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Sibling Rivalry for Parental Resources: A Problem for Equity in Education? A Six-Country Comparison with PISA Data*

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1 Introduction

Looking at the intergenerational patterns of educational attainment, many highly developed and industrialised countries still show a disturbingly high degree of transmission from one generation to the next (e. g. Acemoglu and Piscke, 2001 or Dustmann, 2001 or Ermisch and Francesconi, 2001).[1] Although the sources for this low intergenerational mobility in education and consequently in income, status and wealth, are not yet clear, some results of the PISA study 2000 have clearly indicated an urgent need for a better understanding of the way the educational system deals with social differentiation. Contrary to the political statements, many indicators in the PISA data let us think that the educational system does not fulfil one of its functions, namely to reduce the impact social differences can have on educational achievement.

With the Programme for International Student Assessment (PISA) (see OECD, 2001), the OECD assessed reading, mathematical and scientific literacy in almost all of its member countries and some non-member countries. Apart from the large differences in the literacy achievement between countries, the results also showed large differences in the importance of background factors for explaining differences within and between countries.[2] Among the background factors with the highest explanatory value for student performance were family

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1 In sociology, the Swiss Journal of Sociology has dedicated an entire issue in 2002 (2) to the topic of stratification research in Switzerland.

2 See e. g. Fertig and Schmidt, 2002.

background variables. It proved to be one of the big advantages of the PISA data to provide a rich set of variables on the family background and the interaction between parents and children. Although these variables were significant in all countries, countries differed largely relative to the importance of socio-demographic background in explaining student achievement.

In an earlier paper Wolter and Coradi Vellacott (2002) showed, that besides the usual factors, like education, wealth or the occupational status of parents, family configurations can play an important role in explaining differences between students. Family-size and birth-order used in sociological and economic literature as indicators for budget constraints of parents (in time and money) seem to be important for the explanation of student achievement – at least in the case of Switzerland, the country analysed in the previous study.

In this paper we extend our analysis further, to five other countries that participated in the PISA study in order to find out whether the effects found in Switzerland can also be observed in other countries. The selection of the six countries was guided by three criteria. Firstly we chose the countries who showed the largest gap in all three literacy domains between students in the top and bottom quarters of the socioeconomic index; these are besides Switzerland, Belgium and Germany. Secondly we selected the two top performing countries in reading literacy, Finland and Canada, and thirdly we chose a country that showed average literacy performance but is known for its active social and family policy aimed to reduce socioeconomic differences: France.

All the countries selected in this study have in common that compulsory education is largely public and free so that there are no reasons at first sight, why budget constraints of parents should disadvantage children from big families compared to their peers coming from small families.

2 Literature and Hypotheses

The literature on the correlation between parents' socioeconomic status and educational outcome of students identifies three major sources for this finding: "(1) The education process in middle- and upper-class families might promote the development of attitudes that match the demand of the school-type learning environment, (2) upper class families simply provide better learning resources, and (3) upper class students enjoy direct favoritism in the formal or informal setup of the school system." (Schnabel et al., 179)

We assume that in reality all three potential ways, – the socioeconomic status of parents can influence the educational outcome, – are relevant simultaneously.[3]

3 E. g. Sullivan (2001) developed an operationalisation just for cultural capital. When controlling the possession and transmission of cultural capital, a large influence of the socioeconomic

The problem therefore is that in most cases it is nearly impossible to test them independently. In this paper we are primarily interested in the effect that different amounts of resources might have on educational outcome. We are testing this question with the concept of sibling rivalry.

Sibling rivalry describes a situation in which students coming from large families suffer in their educational achievement from the fact that their parents have to divide limited household resources on more children than parents with less children under similar circumstances. Preconditions for a detrimental effect of the family-size on educational outcome are:

a) that family resources matter for educational achievement,
b) that parents or at least some parents face budget constraints and
c) that some of the family resources are divisible in nature.

The latter is a necessary condition for rivalry; if all the resources where indivisible, students from poor families would be disadvantaged but the size of the family would not matter. If these three conditions are met, and of we find a detrimental effect of the size of the family on educational outcomes and at the same time control the observable differences between parents (formal education, employment situation, socioeconomic status and others), we should get a clear indication that parental resources and not only status, socialisation, the expectations of the parents or their attitudes account for the educational success.

a) Problem of endogeneity

Although not only economists have looked at the effects of family size on children's outcomes, the approach of Becker (1960) to the economics of the family has influenced a great number of empirical studies in the past four decades. In his initial work on fertility decisions he introduced the notion of "quality of children" and presented the decision of families on the number of children they will have as a joint decision about quantity and quality of their descendants. Whereas this initial work was more interested in explaining the pattern of fertility in the twentieth century, Becker also discussed the implications for the investment (private and public) in human capital and the potential need for redistributional policies (see e. g. Becker and Tomes, 1986). The work of Becker on the joint decision of parents on the quantity and quality of their children also highlighted a potential problem with the analysis of family-size effects. Family-size effects can also be the result of unobserved heterogeneity between families and not or not only of budget constraints.

As in most other studies, we have to analyse the family-size effect with the help of outcome data. It is therefore not possible to completely rule out the

status on educational outcome remains, suggesting that socioeconomic "reproduction" is created through different channels simultaneously.

existence of a factor that might influence the fertility decisions of parents, their aptitude to support their children and the heritable "ability"[4] jointly. In such a case the educational outcome of students from large families would not necessarily have to be the result of budget constraints and sustaining those families with money would therefore not automatically help the children.

Due to this, we are not able to claim that any correlations between family-size and educational outcome are of causal nature. However, the data used in this study helps us in two ways. Firstly, we have a richer data set on parents and families than used in most other studies and the control of observable differences between families should substantially reduce the danger of endogeneity. Secondly, we can directly test our hypothesis with the help of "process" variables. These variables stand for the resources (time and money) parents spend on each child and we can therefore directly test whether the resources spent per child depend on the number of children within a family and whether a reduction of these resources affects the educational outcome. Additionally, variations of the family-size effect, like the birth-order effect (as shown in Wolter and Coradi Vellacott, 2002), show clearly, that applications of the resource hypothesis under circumstances that do not depend on parents fertility choices, generate results that point in the same direction as the analysis of size-effects.

b) Specification of variables

Regarding the educational outcome – the dependent variable in all the empirical analyses – three different measures are commonly used.[5] The most straightforward measure is educational achievement, measured in school tests[6] or as in this study in comparative tests of competencies. The second measure, widely used in the empirical literature, is educational attainment, usually measured by grades or completed school years or levels.[7] Thirdly and evidently for the economists, the impact on wages as an educational outcome can also be tested.[8] In the ideal case, the three outcomes would be linked with an almost complete correlation and the choice of the dependent variable would not make any difference. However, we

4 Behrman and Rosenzweig (2002) highlight the problem of causality in their paper on higher educational achievements of children of better-educated mothers. They explain the observation with correlations between schooling, heritable "ability" and assortative mating. Their results come from a twin study.

5 Besides the three outcomes mentioned here, other dependent variables, like health outcome (e.g. Garg and Morduch) have been used as well.

6 Stafford (1976) uses teacher ratings of cognitive skills of pupils. Willms (1986) uses the number of siblings as one of his independent variables in explaining differences in exam results in Scotland. Hanushek (1992) uses results from the Gary Income Maintenance Experiment (which at the same time limits his sample to black, low-income families).

7 E. g. Lindert (1976), Mare and Chen (1986a, 1986b), Hauser and Kuo (1998), Bauer and Gang (2000).

8 E. g. Kessler (1991), Björklund and Jäntti (1994).

are well aware of the fact that due to many exogenous (and endogenous) factors, high achievers in school tests are not attaining automatically higher school levels nor stay longer in school, and educational attainment is not always reflected in higher salaries. In order to test the effect of the family-size on educational outcomes we therefore prefer the direct test on the school performance of pupils.

Almost all studies, with the notable exception of the study of Hanushek (1992), measure the impact of contemporaneous or cumulated inputs in a cross-sectional analysis of achievement levels, a procedure that can create problems. Hanushek had the advantage of a data set with several achievement observations over time. Therefore he was able to regress changes in inputs on changes in achievement ("value-added" specification). Unfortunately, most of the data sets at hand do not allow comparing the change in achievement for individuals over time.

Beside the problem that family resources can differ in quantity and quality, another distinction should be made. Some resources are divisible and others are not.[9] Indivisible resources, like the socioeconomic status of the parents[10] or the location of living have the same impact on the achievement of their children, independently of the size of the family. Other resources, monetary and non-monetary, are divisible, and an additional child dilutes the resources available for the other siblings. Some resources can change their nature in order to be better adapted to the size of the family. Hanushek (1992, 86) discusses in this respect the concept of "public time" versus "private time". Public time has the nature of a public good and all children can share it without lowering the amount available to others. Private time is the time parents spend with a single child and which therefore can not be spent on the other children. The decision how parents divide their time into private and public time will probably depend on the size of the family. When the family gets larger, parents can substitute private time with public time but as public time most probably has less educational value than private time, overall achievement will still be affected negatively. In any case, due to the fact that not all the family resources are indivisible and the substitution of resources has limits, theory would predict that the size of the family has a negative effect on all siblings but the reduction in achievement might not be linear. As parents will also differ in the quality and quantity of indivisible resources, we can

9 Behrman and Rosenzweig (2002, 334) refer in their paper to information intensive versus time intensive resources that influence the outcome. If it is the first effect that matters most, the education of the parents leads to better schooling outcomes of their children, independently of the time parents spend with each child.

10 Schoon and Parsons (2002) show e. g. how the socioeconomic status of parents shapes the expectations and aspirations of the children and by these affects their educational and occupational attainment. If we assume that parents don't need "private" time to transmit their own attitudes to the children but that they simply act as role models, the status of parents influences the children's behaviour independently of the size of families.

predict that the negative impact of the family-size will be different among families and less so for families with a bigger share of indivisible resources.[11]

c) Why should parental resources matter if education is free?

Whereas most sociologists and economists would accept that all the conditions for family-size effects hold, the most recent empirical literature is ambiguous to a certain extent.[12] Among the studies we refer to in this paper, the ones from the US generally show family-size effects, whereas studies in Europe find only minor effects. The only study so far that we are aware of which compares different countries (Björklund and Jäntti, 1994) shows the same difference in the effects between the USA and European countries. These differences are explained by the facts that education is publicly provided and free in most of the European countries and that lasting budget constraints are fought with distributional policies that target larger families with generous child allowances, free child care and other measures. Despite the undeniable effect these factors should have, we are not convinced that the provision of free education is a sufficient condition to overcome all possible budget constraints.

At least four counter arguments come easily to our mind. Firstly, although education is largely public and free, it is not homogenous in quality. PISA shows in some countries large inter-school differences in the quality of schooling provided by public schools and it is rather obvious that wealthy parents can choose either the school or their location of residence[13] more freely than others and can thereby also select the best schools for their children.[14]

Secondly, not paying tuition fees for schooling does not mean that money is not important in influencing the performance of a student. More and more families have to pay for educational resources, like computers or educational software. Thirdly, most recent research in language learning shows that children

11 According to the theories of Bourdieu (1983) or Coleman (1988) on social capital, parents differ in their possession of economic, cultural and social capital. Especially the latter two but also parts of the economic capital (prestige, power) are indivisible. In this case we would expect that children from families from a higher social class should suffer the least from a dilution of parental resources due to the family size. Regarding the private time of parents, which is perhaps the most divisible resource, richer parents have also the possibility to substitute their own time with purchased child care (on the decisions to ask for nonrelative child care see e. g. Joesch and Hiedemann, 2002 or Lundholm and Ohlsson, 2002).

12 The number of empirical studies, however, is not impressingly large and apart from the study for Germany (Bauer and Gang, 2000) and the comparative one for the USA, Finland and Sweden (Björklund and Jäntti, 1994) we do not know of any other analysis that included European countries.

13 In case there is no school choice for parents in the public school system, as in Switzerland, the choice of residence (catchment area) replaces the school choice.

14 Duru-Bellat (2002) argues in the case of France, that the pronounced process for more decentralised and autonomous schools leads to an increased importance of contextual factors which could provoke a widening of social gaps in educational outcome.

already differ significantly in their language capacities at the time of school entry.[15] The socioeconomic background in which children are raised can largely explain these differences. It is therefore possible and probable that children already benefit from parental resources in their pre-school time, where governmental regulation and the public provision of child care and education is less dense. Last but not least, money is not the only or the most important limited family resource. The time parents can spend with their children, helping them with their homework or even spending time with them on extra-curricular activities can positively influence the educational outcome. The more children a family has, the less time (ceteris paribus) parents will thus be able to spend with each of their children.

Taking these arguments together, we think that there are enough reasons to believe that family size effects can also be observed under circumstances, where tuition fees or private schools are not the major reason for budget constraints of families. The existence of a significant family-size effect will, however, also depend on numerous factors like social policy, school organisation, the provision of early childhood care, the possibility of school choice and others, which vary between countries and within the countries with a federal political system. Even in a situation where family resources matter for the educational success of children, school systems and social policies might be able to compensate for the negative effects of sibling rivalry completely.

Finding strong family-size effects, however, would be a challenge for educational and social policy as it indicates that the children from larger families do not have the same chances in the school system as their peers coming from small families.[16]

15 See e. g. Lee and Burkam, 2002.

16 Not finding any resource effects or finding a small degree of social differentiation in the school system for fifteen-year old students does, however, not mean that equity in the whole educational system is automatically guaranteed. In the case of France, cohort studies show (see e. g. Duru-Bellat and Kieffer, 2000) that with the mass expansion of the tertiary system, the influence of the socioeconomic background on attaining upper secondary education was reduced substantially in the second half of the last century. At the same time upper class children are still more likely to attain the prestigious "grandes écoles" at tertiary level (p. 347). So the former inequity in the chances to attain upper secondary education was shifted to the tertiary level. The same shift can be observed in most countries with a complex institutional hierarchy in the tertiary education system (e. g. Reay et al., 2001 for the UK).

3 The model[17]

In its basic version, the model that predicts a negative family-size effect starts from the idea that limited parental resources have to be divided by the number of siblings and therefore any increase in the family-size will dilute the beneficial effect which family resources can have for their children. Although this rule applies to all levels of income and endowments, it is clear that parents with different budgets of money and time face different constraints. Richer parents can purchase resources. Poor parents can not always do the same nor have access to credit. Besides the possibility of using outside, non-relative sources to counterbalance the family-size effect, the proportion of indivisible resources is also likely to depend on the parents' education, wealth and status.

Credit constraints, the quality of parental resources and the amount (quantity and quality) of indivisible resources therefore lead to a reinterpretation of the simple model. We would expect that children from better off parents (both in terms of income and education) would not suffer significantly from the presence of siblings. These parents would be almost completely unconstrained. At the same time children in poor families with the same size of sibship would be significantly affected by the presence of siblings, as their parents face binding budget constraints.

Outside factors, like the provision of free education, free child-care or generous child allowances also have to be taken into account when predicting the size of a sibling effect. They are especially important when searching for explanations for observed differences between countries in the family-size effects. In this paper, however, we concentrate on empirical testing of the family-size hypothesis in different countries without offering yet explanations for potential differences in these effects between the countries analysed.

4 Data

In this paper we use the international PISA data set 2000 for Belgium, Canada, Finland, France, Germany and Switzerland. The full sample of the data has roughly 57'000 observations. Table 1 gives an overview of the observations per country. Due to the fact that Canada assessed in all provinces with representative samples, the number of observations is much higher than in all other countries. When using the international data set, weighting of observations therefore becomes crucial.

17 A more elaborated version of the model and its predictions can be found in Wolter and Coradi Vellacott (2002).

Reading literacy in PISA is standardised to 500 points (OECD average) with a standard error of 100 points (see OECD, 2001). Table 1 also shows the mean in the combined reading literacy scale per country and the difference in literacy achievement between students coming from the top and from the bottom quartile of the socioeconomic status.

Table 1: Descriptive statistics for the six countries

	Mean literacy score	Differences by socio-economic status	Number of observations	Not test language*
Belgium	507	103	6'670	22.9%
Canada	534	67	29'687	9.6%
Finland	546	52	4'864	5.8%
France	505	83	4'673	5.1%
Germany	484	114	5'073	7.1%
Switzerland	494	115	6'100**	18.3%

Notes:

* Students who most of the time speak a language at home that is not the test language.

** The data set used for Switzerland in this paper differs from the one used in the paper Wolter and Coradi Vellacott (2002). In this paper we use the international sample of fifteen-year old students, whereas in the previous paper we had used the national sample of students of the 9th grade.

Data source: OECD (2001)

Most of the variables used were taken from the PISA data set; some of the variables were created from different variables in the data set. Altogether we use five groups of independent variables and two groups of dependent variables in this paper (see also table 2). The independent variables are:

1 Economic situation of families: Two variables are used as proxies for the wealth and income of families, as no direct measure is available.[18] The most important variable is the so-called "ISEI" index. The index ranks students according to the occupational status of their parents. The ranking depends on the income that each occupation is likely to generate. The second variable characterises the employment situation of parents.

2 Education of parents: Two variables are used to assess the educational background of parents. The first variable is the formal education of both

18 Note that all the information on the family background comes from the student questionnaires. For this reason it is obvious that some questions could not be asked since it could be assumed that students would not know the answer.

parents (ranked according to ISCED definition) the second variable ("closeness to education") reflects the use of education and educational and cultural goods by parents in the socialisation process of their children.

3 Migration status of parents and children: We tested several possibilities and the richness of PISA data allows us to differentiate between migrants and natives not only on the criteria of nationality. We decided to use three different (dummy) variables, because we found that they all had an independent and significant impact on reading literacy. Firstly we use a variable for the birthplace of parents, secondly one for the birthplace of the student and thirdly a dummy for the test language.

Table 2: Variable Definitions

Dependent Variables	
Reading	Achievement in reading literacy as defined in PISA
Room	The variable is 1 if the child has his own room and 0 otherwise
Soccom	Composite index of three questions: how often do parents discuss with you school matters, take meals with you and how often do they take time to talk
Independent Variables	
ISEI	Socioeconomic index of occupational status (ranges from 0 to 90)*
Parents' employment situation	Dummy: value 1 if at least one adult in the family is full time employed and 0 otherwise
Fathers' education	Formal education of father expressed in ISCED level
Mothers' education	Formal education of mother expressed in ISCED level
Closeness to education	Composite index of four variables: the number of books at home, the frequency of discussions with parents on social, political and cultural matters, the possession of cultural goods and the possession of educational resources
Parents foreign born	Dummy; value 1 if both parents were born outside the test country
Student foreign born	Dummy; value 1 if the student was born outside the test country
Other language than official language	Child speaks at home most of the time a language that is different from the language of assessment, from other official languages or from national dialects.
Single headed family	Dummy; value 1 if the family has only one adult person
Mixed family	Dummy; value 1 if one or both adult persons in the family are not the parents (male or female guardian)
Other family	Dummy: value 1 if other combination of adults
NSIB	Number of siblings. The variable is also used as a dummy, with dummies for every size of the family
Gender	Dummy: 1 for girls, 0 for boys

Notes:

* This is an internationally comparable and standardised method of ranking the parents' profession according to their (socio-economic) status (see Ganzeboom et al., 1992). The Index is used as a proxy for income and wealth. Direct information on income and wealth could not be obtained, because students filled in the background survey. This might have an influence on the results. Björklund and Jäntti (1994) report in their paper that when using direct income measures instead of proxies like education and occupation, the sibling effect is either substantially reduced or disappears fully.

4 Family configuration: We differentiated between the classical family structure of students having both parents at home and others and of course the number of siblings.

5 Personal characteristics: The only differentiation we made concerns the gender of the student. Girls did on average always better than boys did.

The dependent variables are on the one side the reading literacy as a proxy for educational achievement and on the other side variables that stand for family resources. The latter category allows us to test our hypothesis that the number of siblings affects the amount of parental resources that can be dedicated to each of the children directly.

5 Results

a) General findings

In a first step, we analyse the impact of the number of siblings on individual test scores in reading literacy in the full sample with all countries. Regression 1 in table 3 shows the coefficient of the linear specification of the sibling variable with no control variables added. The coefficient is highly significant but its magnitude is not overly impressive. In regression 2 we add control variables that represent the economic situation of the household, in regression 3 we add the rest of our structural variables and in regression 4 we add the squared term of the number of siblings in order to make a first test of the assumption of linearity. In all regressions we include country dummies to account for structural differences between the six countries.

The family-size effect is significant and negative. In the simple version, where we do not account for any differences between the families other than the size (regression 1), the effect amounts to –0.14 of one standard deviation in reading literacy per additional child. The inclusion of additional control variables reduces this effect to –0.06[19], but the family-size variable remains significant. The inclusion of the squared term shows, however, that the family-size effect is not linear.

Table 3 shows comparable results as found in Wolter and Coradi Vellacott (2002) and proves at least that the significant family-size effect is not particular to Switzerland. In order to analyse whether there are differences between countries, we discuss four types of analyses, three with the full sample of observations and one with the national sub-samples. In the first analysis with the full sample (table 4) we use the linear specification of the family-size and use interaction terms for this variable with the countries analysed. In the country specific analysis (table 5), we use dummies for the family-size instead.

19 The size of the effect is almost identical as the one found only for Switzerland.

Table 3: Regression on reading literacy[1]

	Regressions			
	1	2	3	4
Independent Variables	Coefficient	Coefficient	Coefficient	Coefficient
Constant	6.350*	6.088*	6.240*	6.235*
ISEI		0.003*	0.001*	0.001*
Parents' employment situation		0.088*	0.038*	0.038*
Fathers' education			0.001	0.001
Mothers' education			0.007*	0.007*
Closeness to education			0.689*	0.689*
Parents foreign born			–0.043*	–0.042*
Student foreign born			–0.018*	–0.018*
Other language than official language			–0.039*	–0.039*
Single headed family			–0.011**	–0.010*
Mixed family			–0.018*	–0.017*
Other family			–0.057*	–0.055*
Girl			0.056*	0.056*
NSIB	–0.029*	–0.019*	–0.012*	–0.004
NSIB squared				–0.001**
Country dummies added	Yes	Yes	Yes	Yes
Adjusted R^2	0.06	0.16	0.30	0.30
Number of observations	56'190	52'444	46'143	46'143

Notes:

1 One standard deviation of the log reading literacy score is 0.1999. All regressions were run on Stata 6.0. No imputation of missing observations was carried out. Tests for heteroskedasticity (Cook-Weisberg) and for omitted variables (Ramsey regression specification error test) were made. The hypotheses of homoskedasticity and of no omitted variables could not be rejected.

* Significance at the 1% level, ** Significance at the 5% level.

The reference person is male, lives in a classical family with both parents (for regressions 3 and 4), his mother tongue is the local language. All observations are weighted. The dependent variable is in a log-linear specification. Because of the stratified sample all regressions have robust standard errors, using schools as clusters. Specifying thereby that the observations are independent across groups (schools) but not necessarily within groups.

The results in table 4 show that family-size effects are significant in all countries but that by adding the control variables, differences between countries disappear partially. In the regression (no.3) with all control variables added, only Belgium and Germany have a statistically significant stronger effect than Finland and if we add a squared term of the number of siblings (no.4) Switzerland has also a stronger effect than Finland. Not surprisingly so, the countries with the higher degree of social differentiation in the PISA results (Belgium, Germany and Switzerland; see table 1) also have a stronger family-size effect than Finland, Canada and France.

Finally we show the results for the full sample with dummies for the family-size, where we add an interaction with the test language and the family-size (table 6) and an interaction with the quartiles of the ISEI variable (table 7), to test whether there are significant differences between students with the test-language

Table 4: Regression on reading literacy with country specific effects[1]

	Regressions			
	1	2	3	4
Independent Variables	Coefficient	Coefficient	Coefficient	Coefficient
NSIB	–0.009*	–0.002	–0.004**	
NSIB Belgium	–0.033*	–0.029*	–0.019*	
NSIB Canada	–0.005	–0.006**	–0.004	
NSIB France	–0.018*	–0.012*	–0.005	
NSIB Germany	–0.030*	–0.024*	–0.010*	
NSIB Switzerland	–0.013*	–0.012*	–0.007	
NSIB squared				–0.001*
NSIB squared Belgium				–0.003*
NSIB squared Canada				–0.000
NSIB squared France				–0.001
NSIB squared Germany				–0.002*
NSIB squared Switzerland				–0.001**
Country dummies added	Yes	Yes	Yes	Yes
Control variables added	No	Yes	Yes	Yes
Adjusted R^2	0.07	0.16	0.30	0.30
Number of observations	56'190	52'444	46'134	46'134

Notes:

1 The control variables in each regression are the same as in table 3.

* Significance at the 1% level, ** Significance at the 5% level.

All observations are weighted. The reference category for the family-size is Finland. The dependent variable is in a log-linear specification.

Table 5a: Regression on reading literacy country wise

Independent Variables	Belgium	Canada	Finland
1 sibling	–0.000	–0.015**	0.000
2 siblings	–0.019**	–0.026*	0.000
3 siblings	–0.040*	–0.026*	–0.003
4 siblings	–0.060*	–0.046*	–0.015
More than 4 siblings	–0.115*	–0.051*	–0.048*
SD dependent variable	0.222	0.189	0.166
Control variables added	Yes	Yes	Yes
Adjusted R^2	0.297	0.205	0.239
Number of observations	5'036	25'245	4'133

Notes:

* Significance at the 1% level, ** Significance at the 5% level.

All observations are weighted. The dependent variable is in a log-linear specification.

Table 5b: Regression on reading literacy country wise

Independent Variables	France	Germany	Switzerland
1 sibling	–0.001	–0.002	0.004
2 siblings	–0.003	–0.009	–0.006
3 siblings	–0.049*	–0.021	–0.009
4 siblings	–0.044*	–0.018	–0.045**
More than 4 siblings	–0.047*	–0.119*	–0.061**
SD dependent variable	0.190	0.226	0.210
Control variables added	Yes	Yes	Yes
Adjusted R^2	0.328	0.326	0.373
Number of observations	3'516	3'562	4'808

Notes:
* Significance at the 1% level, ** Significance at the 5% level.
All observations are weighted. The dependent variable is in a log-linear specification.

and others and between students coming from different socioeconomic background – over the whole sample of all countries.

The differences between the linear and the non-linear specification show, however, that within countries the size effects are distributed differently. Tables 5a and 5b show the results within countries and the dummy specification of the family-size.

According to the results, countries can be divided into four categories (see table 6). Although family-size effects can be observed in all countries analysed, the patterns are quite different. The magnitude of effects ranges from less than one third (Finland) to more than one half (Belgium and Germany) of one standard deviation of reading literacy in big families.

Table 6: Classification of family-size effects

Criteria	In most family-sizes	Only for big families
Small effects	Canada and France	Finland
Big effects	Belgium	Germany and Switzerland

b) Differentiation according to test language and ISEI

According to the model presented in Wolter and Coradi Vellacott (2002), we can expect that family-size effects can differ substantially between different social groups and the migrant and the native population. Therefore, we analyse these sub-groups of the population separately. In tables 7a and 7b, we analyse the

Table 7a: Regression on reading literacy country wise (test language vs. not test language)

Independent Variables	Belgium	Canada	Finland
1 sibling test language	0.006	–0.013	0.001
2 siblings test language	–0.016	–0.023	0.003
3 siblings test language	–0.030**	–0.025	–0.000
4 siblings test language	–0.043**	–0.040*	–0.015
More than 4 siblings test language	–0.100*	–0.045*	–0.041**
1 sibling not test language	–0.021	–0.021	–0.021
2 siblings not test language	–0.032**	–0.040**	–0.037
3 siblings not test language	–0.075*§	–0.022	–0.046
4 siblings not test language	–0.110*§	–0.086*§	–0.018
More than 4 siblings not test language	–0.156*	–0.089**	–0.157**
SD dependent variable	0.222	0.189	0.165
Control variables added	Yes	Yes	Yes
F-test[1]	6.62*	5.98*	2.03**
Adjusted R^2	0.297	0.205	0.239
Number of observations	5'036	25'245	4'133

Notes:

1 An F-test was performed to test whether the coefficients of all family-size variables together are significantly different from 0, which is the case for all countries.

Table 7b: Regression on reading literacy country wise (test language vs. not test language)

Independent Variables	France	Germany	Switzerland
1 sibling test language	–0.000	–0.002	0.012
2 siblings test language	–0.000	–0.009	0.005
3 siblings test language	–0.046*	–0.023	0.006
4 siblings test language	–0.043*	–0.014	–0.024
More than 4 siblings test language	–0.048*	–0.095*	–0.061**
1 sibling not test language	–0.043	0.009	–0.026
2 siblings not test language	–0.113**§	–0.015	–0.052
3 siblings not test language	–0.133*§	0.028	–0.075**§
4 siblings not test language	–0.103**	–0.079	–0.120*§
More than 4 siblings not test language	–0.100**	–0.254**	–0.061
SD dependent variable	0.190	0.226	0.210
Control variables added	Yes	Yes	Yes
F-test	6.11*	3.75*	2.79*
Adjusted R^2	0.328	0.326	0.373
Number of observations	3'516	3'562	4'808

Notes:

* Significance at the 1% level, ** Significance at the 5% level.

§ Denotes the cases, where the coefficients of the students tested in the test language and those not, but coming from the same family-size, are significantly different, at least at the 10% level.

All observations are weighted. The dependent variable is in a log-linear specification. Reference category is a student growing up in a single-child household.

family-size effects within countries and subdivide the student population into those who were assessed in their mother tongue and those whose mother tongue was different from the test language. We see the test language as the best indicator for cultural distance and better suited to our purpose than the place of birth, although we still have the place of birth in the control variables.

Although the size effects seem to be stronger for those who were not tested in their mother tongue, the differences are not statistically significant in the cases of Finland and Germany. The non-significance in some cases might be due to the low number of observations for some of the variables. Especially in the case of Finland, where the number of students not tested in their mother tongue was very small. If we run the same regression for the whole sample of all countries (results not shown here) the differences between the two groups are significant for all family sizes (except for families with 2 children).

Due to the fact that the migrant population is highly diverse from one country to an other, we tested these effects country-wise, whereas for the socioeconomic groups (divided in quartiles) we present the results only for the full sample (table 8). Testing was made for each country and does not change the overall picture much.

Table 8: Regression on reading literacy per ISEI quartile[1]

Independent Variables	ISEI-Quartiles			
	Quartile 1 Coefficient	Quartile 2 Coefficient	Quartile 3 Coefficient	Quartile 4 Coefficient
1 sibling	–0.017	–0.013	0.020	–0.003
2 siblings	–0.030*§	–0.022**§	0.119	0.004
3 siblings	–0.059*§	–0.045*§	0.004	–0.017
4 siblings	–0.046*	–0.069*§	0.011	–0.020
More than 4 siblings	–0.112*§	–0.059*	–0.067*	–0.042**
SD dep. variable	0.203	0.193	0.174	0.162
Control variables added	Yes	Yes	Yes	Yes
Adjusted R^2	0.278	0.232	0.206	0.192
Number of observations	13'386	13'569	9'684	9'661

Notes:

1 ISEI values are chunked around four distinct values. We therefore decided not to take the exact limits of each quartile but rather to observe the borders given by the values where the observations were concentrated. This results in slightly more observations for the lower two quartiles and vice versa.

* Significance at the 1% level, ** Significance at the 5% level.

§ Denotes the cases, where the size effect is significantly different (at the 10% level) from the family-size just below the indicated one.

All observations are weighted. The dependent variable is in a log-linear specification.

As one can easily see, the family-size effects are pretty much concentrated among the lower half of the socioeconomic distribution with the exception of large families (five and more children). The most important finding is that if one puts groups of families from the same socioeconomic background (status) together and controls factors like formal education or place of birth one still finds significant differences between families of different size. If one finds significant size-effects within more homogenous sub-groups of families, the likelihood that we really observe a resource problem and not just a problem of endogeneity should be high.

c) Family size effects on social interaction and home infrastructure

So far, we have been testing whether the family-size had any significant effect on the educational outcome. One of the advantages of PISA is that besides this, we can directly test our hypothesis, that an increasing number of children would reduce the parental resources available per child under given circumstances. The PISA background questionnaires offers different descriptions of parental resources. We therefore tested firstly which of the resources had a significant effect on reading literacy and, subsequently, whether the number of siblings had an effect on the resources available per child. The two kind of resources we found to account for reading literacy were the intensity of social communication between parents and children (variable "soccom") and having a room of one's own (variable "room").[20] The latter should give an indication for physical resources at home. The intensity of social communication should reflect the time resources of the parents.

Tables 9 and 10 show the regression results. We conducted two forms of regressions in each case. The first one analyses country specific differences with an interaction variable. The second one uses the full sample and the dummy specification for the family-size, as the size-effects are not completely linear.

Table 9 shows that the number of siblings affects the probability of having a room of one's own significantly in all six countries. With the exception of

20 The relationship between reading literacy, the housing situation and the socio-economic background of the child is particularly vulnerable to the problem of endogeneity. We postulate that the lack of resources, due to the socio-economic status and more children (sibling effect) forces some parents to "overcrowd" their home. Overcrowding of the house then provokes less good literacy results. Fundamental to this hypothesis is the idea that the overcrowding effect is causal for reading literacy results. However, one could also argue that children with non-observable traits that negatively affect reading literacy are more likely to be in overcrowded housing situations. In this case the less good results in reading would not be directly caused by the resource effect (housing situation). With PISA data alone, it would not be possible to test whether the housing situation has indeed a causal effect on reading literacy or only an indirect one. We therefore have to base our assumption of a causal effect on the research of Goux and Maurin (2003), who have tested this assumption with a data set for France that suited the testing of this hypothesis better. They came to the conclusion, that the disparity of living conditions is a very important causal channel through which the parents' lack of financial resources affects their children's schooling.

Table 9: Probit regression on variable "room"

Independent Variables	Regression		
	number of siblings	family size (full sample)	marginal effects
NSIB	–0.179*		
NSIB Belgium	–0.060**		
NSIB Canada	–0.064*		
NSIB France	–0.088*		
NSIB Germany	0.045		
NSIB Switzerland	–0.077**		
1 sibling		–0.635*	–0.088*
2 siblings		–0.986*	–0.172*
3 siblings		–1.239*	–0.294*
4 siblings		–1.249*	–0.314*
More than 4 siblings		–1.324*	–0.349*
Mean dependent variable	0.892	0.892	0.892
Control variables added	Yes	Yes	Yes
Log likelihood	–12'178.45	–12'136.20	
Adjusted R^2	0.141	0.145	
Number of observations	46'134	46'300	

Notes:

* Significance at the 1% level, ** Significance at the 5% level.
All observations are weighted. Reference category is a student growing up in a single-child household.

Table 10: Regression on variable "soccom"

Independent Variables	Regression	
	Number of siblings country wise	family size (full sample)
NSIB	–0.026*	
NSIB Belgium	–0.068*	
NSIB Canada	–0.006	
NSIB France	–0.033**	
NSIB Germany	–0.047**	
NSIB Switzerland	–0.042**	
1 sibling		–0.0855*
2 siblings		–0.1693*
3 siblings		–0.2010*
4 siblings		–0.2317*
More than 4 siblings		–0.2893*
SD dependent variable	0.944	0.944
Control variables added	Yes	Yes
F (43, N-44)	66.66	66.64
Adjusted R2	0.111	0.111
Number of observations	46'119	46'285

Notes:

* Significance at the 1% level, ** Significance at the 5% level.
All observations are weighted. Reference category is a student growing up in a single-child household.

Germany the effects in all countries are significantly stronger than in Finland. The second column in table 9 shows the effects for each size of the family and the third column shows the marginal effects. The results indicate that having three or more siblings reduces the probability that a student has his/her own room by 30% and more.
A similar effect can be observed for the intensity of social communication. The effect of the number of siblings is significant in all countries and again, this time with the exception of Canada, stronger in all countries than in Finland. Having four or more siblings reduces the social interaction between parents and child by one quarter of a standard deviation of the variable "soccom".

Tables 9 and 10 show the statistical evidence that the number of children in a household not only affects the educational outcome but also the process that leads to the outcome. Being born into a family with more children reduces the amount of parental resources per child, also when all other observable differences between families are under control.

6 Conclusions

In this paper, we have shown that the educational outcome of a fifteen-year-old child, as assessed in PISA, depends significantly on the number of siblings in his/her family. The negative effect of a large sibship on the educational performance of a child is even more pronounced, if the parents have a low socioeconomic status and/or the child's mother tongue is not the test language. The finding that no significant family-size effect can be measured for students coming from a good socioeconomic background and speaking the test language can be explained by a model that takes into account the nature and the quality of parental resources and the interaction that takes place between siblings.

Although the possibility that some of the family-size effect might be due to unobserved heterogeneity between parents can not be ruled out completely, the concentration of size effects within well defined sub-groups of the population and the richness of the observable characteristics of the parental environment, speak in favour of a resource effect. An additional argument in favour of this explanation is the finding that observed parental resources that affect educational outcomes also depend significantly on the family-size. Contrary to the known empirical studies in this field, we therefore get direct evidence for the detrimental effect of the family-size on the parental resources available children.

The family-size effect is observable in all countries analysed in this study but differs significantly between countries. The pattern we can detect in these differences shows that countries with generally more homogeneous results in the PISA assessment (Finland, Canada and France) also show smaller family-size effects.

Therefore, we can assume that at least a part of the more equitable results in these countries can be attributed to policies that compensate the negative effects the number of siblings has on the amount of parental resources for each child.

Regarding the students that were not tested in their mother tongue, the family-size effect is stronger than for those who were tested in their own language. We assume that the language is a proxy for the cultural distance of migrants to their host country and that besides the quantity of parental resources there is also a quality aspect to take into account. In Finland, with a very low number of students that were not tested in their mother tongue, as well as in Canada (only a small difference) and in Germany we don't find significant differences between migrants and natives, concerning the family-size effect. Notable differences, however, are found in France, Belgium and Switzerland. For the latter two countries, this finding is perhaps not surprising as they have the highest share of students not speaking the test language at home, but the same argument does not apply for the case of France.

We can not attribute differences in the pattern of family-size effects between countries to specific policy measures but we can conclude from these differences that there is apparently room for policies to compensate budget constraints (for which the family-size is used as an indicator) and other effects.

Additionally, we do not know when an intervention would be most promising. The parental resources available to children are not stable over the whole childhood and there is a controversy, whether early interventions or later ones might be more effective.[21]

In the past, equity in education was associated with gender, race and other characteristics of the students rather than with their socioeconomic background.[22] The present findings indicate that some re-thinking is necessary and that besides socio-demographic characteristics of students, the socioeconomic status is still an important source of inequity in the educational system.

21 Literature on early childhood generally finds positive effects of public provision of child-care. Other studies find less important effects of parental resources during the early childhood and more important effects in later stages of the school career (e. g. Jenkins and Schluter, 2002).

22 Only recently, empirical studies stress again the importance of the socioeconomic status of parents (e. g. Black and Sufi, 2002 in a similar context).

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