	0.76	0.43
11 years	IQ (OLS)	1.11	1.06	1.10	0.42
	IQ (2SLS)	3.26	4.79	1.28	0.71
	MQ (OLS)	0.56	0.31	0.19	0.26
	P (OLS)	0.60	0.96	0.94	0.65

Note: Calculations of all direct and indirect multiplier and accelerator effects based on OLS estimates of equation 2.2 (without additional lags, see Table 2.6) and for the IQ in addition based on 2SLS estimates of equation 2.2 (without additional lags, see Table 2.6).

C Appendix for Chapter 4

Table C.1: Definition of variables

Variable	Type*	Definition
Endogenous variable		
child care	0/1	1 if child attends institutional child care
Explanatory variables		
weekly working hours mother	c	actual working time of the mother in hours per week
education mother (in years)	c	amount of education of the mother in years
siblings	0/1	1 if siblings live in the household
child's age 3	0/1	1 if the child is 3 years old (ref.)
child's age 4	0/1	1 if the child is 4 years old
child's age 5	0/1	1 if the child is 5 years old
child's age 6	0/1	1 if the child is 6 years old
child's age 7	0/1	1 if the child is 7 years old
mother's age	c	age of the mother in years
single parent	0/1	1 if the child lives in a single-parent household
(both) parent(s) German	0/1	1 if nationality of both parents is German or single-parent is German
city size	c	size of the municipality the household lives in from 1 = less than 2,000 to 7 = more than 500,000
Laender dummies		
Berlin-West	0/1	1 if Land = Berlin-West
North	0/1	1 if Land = Schleswig-Holstein, Hamburg, Lower Saxony or Bremen
South	0/1	1 if Land = Hesse, Rhineland-Palatinate/Saarland, Baden-Württemberg or Bavaria
North Rhine-Westfalia	0/1	1 if Land = North Rhine-Westfalia
Year dummies		
Year 1989-91 to Year 2004-06	0/1	dummies for 3-year-groups from 1989-91 to 2004-06, ref.: 1989-91

Note: * c = continuous variable

Source: SOEP 1989-2006.

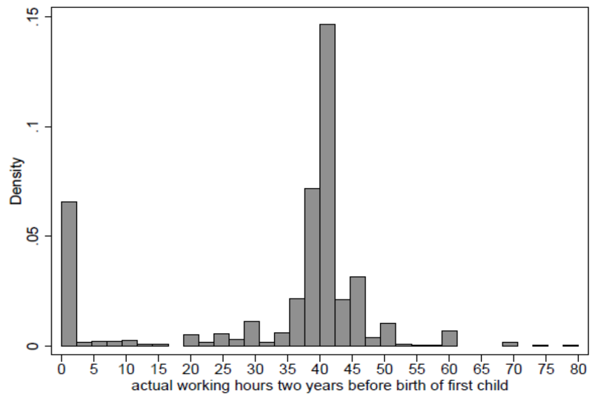
Table C.2: First-stage regression for actual weekly working hours of the mother

instrument		
weekly working hours mother before birth	0.132***	(0.025)
exogenous variables		
education mother (in years)	1.021***	(0.208)
siblings	-10.813***	(0.805)
child's age 4	3.353***	(0.503)
child's age 5	5.759***	(0.619)
child's age 6	7.027***	(0.707)
child's age 7	7.855***	(1.070)
mother's age	-0.030	(0.108)
single parent	3.725***	(1.364)
(both) parent(s) German	-4.171***	(1.107)
city size	0.099	(0.260)
Berlin-West	0.945	(3.720)
North	1.687	(1.281)
South	1.694*	(1.004)
year 1992-94	-0.954	(1.124)
year 1995-97	-2.927**	(1.366)
year 1998-00	-2.343*	(1.408)
year 2001-03	-3.211**	(1.397)
year 2004-06	-2.329	(1.437)
N	2,970	

Note: Clustered standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level.

Source: SOEP 1989-2006. Own calculations.

Figure C.1: Distribution of the actual working hours of the mother two years before birth of the first child



Note: 2,970 observations.
Source: SOEP 1989-2006. Own calculations.

Table C.3: Specification tests

Test	description
general	To test for exogeneity of the instrument, we include a second instrumental variable. For this purpose we use more lags of the working time of the mother. We include maternal working time three years and one year before birth of the first child.
a)	Instrument: weekly working hours before birth in $t-2$ and in $t-1$ The Sargan-test statistic for overidentification has a value of 1.131 (p-value: 0.2876). The null-hypothesis that $E(u,z) = 0$ (i.e. the instruments are exogenous) cannot be rejected. A second test of overidentification is the Basmann-test. The test statistic has a value of 1.12 (p-value: 0.2893), so the null-hypothesis that $E(u,z) = 0$ (i.e. the instruments are exogenous) cannot be rejected.
b)	Instrument: weekly working hours before birth in $t-2$ and in $t-3$. The Sargan-test-statistic has a value of 1.805 (p-value: 0.1791), so the null-hypothesis cannot be rejected. The Basmann-test-statistic has a value of 1.789 (p-value: 0.1810), so the null-hypothesis cannot be rejected.

D Appendix for Chapter 5

Table D.1: The child's disorders

0-19 months		26-47 months		62-81 months	
	share		share		share
motor function (crawling, walking)	2.40	motor impairment	2.50	motor impairment	8.70
sensory (sight, hearing)	0.44	visual impairment	2.39	visual impairment	5.80
mental disability	0.11	asthma	0.79	respiratory disorder	33.33
chronic illness	0.22	chronic bronchitis	4.66	neurodermatitis	7.25
neurological disorder (including convulsions)	0.33	spastic/acute bronchitis	9.90	nutritional disorder	3.62
speech (pronunciation, speech acquisition)	0.11	middle-ear inflammation	23.21	middle-ear inflammation	31.12
regulatory system (crying, sleeping, eating)	0.44	pseudocroup/Croup syndrome	8.01	other impairment	8.70
physical disability	0.33	hay fever	1.02		
other impairment	0.53	neurodermatitis	9.10		
		nutritional disorder	1.48		
		hearing impairment	1.25		
		other impairment	5.23		
		no disorder (%)			
	95.09		**53.79**		**57.97**

Source: SOEP 2003-2008. Own calculations.

Table D.2: Descriptive statistics of child, parent and household characteristics differentiated by child's age

	children 0-19 months		children 26-47 months		children 62-81 months	
	mean	std.dev.	mean	std.dev.	mean	std.dev.
			Child's characteristics			
Child's age (months)	6.92	(3.77)	33.59	(3.42)	69.65	(3.98)
Firstborn	0.41	(0.49)				
Number of siblings	1.86	(0.98)	1.97	(0.99)	2.28	(0.97)
Girl	0.51	(0.50)	0.51	(0.50)	0.49	(0.50)
			Parent's and household characteristics			
Mother's education 'no' degree	0.14	(0.34)	0.12	(0.33)	0.09	(0.28)
Mother's vocational degree	0.62	(0.48)	0.62	(0.49)	0.66	(0.48)
Mother's university degree	0.24	(0.43)	0.26	(0.44)	0.25	(0.44)
Father's education 'no' degree	0.10	(0.31)	0.12	(0.32)	0.06	(0.23)
Father's vocational degree	0.70	(0.46)	0.55	(0.50)	0.65	(0.48)
Father's university degree	0.20	(0.40)	0.33	(0.47)	0.29	(0.46)
Household income (€1000)	2.53	(1.82)	2.73	(1.95)	3.26	(1.64)
Private insurance	0.11	(0.32)	0.12	(0.32)	0.12	(0.32)
Mother's age	31.90	(5.16)	34.02	(5.32)	36.83	(5.08)
Father's age	34.83	(5.51)	36.91	(5.49)	39.68	(6.0)
Single parent	0.01	(0.03)	0.01	(0.04)	0.014	(0.12)
Migration[1]	0.12	(0.33)	0.11	(0.31)	0.11	(0.31)
Municipality	3.74	(1.90)	3.80	(1.88)	3.98	(1.76)

Note: Standard deviations are in parentheses. [1]It takes the value 1 of at least one of the parents have a migration background.

Source: SOEP 2003-2008. Own calculations.

Table D.3: Intergenerational links between parents' height and child's weight at birth

	all children		girls		boys	
	mother	parents	mother	parents	mother	parents
Mother's height	15.60***	14.97***	14.48***	13.32***	16.26***	14.91***
	(3.26)	(3.64)	(4.08)	(4.28)	(4.79)	(5.55)
Father's height		3.03		3.03		2.93
		(3.73)		(4.29)		(5.62)
Mother smoking	-114.74**	-108.80*	-152.12**	-227.89***	-72.85	-26.11
	(55.84)	(60.17)	(76.44)	(82.32)	(81.06)	(85.21)
Father smoking		-13.82		139.02**		-138.82**
		(50.65)		(64.02)		(69.20)
Firstborn	-103.05**	-107.60**	-106.91*	-118.07*	-117.21	-111.11
	(50.27)	(51.25)	(64.63)	(65.48)	(84.16)	(83.45)
Number of children	9.96	12.14	6.03	3.64	-1.32	7.77
in household	(34.15)	(35.10)	(42.31)	(43.13)	(50.31)	(51.93)
Girl	-86.28**	-84.14**				
	(38.43)	(38.12)				
Mother's vocational	152.94**	145.12**	108.02	101.96	195.31**	185.0**
degree	(67.95)	(64.59)	(91.33)	(85.66)	(98.95)	(94.92)
Mother's university	147.18*	146.99*	50.19	66.74	256.31**	231.69*
degree	(87.35)	(82.59)	(106.23)	(103.11)	(127.52)	(124.24)
Father's vocational		61.06		104.89		47.46
degree		(70.33)		(103.61)		(89.24)
Father's university		20.98		58.90		23.82
degree		(93.18)		(125.48)		(125.48)
Household income	-2.84	-3.71	-3.47	-1.18	0.13	-3.87
(€1000)	(16.82)	(17.34)	(19.57)	(20.76)	(21.60)	(22.35)
Private insurance	-129.17*	-127.83*	-202.02**	-215.44**	-12.33	-18.22
	(72.16)	(74.32)	(86.84)	(88.32)	(103.46)	(106.70)
Mother's age	-3.17	-0.22	-2.27	4.47	-4.05	-6.53
	(5.16)	(7.10)	(6.19)	(8.10)	(7.18)	(9.71)
Father's age		-4.73		-8.61		0.70
		(6.76)		(7.45)		(10.58)
Single parent	-16.19	-58.03	-62.82	-197.11	-	-
	(55.99)	(98.15)	(67.79)	(128.49)	-	-
Migration	28.92	44.37	24.76	44.11	43.19	52.35
	(68.43)	(71.74)	(80.13)	(85.94)	(100.84)	(103.88)
Municipality	-1.39	-0.37	-12.28	-8.06	7.94	10.36
	(12.07)	(11.79)	(15.43)	(14.62)	(16.38)	(16.46)
Constant	810.60	396.22	1005.68	556.42	642.55	390.92
	(563.46)	(687.92)	(754.59)	(954.44)	(785.09)	(870.85)
Observations	925	925	472	472	453	453

Note: Clustering-robust standard errors (at the family level) are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level.

Source: SOEP 2003-2008. Own calculations.

Table D.4: Intergenerational links between parents' self-rated health and child's disorders at 0-19 months

	all children		girls		boys	
	mother	parents	mother	parents	mother	parents
Mother's self-rated	-0.017**	-0.016*	-0.005	-0.005	-0.019***	-0.016***
health ($t-1$)	(0.008)	(0.008)	(0.014)	(0.014)	(0.007)	(0.006)
Father's self-rated		-0.004		0.003		-0.007
health ($t-1$)		(0.008)		(0.01)		(0.007)
Mother smoking	0.003	-0.003	0.009	0.005	-0.006	-0.009
	(0.017)	(0.015)	(0.03)	(0.03)	(0.01)	(0.009)
Father smoking		0.008		0.01		-0.003
		(0.01)		(0.02)		(0.01)
Child's age	0.005***	0.005***	0.005*	0.005*	0.004***	0.004***
	(0.0016)	(0.002)	(0.0027)	(0.003)	(0.0015)	(0.001)
Firstborn	-0.013	-0.012	-0.02	-0.02	-0.014	-0.006
	(0.017)	(0.017)	(0.03)	(0.03)	(0.017)	(0.014)
Number of children	-0.006	-0.006	0.006	0.003	-0.02	-0.014
in household	(0.01)	(0.009)	(0.01)	(0.01)	(0.01)	(0.01)
Girl	0.013	0.01				
Mother's vocational	-0.004	0.002	0.01	0.01	-0.01	-0.006
degree	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
Mother's university	-0.004	0.006	0.02	0.016	-0.02	-0.003
degree	(0.02)	(0.03)	(0.04)	(0.038)	(0.02)	(0.02)
Father's vocational		-0.03		-0.016		-0.03
degree		(0.02)		(0.04)		(0.02)
Father's university		-0.025		-0.005		-0.03***
degree		(0.016)		(0.035)		(0.01)
Household income	-0.003	-0.002	-0.002	-0.001	-0.006	-0.006
(€1000)	(0.004)	(0.001)	(0.006)	(0.005)	(0.004)	(0.003)
Private insurance	0.001	0.003	-0.002	0.002	0.009	0.01
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
Mother's age	0.001	0.0003	-0.0006	-0.002	0.001	0.002
	(0.001)	(0.002)	(0.0002)	(0.002)	(0.002)	(0.002)
Father's age		0.0001		0.003		-0.0008
		(0.002)		(0.002)		(0.002)
	(0.013)	(0.01)				
Migration	-0.01	-0.01	-0.02	-0.02	0.0009	-0.004
	(0.017)	(0.015)	(0.02)	(0.02)	(0.002)	(0.01)
Municipality	0.008**	0.008**	0.007	0.006	0.008**	0.008**
	(0.003)	(0.03)	(0.005)	(0.005)	(0.003)	(0.003)
Observations	837	837	423	423	414	414

Note: Clustering-robust standard errors (at the family level) are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models for parents (mothers) control for single parenthood.

Source: SOEP 2003-2008. Own calculations.

Table D.5: Intergenerational links between parents' self-rated health and child's self-rated health at 0-19 months

	all children		girls		boys	
	mother	parents	mother	parents	mother	parents
Mother's self-rated	0.10***	0.10***	0.12**	0.12**	0.07	0.07
health ($t-1$)	(0.037)	(0.037)	(0.056)	(0.055)	(0.05)	(0.05)
Father's self-rated		-0.005		-0.02		0.004
health ($t-1$)		(0.03)		(0.04)		(0.05)
Mother smoking	0.06	0.02	0.06	-0.02	0.08	0.06
	(0.08)	(0.09)	(0.09)	(0.10)	(0.12)	(0.12)
Father smoking		0.10		0.12		0.09
		(0.07)		(0.08)		(0.09)
Child's age	0.007	0.008	0.007	0.009	0.006	0.007
	(0.007)	(0.007)	(0.01)	(0.45)	(0.009)	(0.009)
Firstborn	0.16**	0.16**	0.20**	0.21**	0.13	0.10
	(0.07)	(0.07)	(0.09)	(0.09)	(0.10)	(0.11)
Number of children	0.09***	0.09***	0.07	0.08*	0.11**	0.11**
in household	(0.03)	(0.03)	(0.04)	(0.04)	(0.05)	(0.05)
Girl	0.09*	0.10*				
Mother's vocational	0.02	0.03	0.05	0.07	-0.0009	-0.01
degree	(0.09)	(0.09)	(0.11)	(0.11)	(0.15)	(0.12)
Mother's university	0.06	0.07	0.04	0.03	0.09	0.13
degree	(0.11)	(0.11)	(0.13)	(0.13)	(0.18)	(0.17)
Father's vocational		0.017		-0.03		0.09
degree		(0.11)		(0.14)		(0.15)
Father's university		0.026		0.07		-0.02
degree		(0.13)		(0.17)		(0.18)
Household income	0.006	0.008	-0.012	-0.009	0.03	0.03
(€1000)	(0.016)	(0.016)	(0.018)	(0.02)	(0.02)	(0.02)
Private insurance	0.001	-0.001	0.02	-0.005	-0.03	-0.01
	(0.08)	(0.08)	(0.09)	(0.09)	(0.12)	(0.12)
Mother's age	-0.0001	0.009	0.009	0.02**	-0.01	-0.006
	(0.006)	(0.008)	(0.007)	(0.01)	(0.01)	(0.01)
Father's age		-0.012		-0.02**		-0.004
		(0.008)		(0.01)		(0.01)
Migration	0.007	0.008	0.03	0.03	-0.02	-0.007
	(0.10)	(0.10)	(0.11)	(0.12)	(0.14)	(0.14)
Municipality	0.0005	0.0006	0.01	0.09	-0.01	-0.015
	(0.015)	(0.015)	(0.02)	(0.02)	(0.02)	(0.02)
Constant	2.68***	2.76***	2.40***	2.64***	3.09***	2.99***
	(0.27)	(0.32)	(0.39)	(0.45)	(0.38)	(0.44)
Observations	840	840	426	426	414	414

Note: Clustering-robust standard errors (at the family level) are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models for parents (mothers) control for single parenthood.

Source: SOEP 2003-2008. Own calculations.

Table D.6: Intergenerational transmissions between parents' weight and child's weight: fixed effects results

	all children	girls	boys
Mother's weight	0.076	0.086	0.06
	(0.12)	(0.22)	(0.12)
Father's weight	0.32**	0.34	0.31**
	(0.13)	(0.24)	(0.13)
Number of children	3.96***	1.77	5.33***
in household	(1.06)	(2.02)	(1.08)
Household income (€1000)	0.46	-0.0002	0.877
	(0.59)	(0.001)	(0.56)
Private insurance	3.50	-	1.89
	(7.48)	-	(6.01)
Municipality	-0.42	-	-0.66
	(1.74)	-	(1.39)
Constant	-24.82	-21.72	-26.56*
	(15.29)	(24.04)	(15.26)
Observations	589	295	294

Note: Standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models for control for single parenthood.
Source: SOEP 2003-2008. Own calculations.

Table D.7: Intergenerational transmissions between parents' weight and child's height: fixed effects results

	all children	girls	boys
Mother's weight	0.267	0.179	0.29
	(0.38)	(0.61)	(0.47)
Father's weight	1.07***	0.95	1.16**
	(0.398)	(0.67)	(0.47)
Number of children	9.40***	6.05	11.75***
in household	(3.23)	(5.57)	(3.75)
Household income (€1000)	1.23	-2.40	2.66
	(1.73)	(3.56)	(1.82)
Private insurance	16.75	-	14.04
	(21.84)	-	(19.69)
Municipality	-2.03	-	-2.60
	(5.09)	-	(4.55)
Constant	-28.96	-0.54	-44.60
	(47.24)	(67.34)	(55.21)
Observations	579	293	286

Note: Standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models for control for single parenthood.
Source: SOEP 2003-2008. Own calculations.

Table D.8: Intergenerational transmissions between parents' self-rated health and child's self-rated health: fixed effects results

	all children	girls	boys
Mother's self-rated health $(t-1)$	0.13***	0.11*	0.136**
	(0.045)	(0.06)	(0.06)
Father's self-rated health $(t-1)$	-0.06	-0.046	-0.08
	(0.05)	(0.077)	(0.07)
Number of children	0.03	0.20	-0.17
in household	(0.09)	(0.13)	(013)
Household income (€1000)	-0.03	-0.026	-0.03
	(0.04)	(0.05)	(0.06)
Private insurance	-0.002	0.18	-0.16
	(0.33)	(0.46)	(0.49)
Municipality	-0.08	-0.04	-0.13
	(0.067)	(0.10)	(0.09)
Constant	3.59***	3.11***	4.13***
	(0.46)	(0.68)	(0.63)
Observations	642	325	318

Note: Standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models for control for single parenthood.

Source: SOEP 2003-2008. Own calculations.

E Appendix for Chapter 6

Table E.1: Descriptive statistics of early noncognitive skills (3 months - 2 years)

	mean	std.dev.	mean	std.dev.	N
Attention span	**Low attention span**		**Mid attention span**		
Total sample	0.10	0.30	0.27	0.44	353
High risk subsample	0.14	0.35	0.36	0.48	33
No risk subsample	0.06	0.23	0.24	0.43	44
Boys	0.14	0.34	0.29	0.45	169
Girls	0.07	0.26	0.25	0.44	184
Approach	**React sometimes**				
Total sample	0.43	0.49			353
High risk subsample	0.49	0.50			33
No risk subsample	0.28	0.45			44
Boys	0.45	0.50			169
Girls	0.40	0.49			184
Prevailing mood	**Bad temper**		**Satisfied**		
Total sample	0.29	0.45	0.57	0.49	353
High risk subsample	0.34	0.48	0.48	0.50	33
No risk subsample	0.23	0.43	0.58	0.50	44
Boys	0.34	0.47	0.53	0.50	169
Girls	0.24	0.43	0.61	0.49	184
Distractibility	**Difficult to calm**		**Adequate to calm**		
Total sample	0.21	0.41	0.54	0.50	353
High risk subsample	0.24	0.43	0.50	0.50	33
No risk subsample	0.18	0.39	0.49	0.50	44
Boys	0.27	0.44	0.52	0.50	169
Girls	0.16	0.36	0.56	0.50	184

Source: Mannheim Study of Children at Risk 1986-2006. Own calculations.

Table E.2: Descriptive statistics of social outcomes in adolescence (8 - 19 years)

	mean	std.dev.	age	N
		Grade math		
Total sample	2.73	1.01	11-15	353
High risk subsample	3.01	0.93	11-15	33
No risk subsample	2.42	0.95	11-15	44
Boys	2.67	1.01	11-15	169
Girls	2.78	1.0	11-15	184
		Grade German		
Total sample	2.66	0.91	11-15	353
High risk subsample	2.90	0.85	11-15	33
No risk subsample	2.38	0.81	11-15	44
Boys	2.82	0.91	11-15	169
Girls	2.52	0.88	11-15	184
		Delinquency		
Total sample	5.34	5.62	15-19	337
High risk subsample	6.93	6.52	15-19	32
No risk subsample	3.61	4.89	15-19	42
Boys	6.91	6.57	15-19	160
Girls	3.95	4.16	15-19	177
		Smoking		
Total sample	0.36	0.48	15-19	337
High risk subsample	0.41	0.50	15-19	32
No risk subsample	0.26	0.44	15-19	42
Boys	0.35	0.48	15-19	160
Girls	0.36	0.48	15-19	177
		Average alcohol consumption		
Total sample	11.07	21.02	15-19	322
High risk subsample	11.02	21.70	15-19	28
No risk subsample	10.02	19.19	15-19	42
Boys	15.42	25.81	15-19	149
Girls	7.32	14.82	15-19	173
		Autonomy		
Total sample	4.70	0.96	8-11	353
High risk subsample	4.68	1.09	8-11	33
No risk subsample	4.71	0.91	8-11	44
Boys	4.59	1.01	8-11	169
Girls	4.82	0.89	8-11	184

Source: Mannheim Study of Children at Risk 1986-2006. Own calculations.

Table E.3: Within-variation of noncognitive skills and social outcomes

	low	mid	high	continuous
Attention span	0.14	0.27	0.28	0.62
Approach	0.33		0.33	0.20
Prevailing mood	0.28	0.32	0.21	0.36
Distractibility	0.22	0.29	0.24	0.35
Grade math				0.60
Grade German				0.50
Delinquency				2.56
Smoking				0.26
Average alcohol consumption				15.0
Autonomy				0.49

Source: Mannheim Study of Children at Risk 1986-2006. Own calculations.

Table E.4: Estimated effects of early noncognitive skills on grades in math between 11-15 years

Sample	Total OLS	Total F.E.	Representative F.E.	Boys F.E.	Girls F.E.
	Attention span (Omitted category *high attention span*)				
Low attention span	0.61***	0.57***	0.55***	0.63***	0.52***
	(0.10)	(0.11)	(0.11)	(0.13)	(0.19)
Mid attention span	0.42***	0.40***	0.39***	0.50***	0.33***
	(0.066)	(0.07)	(0.07)	(0.10)	(0.11)
Chi^2-test: No early skill effect	65.18***	23.81***	21.54***	19.62***	7.27***
Sample size	353	353	353	169	184
R-squared	0.08	0.09	0.09	0.14	0.07
	Approach (Omitted category *high interest*)				
React sometimes	0.13***	0.20***	0.23***	0.34***	0.02
	(0.06)	(0.076)	(0.079)	(0.10)	(0.11)
Chi^2-test: No early skill effect	4.44**	6.61***	8.33***	15.54***	0.02
Sample size	352	352	352	168	184
R-squared	0.02	0.03	0.035	0.11	0.01
	Prevailing mood (Omitted category *good temper*)				
Bad temper	0.25**	0.23*	0.21	0.29	0.23
	(0.11)	(0.14)	(0.14)	(0.21)	(0.19)
Satisfied	0.13	0.14	0.11	0.17	0.13
	(0.10)	(0.13)	(0.13)	(0.19)	(0.17)
Chi^2-test: No early skill effect	5.54*	1.44	1.17	0.99	0.71
Sample size	350	350	350	167	183
R-squared	0.02	0.03	0.04	0.05	0.03
	Distractibility (Omitted category *easy to calm*)				
Difficult to calm	0.43***	0.47***	0.46***	0.44**	0.49**
	(0.11)	(0.14)	(0.14)	(0.19)	(0.22)
Adequate to calm	0.15*	0.15	0.07	0.16	0.13
	(0.09)	(0.11)	(0.11)	(0.16)	(0.16)
Chi^2-test: No early skill effect	15.72***	5.92***	6.19***	2.71*	2.59*
Sample size	348	348	348	166	182
R-squared	0.06	0.06	0.07	0.09	0.06

Note: Standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models include a dummy variable for a single household, a dummy variable for the number of household members (from two to more than 5 members) and a dummy variable which takes the value one if the family composition has not changed until now.

Source: Mannheim Study of Children at Risk 1986-2006. Own calculations.

Table E.5: Estimated effects of early noncognitive skills on grades in German between 11-15 years

Sample	Total OLS	Total F.E.	Representative F.E.	Boys F.E.	Girls F.E.
	Attention span (Omitted category *high attention span*)				
Low attention span	0.50***	0.36***	0.35***	0.57***	0.06
	(0.09)	(0.10)	(0.10)	(0.12)	(0.16)
Mid attention span	0.30***	0.27***	0.20***	0.35***	0.19**
	(0.06)	(0.06)	(0.06)	(0.09)	(0.09)
Chi^2-test: No early skill effect	49.01***	13.35***	9.75***	14.73***	2.13
Sample size	353	353	353	169	184
R-squared	0.05	0.06	0.05	0.11	0.03
	Approach (Omitted category *high interest*)				
React sometimes	0.24***	0.23***	0.25***	0.34***	0.12
	(0.06)	(0.07)	(0.07)	(0.10)	(0.11)
Chi^2-test: No early skill effect	15.29***	9.90***	11.28***	11.28**	1.36
Sample size	352	352	352	168	184
R-squared	0.04	0.04	0.04	0.09	0.03
	Prevailing mood (Omitted category *good temper*)				
Bad temper	0.23**	0.25**	0.18	0.43**	0.13
	(0.10)	(0.12)	(0.12)	(0.19)	(0.15)
Satisfied	0.14	0.15	0.12	0.34**	0.02
	(0.09)	(0.11)	(0.10)	(0.17)	(0.14)
Chi^2-test: No early skill effect	5.98**	2.28*	1.20	2.69*	0.60
Sample size	350	350	350	167	183
R-squared	0.02	0.03	0.04	0.04	0.02
	Distractibility (Omitted category *easy to calm*)				
Difficult to calm	0.26***	0.15	0.11	0.10	0.18
	(0.09)	(0.12)	(0.12)	(0.17)	(0.17)
Adequate to calm	0.18**	0.09	0.07	0.16	0.17
	(0.08)	(0.09)	(0.09)	(0.16)	(0.13)
Chi^2-test: No early skill effect	8.28**	0.88	0.46	0.25	0.22
Sample size	348	348	348	166	182
R-squared	0.02	0.03	0.03	0.04	0.05

Note: Standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models include a dummy variable for a single household, a dummy variable for the number of household members (from two to more than 5 members) and a dummy variable which takes the value one if the family composition has not changed until now.

Source: Mannheim Study of Children at Risk 1986-2006. Own calculations.

Table E.6: Estimated effects of early noncognitive skills on delinquency between 15-19 years

Sample	Total OLS	Total F.E.	Representative F.E.	Boys F.E.	Girls F.E.
	Attention span (Omitted category *high attention span*)				
Low attention span	3.04***	3.24***	3.11***	4.94***	0.89
	(0.52)	(0.59)	(0.59)	(0.92)	(0.74)
Mid attention span	1.88***	2.03***	2.18***	2.35***	1.69***
	(0.37)	(0.40)	(0.41)	(0.69)	(0.45)
Chi^2-test: No early skill effect	48.94***	22.53***	23.03	16.26***	7.22***
Sample size	337	337	337	160	177
R-squared	0.14	0.15	0.16	0.24	0.12
	Approach (Omitted category *high interest*)				
React sometimes	1.16***	1.39***	1.53***	2.30***	0.45
	(0.37)	(0.43)	(0.44)	(0.73)	(0.48)
Chi^2-test:No early skill effect	9.63	10.46***	12.07***	9.90***	0.88
Sample size	337	337	337	160	177
R-squared	0.04	0.06	0.07	0.13	0.04
	Prevailing mood (Omitted category *good temper*)				
Bad temper	-0.16	-0.17	0.39	-0.57	-0.08
	(0.68)	(0.86)	(0.90)	(1.88)	(0.89)
Satisfied	0.68	0.70	1.03	1.41	-0.31
	(0.62)	(0.78)	(0.80)	(1.68)	(0.82)
Chi^2-test: No early skill effect	3.81	1.29	1.15	2.25	0.10
Sample size	331	331	331	159	172
R-squared	0.02	0.04	0.04	0.14	0.04
	Distractibility (Omitted category *easy to calm*)				
Difficult to calm	0.65	1.61*	1.80*	3.65**	-0.51
	(0.71)	(0.96)	(1.0)	(1.50)	(1.15)
Adequate to calm	-0.18	0.19	0.15	1.79	-1.13
	(0.55)	(0.72)	(0.74)	(1.23)	(0.79)
Chi^2-test: No early skill effect	1.85	1.79	2.14	2.95*	1.09
Sample size	317	317	317	146	171
R-squared	.02	0.07	0.09	0.20	0.07

Note: Standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models include a dummy variable for a single household, a dummy variable for the number of household members (from two to more than 5 members) and a dummy variable which takes the value one if the family composition has not changed until now.

Source: Mannheim Study of Children at Risk 1986-2006. Own calculations.

Table E.7: Estimated effects of early noncognitive skills on smoking between 15-19 years

Sample	Total OLS	Total F.E.	Representative F.E.	Boys F.E.	Girls F.E.
	Attention span (Omitted category *high attention span*)				
Low attention span	0.11**	0.13**	0.15**	0.31***	-0.12
	(0.05)	(0.06)	(0.06)	(0.08)	(0.10)
Mid attention span	0.09**	0.11**	0.13***	0.21***	0.02
	(0.04)	(0.04)	(0.04)	(0.06)	(0.06)
Chi^2-test: No early skill effect	8.64**	4.19**	5.68***	10.15***	0.86
Sample size	337	337	337	160	177
R-squared	0.05	0.09	0.11	0.21	0.07
	Approach (Omitted category *high interest*)				
React sometimes	0.07*	0.10**	0.10**	0.15**	0.04
	(0.035)	(0.04)	(0.046)	(0.06)	(0.06)
Chi^2-test: No early skill effect	3.67*	5.20**	5.01**	5.71**	0.52
Sample size	337	337	337	160	177
R-squared	0.04	0.08	0.09	0.13	0.07
	Prevailing mood (Omitted category *good temper*)				
Bad temper	0.04	0.19**	0.16*	-0.03	0.26**
	(0.06)	(0.09)	(0.097)	(0.18)	(0.11)
Satisfied	0.07	0.10	0.09	-0.06	0.13
	(0.06)	(0.08)	(0.09)	(0.16)	(0.10)
Chi^2-test: No early skill effect	1.79	2.28	1.45	0.11	2.67*
Sample size	331	331	331	159	172
R-squared	0.02	0.07	0.09	0.12	0.11
	Distractibility (Omitted category *easy to calm*)				
Difficult to calm	-0.14**	-0.13	-0.12	-0.14	-0.11
	(0.06)	(0.09)	(0.09)	(0.13)	(0.15)
Adequate to calm	-0.11**	-0.14**	-0.15**	-0.12	-0.17*
	(0.05)	(0.07)	(0.07)	(0.11)	(0.10)
Chi^2-test: No early skill effect	6.31**	2.14	2.22	0.73	1.52
Sample size	317	317	317	146	171
R-squared	0.05	0.10	0.11	0.07	0.18

Note: Standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models include a dummy variable for a single household, a dummy variable for the number of household members (from two to more than 5 members) and a dummy variable which takes the value one if the family composition has not changed until now.

Source: Mannheim Study of Children at Risk 1986-2006. Own calculations.

Table E.8: Estimated effects of early noncognitive skills on average alcohol consumption between 15-19 years

Sample	Total OLS	Total F.E.	Representative F.E.	Boys F.E.	Girls F.E.
	Attention span (Omitted Category *high attention span*)				
Low attention span	12.73***	22.04***	22.77***	33.5***	8.22**
	(2.48)	(3.42)	(3.45)	(5.50)	(3.70)
Mid attention span	9.08***	13.66***	11.30***	19.54***	7.57***
	(1.82)	(2.31)	(2.39)	(4.13)	(2.25)
Chi^2-test: No early skill effect	40.66***	31.22***	27.49***	23.51***	7.20***
Sample size	322	322	322	149	173
R-squared	0.16	0.20	0.18	0.33	0.10
	Approach (Omitted category *high interest*)				
React sometimes	3.38**	7.90***	8.89***	10.27**	5.06**
	(1.69)	(2.54)	(2.61)	(4.63)	(2.37)
Chi^2-test: No early skill effect	3.99**	9.65***	11.63***	4.91**	4.58**
Sample size	322	322	322	149	173
R-squared	0.03	0.07	0.07	0.13	0.05
	Prevailing mood (Omitted category *good temper*)				
Bad temper	0.72	3.64	4.08	-6.21	5.41
	(3.17)	(5.47)	(5.83)	(13.46)	(4.43)
Satisfied	0.59	3.62	5.56	-2.0	1.85
	(2.89)	(4.93)	(5.19)	(12.03)	(4.04)
Chi^2-test: No early skill effect	0.05	0.28	0.59	0.20	0.90
Sample size	318	318	318	149	169
R-squared	0.007	0.03	0.04	0.10	0.07
	Distractibility (Omitted category *easy to calm*)				
Difficult to calm	1.24	11.60**	15.10***	27.10***	-6.95
	(2.89)	(5.43)	(5.94)	(9.20)	(5.45)
Adequate to calm	-1.19	5.15	5.58	14.73**	-4.17
	(2.26)	(4.06)	(4.40)	(7.51)	(3.73)
Chi^2-test: No early skill effect	1.01	2.28	3.26**	4.34**	0.96
Sample size	306	306	306	139	167
R-squared	0.01	0.07	0.09	0.18	0.07

Note: Standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models include a dummy variable for a single household, a dummy variable for the number of household members (from two to more than 5 members) and a dummy variable which takes the value one if the family composition has not changed until now.

Source: Mannheim Study of Children at Risk 1986-2006. Own calculations.

Table E.9: Estimated effects of early noncognitive skills on autonomy between 8-11 years

Sample	Total OLS	Total F.E.	Representative F.E.	Boys F.E.	Girls F.E.
	Attention span (Omitted category *high attention span*)				
Low attention span	-0.07	-0.07	-0.04	-0.39	0.35
	(0.19)	(0.22)	(0.21)	(0.30)	(0.33)
Mid attention span	-0.12	-0.09	-0.05	-0.05	-0.12
	(0.09)	(0.10)	(0.10)	(0.14)	(0.16)
Chi^2-test: No early skill effect	2.06	0.39	0.15	0.89	0.97
Sample size	353	353	353	169	184
R-squared	0.01	0.02	0.03	0.04	0.03
	Approach (Omitted category *high interest*)				
React sometimes	0.02	0.17**	0.19**	0.26**	0.07
	(0.07)	(0.08)	(0.08)	(0.12)	(0.12)
Chi^2-test: No early skill effect	0.07	4.59**	5.39**	4.84**	0.37
Sample size	353	353	353	169	184
R-squared	0.01	0.03	0.04	0.06	0.02
	Prevailing mood (Omitted category *good temper*)				
Bad temper	-0.46***	-0.31*	-0.35**	0.09	-0.62***
	(0.12)	(0.16)	(0.16)	(0.27)	(0.20)
Satisfied	-0.15	-0.11	-0.12	0.22	-0.33**
	(0.10)	(0.14)	(0.14)	(0.23)	(0.17)
Chi^2-test: No early skill effect	20.28***	2.30*	3.03**	0.69	4.64**
Sample size	350	350	350	168	182
R-squared	0.03	0.04	0.06	0.05	0.11
	Distractibility (Omitted category *easy to calm*)				
Difficult to calm	-0.35***	-0.20	-0.06	0.05	-0.52**
	(0.12)	(0.18)	(0.17)	(0.29)	(0.23)
Adequate to calm	-0.24***	-0.17	-0.06	-0.09	-0.20
	(0.09)	(0.13)	(0.12)	(0.22)	(0.16)
Chi^2-test: No early skill effect	9.43***	0.93	0.12	0.26	2.63*
Sample size	337	337	337	161	176
R-squared	0.03	0.04	0.04	0.03	0.13

Note: Standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models include a dummy variable for a single household, a dummy variable for the number of household members (from two to more than 5 members) and a dummy variable which takes the value one if the family composition has not changed until now.

Source: Mannheim Study of Children at Risk 1986-2006. Own calculations.

Table E.10: Estimated effects in risk samples for grades in math and German

	grade math		grade German	
Subsamples	Psychosocial	Organic	Psychosocial	Organic
	Attention span (Omitted category *high attention span*)			
Low attention span	0.48**	1.07***	0.03	0.52**
	(0.24)	(0.27)	(0.20)	(0.25)
Mid attention span	0.39***	0.50***	0.16	0.48***
	(0.17)	(0.15)	(0.14)	(0.14)
Chi^2-test: No early skill effect	3.91***	12.42***	0.63	7.52***
Sample size	77	77	77	77
R-squared	0.07	0.20	0.04	0.14
	Approach (Omitted category *high interest*)			
React sometimes	0.26	0.28*	0.24	0.14
	(0.18)	(0.16)	(0.16)	(0.17)
Chi^2-test: No early skill effect	1.97	2.97*	2.47	0.64
Sample size	77	77	77	77
R-squared	0.06	0.07	0.06	0.08
	Prevailing mood (Omitted category *good temper*)			
Bad temper	-0.07	0.46	-0.07	0.33
	(0.30)	(0.29)	(0.19)	(0.27)
Satisfied	-0.02	0.32	0.06	0.20
	(0.27)	(0.26)	(0.21)	(0.24)
Chi^2-test: No early skill effect	0.04	1.21	0.36	0.64
Sample size	77	77	77	77
R-squared	0.02	0.11	0.05	0.08
	Distractibility (Omitted category *easy to calm*)			
Difficult to calm	0.33	0.35	-0.07	0.24
	(0.31)	(0.30)	(0.23)	(0.27)
Adequate to calm	0.02	0.15	0.19	0.05
	(0.24)	(0.23)	(0.18)	(0.20)
Chi^2-test: No early skill effect	0.76	0.68	1.05	0.50
Sample size	77	77	77	77
R-squared	0.09	0.16	0.11	0.07

Note: Standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models include a dummy variable for a single household, a dummy variable for the number of household members (from two to more than 5 members) and a dummy variable which takes the value one if the family composition has not changed until now.

Source: Mannheim Study of Children at Risk 1986-2006. Own calculations.

Table E.11: Estimated effects in risk samples for smoking and alcohol consumption

	smoking		average alcohol use	
Subsamples	Psychosocial	Organic	Psychosocial	Organic
	Attention span (Omitted category *high attention span*)			
Low attention span	0.23*	-1.38e-30	27.36***	13.68
	(0.14)	(0.17)	(7.53)	(8.66)
Mid attention span	0.30***	0.03	7.85***	20.89***
	(0.10)	(0.10)	(5.42)	(4.97)
Chi^2-test: No early skill effect	5.63***	0.04	7.01***	10.07***
Sample size	73	75	72	72
R-squared	0.29	0.16	0.21	0.25
	Approach (Omitted category *high interest*)			
React sometimes	0.12	0.11	9.89*	12.31**
	(0.10)	(0.09)	(5.54)	(5.22)
Chi^2-test: No early skill effect	1.49	1.36	3.19*	5.56**
Sample size	73	75	72	72
R-squared	0.19	0.17	0.09	0.09
	Prevailing mood (Omitted category *good temper*)			
Bad temper	-0.10	0.28	-5.40	15.92
	(0.21)	(0.23)	(13.05)	(14.74)
Satisfied	-0.10	0.08	5.43	9.36
	(0.19)	(0.19)	(12.25)	(11.96)
Chi^2-test: No early skill effect	0.15	1.21	0.58	0.60
Sample size	73	74	72	72
R-squared	0.25	0.21	0.04	0.04
	Distractibility (Omitted category *easy to calm*)			
Difficult to calm	-0.03	-0.23	34.69***	9.73
	(0.19)	(0.22)	(12.24)	(12.82)
Adequate to calm	-0.06	-0.21	12.90	9.14
	(0.14)	(0.16)	(9.34)	(9.31)
Chi^2-test: No early skill effect	0.09	0.94	4.02**	0.50
Sample size	72	69	71	67
R-squared	0.16	0.30	0.19	0.04

Note: Standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models include a dummy variable for a single household, a dummy variable for the number of household members (from two to more than 5 members) and a dummy variable which takes the value one if the family composition has not changed until now.

Source: Mannheim Study of Children at Risk 1986-2006. Own calculations.

Table E.12: Estimated effects in risk samples for delinquency and autonomy

	delinquency		autonomy	
Subsamples	Psychosocial	Organic	Psychosocial	Organic
	Attention span (Omitted category *high attention span*)			
Low attention span	2.50**	2.89**	-0.47	0.06
	(1.27)	(1.47)	(0.42)	(0.63)
Mid attention span	2.83***	1.97**	0.02	-0.33
	(0.91)	(0.84)	(0.23)	(0.24)
Chi^2-test: No early skill effect	5.97***	4.64**	0.63	0.97
Sample size	73	75	77	77
R-squared	0.20	0.17	0.11	0.15
	Approach (Omitted category *high interest*)			
React sometimes	1.86**	1.58*	0.0001	0.17
	(0.91)	(0.84)	(0.18)	(0.14)
Chi^2-test: No early skill effect	4.16**	3.54*	0.00	1.45
Sample size	73	75	77	77
R-squared	0.11	0.09	0.09	0.14
	Prevailing mood (Omitted category *good temper*)			
Bad temper	-0.87	1.77	-0.80**	0.09
	(1.92)	(1.80)	(0.34)	(0.36)
Satisfied	1.08	1.94	-0.46	0.35
	(1.80)	(1.46)	(0.28)	(0.31)
Chi^2-test: No early skill effect	0.88	0.89	2.87*	1.35
Sample size	73	74	77	77
R-squared	0.08	0.13	0.24	0.24
	Distractibility (Omitted category *easy to calm*)			
Difficult to calm	2.88	0.83	0.27	-0.38
	(1.85)	(1.81)	(0.36)	(0.38)
Adequate to calm	-0.52	0.43	0.21	-0.24
	(1.41)	(1.32)	(0.25)	(0.30)
Chi^2-test: No early skill effect	2.17	0.11	0.43	0.53
Sample size	72	69	76	73
R-squared	0.14	0.13	0.26	0.28

Note: Standard errors are in parentheses: ***significant at 1% level; **significant at 5% level; *significant at 10% level. All models include a dummy variable for a single household, a dummy variable for the number of household members (from two to more than 5 members) and a dummy variable which takes the value one if the family composition has not changed until now.

Source: Mannheim Study of Children at Risk 1986-2006. Own calculations.

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Refereed Publications

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Blomeyer Dorothea, Katja Coneus, Manfred Laucht and Friedhelm Pfeiffer: (2009) 'Initial Risk Matrix, Home Resources, Ability Development and Children's Achievement.', *Journal of the European Economic Association, Papers and Proceedings 7 (2-3), 638-648.*

Working Papers

Coneus, Katja and Maresa Sprietsma: 'Intergenerational Transmission of Human Capital in Early Childhood', *ZEW Discussion Paper No. 2009-038*

Coneus, Katja, Johannes Gernandt and Marianne Saam: 'Noncognitive Skills, School Achievements and Educational Dropout', *ZEW Discussion Paper No. 2009-019*

Coneus Katja and Manfred Laucht: 'The Effect of Early Noncognitive Skills on Social Outcomes in Adolescence', *ZEW Discussion Paper No. 2008-115*

Blomeyer Dorothea, Katja Coneus, Manfred Laucht and Friedhelm Pfeiffer: 'Initial Risk Matrix, Home Resources, Ability Development and Children's Achievement.', *ZEW Discussion Paper No. 2008-100*

Coneus, Katja and C. Katharina Spiess: 'The Intergenerational Transmission of Health in Early Childhood', *ZEW Discussion Paper No. 2008-073*

Blomeyer Dorothea, Katja Coneus, Manfred Laucht and Friedhelm Pfeiffer: 'Self-Productivity and Complementarities in Human Development: Evidence from MARS', *ZEW Discussion Paper No. 2008-067, IZA Discussion Paper No. 3734*

Coneus, Katja, Johannes Gernandt and Marianne Saam: 'Noncognitive Skills, Internet Use and Educational Dropout', *ZEW Discussion Paper No. 2008-044*

Coneus Katja, Kathrin Göggel and Grit Mühler: 'Determinants of Child Care Participation.', *ZEW Discussion Paper No. 2007-074*

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Presentations at conferences and research seminars

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July 2009	*The Intergenerational Transmission of Health in Early Childhood*, Invited Session, IHEA Beijing, China.
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Ehrenwörtliche Erklärung

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