Do co-residing grandparents alleviate the negative effect of sibship size on educational achievement?

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1. Variations in the associations between family size and education outcomes

Number of siblings, or family size, has traditionally been as one of the exogenous variables in the status attainment model. Duncan (1968) incorporated this variable in to the basic stratification model just one year after *The American Occupational Structure* [Blau, Duncan 1967] had been published. Many classical studies reported a negative association between the number of siblings a person had and his/her educational attainment, or occupational status (see e.g. [Duncan 1968; Featherman, Hauser 1978; Hauser, Sewell 1985; Shavit, Blossfeld 1993]). The negative association between number of siblings and various measures of one's socioeconomic standing are now taken to be robustly and convincingly documented in many advanced industrialized societies [see also Booth, Kee 2005; Jaeger 2008; Olneck, Bills 1979; Park 2005; van Eijck, de Graaf 1995; Steelman et al. 2002 offer a comprehensive review of this literature].

The literature offers three explanations for the negative association between family size and education outcomes. First, the confluence model posits that each additional birth into the family changes the interpersonal dynamics and intellectual level of the family environment. Each child is then exposed to more (or less) advantageous environments for shorter (or longer) periods of his/her life, which cumulatively produces different cognitive as well as school outcomes [Guo, VanWey 1999; Jaeger 2009; Steelman 1985; Zajonc, Marcus 1975]. Second, the resource dilution model assumes that the family has only a limited amount of economic and non-economic resources that can be used for the benefit of the children. Therefore, the more children there are in the family, the lower the share each child can claim

and the larger the negative effects on education [Downey 1995; Eijck, de Graaf 1995; Jaeger 2008, 2009]. Third, some authors propose that the association between family size and schooling is spurious, since fertility and children's schooling may be jointly determined [Guo, VanWey 1999].

The empirical evidence regarding the effects of family size on education outcomes is far less consistent when we look at less industrialized societies or at specific subpopulations. For instance Shavit and Pierce [1991] found out that number of siblings has a negative effect on educational attainment of Jews in Israel, but has no effect on education among the Arabs. The authors argued that, among other things, the Arabs can rely on the help of the extended family (the *hamula*) to share the cost of child rearing. Then, family size has no detrimental consequences for one's education. Similarly, Sudha (1997) reports a negative effect of sibship size among the Chinese and Indians in Malaysia, but no effect among the Malays, whose education, as the author points out, has been subsidized by the state for several decades. Gomes (1984) finds a positive effect of family size (particularly among the largest families with 7 or more kids) in Kenya, where parents maintain control over the earnings of the eldest child and can use it for the benefit of the younger siblings (see also Buchmann [2000]). Similar positive consequences of family size have been reported in Botswana [Chernichosky 1985].

Often, the effect of the number of siblings varies across cohorts within one society. Maralani [2008], for example, reports strong positive effect of family size on schooling in early urban cohorts in Indonesia and negative effects in more recent urban cohorts. Moreover, her analysis reveals no association between family size and children's schooling for any cohort of rural children. Similarly, Lu and Treiman [2008] also identify variations in the association between family size and education across cohorts in China. Anh et al. [1998] find the negative association only in very large families (with at least 6 children) in Vietnam.

Many explanations have been speculatively proposed to account for the variability in sibship size effects across contexts reaching from family organization, cultural roles, and intergenerational wealth flows to the cost of education, demand for education, and mode of production in a given society/historical period [Maralani 2008; Sudha 1997]. Generally, the list of explananda consists of factors that "influence both the availability of resources and their internal allocation within a family" [Lu, Treiman 2008: 813].

Family organization and cultural roles that influence the amount and/or direction of the wealth flows between generations are particularly interesting to study since they determine "whether the burden of child rearing is limited to the nuclear family or extended across broader kin networks, whether and how much school-aged children work inside and outside the home" [Maralani 2008: 694]. Maralani [2008: 695] concludes that "(i)n societies where parents bear most of the cost of schooling and where the costs are high, we might expect a negative relationship between family size and educational attainment. In societies with extended kinship networks and lower schooling costs, the relationship may be neutral or positive". Sudha [1997] adds that families may start applying resource-distribution and family-planning processes only at higher levels of development as the importance of schooling for socioeconomic achievement rises. A negative effect association between family size and schooling may emerge as a result.

While there are the many explanations of the variability of the association between family size and educational attainment, there is surprisingly little empirical comparative research in this area. Most published papers are single country studies. These sometimes make comparisons across cohorts or historical periods [e.g. Maralani 2008; Lu, Treiman 2008], or across various segments of one society [Maralani 2008; Shavit, Pierce 1991]. Comparisons across societies are very uncommon.

Moreover, the explanatory variables of interest are seldom measured explicitly in these papers. Rather, speculative statements about the sources and nature of the differences between contexts are offered. These tentative interpretations, while often very enlightening and instructive, are not explicit empirical tests. More rigorous tests would perhaps require finding measures of key explanatory variables and finding contexts with sufficient variation of these variables. Given the enormous importance of the family and family organization for social stratification, this lack of explicit test and explicit quantitative comparisons is striking.

There are, nevertheless, a few exceptions to this rule. Wolter [2003] used PISA 2000 data for six countries (Belgium, Germany, Switzerland, Canada, Finland, France), to explore the size of the effect of sibship size on reading literacy test scores. While this effect turned out to be negative in all countries, its size varied significantly being strongest and very pervasive in Belgium and weakest in Finland, where only children from very large families faced any disadvantages. Wolter attributed cross-country differences to different policies. Park [2005] took this issue a step further and included several country-level quantitative measures of the public welfare provisions for families with children, public spending on family policies and on education into his multi-level model of reading literacy test scores across 20 countries selected from the PISA 2000 database. He found out that the negative effect of sibship size was indeed lessened by strong and deepened by weak public (family-oriented) policies.

2. Effects of coresidence with grandparents

There has been little effort to systematically explore and describe the circumstances that lead to and the consequences of coresidence of grandparents and grandchildren for school outcomes in an international comparative perspective. While most empirical studies focus on one country, there exist two different approaches to the issue. Some studies explore three-

generation households (grandparents, parents, grandchildren), whereas other emphasize skipped-generation households (grandparents, grandchildren). While the former type is relatively common in less developed societies and becomes less prevalent as the society and economy modernize [Pong, Chen 2007], the latter type seems to be increasingly common in some, mostly advanced industrialized societies due to increasing incidence of specific problem behaviors such as drug addiction, teenage pregnancy, HIV infection, and divorce [Albuquerque 2008; Bryson, Casper 1999; Caputo 2001; Hayslip, Kaminski 2005; Kelch-Oliver 2011; Minkler 1999; Pong, Chen 2007]. Furthermore, each of these household types seem to be produced by diverse social mechanisms (three generation households result most often from tradition, while skip-generation households are a reaction to social dislocation) and prevail at different levels of social development [Park 2005b].

Studies of skipped-generation households are more common (indeed research on three-generation households is almost completely missing from sociology, [Pong, Chen 2007]). True three-generation households are more often researched in non-western societies, where they are more prevalent [Pong, Chen 2007, 2010; Pong, Frick, Moyi 2004]. In Europe multigenerational households can be found in Southern European countries (such as Italy) and in Central European countries (such as Hungary). But even here the situation is more likely due to the need of the offspring (de Jong Gierveld, de Valk, Blommesteijn 1999; Pong, Frick, Moyi 2004). Elsewhere in Europe, three-generation households are very rare, perhaps because most Europeans value privacy and emphasize the nuclear family and independent living [Pong, Frick, Moyi 2004; Glaser et al. 2010; de Jong Gierveld, de Valk, Blommesteijn 1999].

Living with a grandparent (or several grandparents) can either be a result of tradition or necessity. While traditional coresidence may be beneficial for the kids, necessity often indicates trouble and social disorder. Necessity may result from the situation in either of the generations, but coresidence for the sake of the younger generation seems to be more common

in modern societies [Park 2005b; Albuquerque 2008]. Since grandparents are rather reluctant to interfere with the lives of their (grand)children unless they absolutely must intervene [Jendrek 1994; Shore and Hayslip 1994]. Hence, grandparental coresidence is less and less common and typically indicates a highly de-stabilized and vulnerable family situation [Glaser et al. 2010; Pebley, Rudkin 1999; Cherlin, Furstenberg 1992; Bengston 2001; Park 2005]. The more modern a society becomes, the less common three generation households are, and the more extreme their situation may be.

Coresidence of three generations may have both positive and negative consequences for the children and may operate directly or indirectly [Denham, Smith 1989]. Grandchildren can benefit from grandparent doing a part of the housework so the parent is left with greater amount of time to spend with the offspring [Pong, Chen 2010]. Furthermore, grandparents may directly contribute to the pool of the available financial resources [Mutchler, Baker 2009; Dunifon, Kowaleski-Jones 2007; Pong, Frick, Moyi 2004]. The grandparents can also function as role models and the children can learn to plan their future or can develop more effective relationship with adults [Denham, Smith 1989; Hayslip, Kaminski 2005]. Grandparents can also supervise the child and thus help prevent problematic behaviour [Pong, Frick, Moyi 2004; Pong and Chen 2010].

The co-residency situation (in three generational families) also might create conflict, for example because of different views on parenting by different generations. Such conflict environment could have negative impact on the offspring, since the child does not know who is the primary authority or suffers stress [Pong and Chen 2010]. Furthermore, grandchildren can be deprived of a certain proportion of family resources that are redirected to the grandparent – be those resources monetary, material (such as own room to study and do homework), or other (parental time, attention etc.) [Pong, Chen 2007, 2010]. Yet, the negative effect identified in a regression model (a typical instrument of most studies) may result from

non-random selection into coresidence: „it is hypothesised that the children's difficulties may be due to the family difficulties which led to the grandparent's involvement" [Glaser et al 2010: 33; see also Cherlin, Furstenberg 1992; Pong, Chen 2007]. Indeed, the main effect of coresidence is typically negative (see also [Monseru, Elder 2010].

Empirically, a net positive effect of coresident grandparent on behavioral or educational outcomes has been shown in single-mother families in the USA [Deleire, Kalil 2002; Dunifon, Kowaleski-Jones 2007]. Aquilino [1996] reports net positive effect of coresidence on a variety of school and other outcomes (including high school graduation and college entry) even in US intact families. Similar effects have been found in intact families in Taiwan [Pong, Chen 2007, 2010]. Parker and Short (2009) were able to document positive effect of co-resident grandmother on school enrolment of children of absent (dead or non-coresident) mothers in Lesotho, South Africa.

Educational disadvantage of children in skipped-generation households was found by Monseru and Elder [2010]. Bryson and Casper [1999] document that children in skipped-generation households are more likely to be poor, receive public assistance, and have no health insurance. Mutcher and Baker [2009] also point out that coresidence in single-parent families implies greater odds of being below the poverty line in comparison to single-mother families without a coresiding grandparent, since the latter are more likely to receive substantial financial aid from non-coresiding grandparents or from other sources. Working with international data, Pong, Frick, and Moyi (2004) found a negative effect of grandparental co-residence on test scores of 3rd and 4th grade students. Yet, they also found out that this effect is weaker in countries where living with grandparents is more common (the strongest negative effect was found in USA and England). Moreover, they identified some variation in this effect by family structure – with children from guardian families (but not from other family types) actually benefiting from grandparent in the household.

So, as summarized by Denham and Smith (1989), „[i]n any event, it is obvious that the influence of grandparents upon grandchildren depends upon a variety of individual, family, and cultural factors“ (p. 348).

3. Linking family size and coresidence effects

Both family size effects and coresidence effects appear to be context dependent. The contexts that matter may be identified both at the family level and at the societal level. In this paper we link the literature on sibship size and coresidence with grandparents into one analytical context and study how the effect of sibship size on reading test scores may depend on coresidence, and how this correlation may change with socioeconomic development.

We argue that coresidence with grandparents may be used as an explicit indicator of how the family works and is organized. Grandparental coresidence in less developed societies is likely to have positive consequences for the child's school outcomes and is likely to alleviate some potentially negative consequences of the lack of resources in the family (such as low socioeconomic status, or larger family size). At higher levels industrialization, coresidence is likely to indicate social dislocation and hence would have negative effects on children. Furthermore, the negative impact of coresidence is likely to be larger if combined with other disadvantages such as larger sibship or low SES.

So, overall, the (main) effect of coresidence is likely to turn from positive to negative with increasing development. Similarly, a protective effect of coresidence (against lack of resources) is likely to change to detrimental with increasing development. Since our analysis work with the PISA 2000 data, i.e. with data from relatively advanced societies, the analysis does not cover the entire possible range of development and our data may not capture a full variation of main effects and interactions of coresidence.

4. Data and variables

We use data from the first wave of OECD "Programme for International Student Assessment" (PISA 2000). PISA "is a collaborative effort among OECD Member countries to measure how well 15-year-old young adults approaching the end of compulsory schooling are prepared to meet the challenges of today's knowledge societies" (Adams, Wu, 2002: 15). PISA assesses reading, mathematical, and scientific literacy while also collecting additional school- and student-level information. In the course of data collection, several questionnaires are used. Data from these questionnaires can then be found in separate datasets. Although there are more recent versions of the data available (collected in 2003, 2006, and 2009) the 2000 dataset contains richer information on the composition of a student's household (namely information about siblings and co-residence with grandparents).

PISA 2000 was primarily aimed at reading literacy (Adams, Wu, 2002) of children born between 1983 and 1987; reading literacy being defined as "the ability to understand, use, and reflect on written texts in order to achieve one' goals, to develop one's knowledge and potential, and to participate effectively in society" (OECD 2001 in Park 2005). What is being measured is an individual student's ability to retrieve, interpret, reflect and evaluate information (OECD 2001). PISA 2000 used several questionnaires (student, school, computer familiarity, cross-curricular competencies questionnaire). In our analysis we are working with dataset from the *student questionnaire,* which (apart from the literacy variables) contains information about siblings, structure of student's family and about education and occupation of student's parents.

The PISA 2000 dataset contains information about 43 countries (in 2000 data were collected in 32 countries – 28 OECD and 4 non-OECD countries; the rest was collected in 2002). The data collection was done in a way that allows international comparison (Adams, Wu 2002). In

our analysis we decided to exclude the following countries: Japan, Netherlands and Lichtenstein, the reason being missing variables of parental education in Japan, extremely low school-participation rate in Netherlands (for more see [Adams and Wu 2002: 186]) and small number of observations in Lichtenstein. This means that we are working with total count of 40 countries.[1]

The dependent variable used here is reading literacy test score. Instead of single value (test score reached by an individual student), however, PISA reports five plausible values. This is the recommended way to deal with test scores from student studies such as PISA or TIMSS (Carstens, Hastedt 2010; Wu 2004). "The plausible values represent a set of random values for each selected student at random from an estimated ability distribution of students with similar item response patterns and background. They are intended to provide good estimates of parameters of student populations (for example, country mean scores), rather than estimates of individual student proficiency" (OECD 2002: 22). We used STATA multiple imputation package to work with plausible values.

In the student questionnaire, students were asked "How many brothers and sisters do you have?". In their answer they were to report number of younger, older, and same-age siblings by ticking the relevant box (ranging from "none" to "four or more"). The final count of siblings of any age was then combined into the variable of number of siblings. However, it is not clear whether these siblings are biological only or biological and step-siblings. The original variable of number of siblings ranged from 0 to 12 siblings. We recoded this variable

[1] The dataset in the .txt format together with corresponding control file is freely downloadable from the PISA website (http://pisa2000.acer.edu.au/downloads.php). Using the control file it is then transferred into SAS or SPSS file. Since we wanted to analyse the data using Stata, we transferred the .sav file into .dta file using user written command "usespss" to open and command "save ___.dta" to save the dataset as Stata file. This transformation changed coding of missing values from 8, 9, 7 in SPSS to .a, .b, .c in Stata.

to range from 0 to 8 (8 meaning eight and more siblings) to avoid bias due to outliers. Table 1 presents the average number of siblings in the analytical sample (for its definition, see below), which is 1.9. Several country means fall below the average, with the lowest values recorded in Bulgaria (1.0), Italy (1.3), Korea (1.3). The highest number of siblings is in Peru (3.0), Indonesia (2.9), Israel (2.9), and Mexico (2.9; see Table 2).

Students were also asked "Who usually lives at home with you". They were given eight possible yes or no items. One of these items related to grandparent(s). Based on the data we are able to assess whether the student lives in a household with a grandparent(s) but not with how many. There was quite a large number of students whose answer to this question was coded as a missing value. At first we wanted to keep this "non-response" as additional category of the co-residency variable, at the end we however decided to remove all of the missing observations. The grandparental co-residence is therefore measured by a dichotomous variable with category 1 standing for the incidence of shared household with a grandparent(s) and 0 for living in household without grandparent(s). Overall, about 20 % of students in the analytical sample coreside with their grandparent. Coresidence is somewhat less common (approx. 14 %) in families with one biological parent and one step-parent, while about 20 % os students in two-biological parent and single-parent families coreside with their grandparents (see Table 1). About 2 % of students coreside in Finland, 4 % in Iceland and Sweeden. At the other extreme, we find 50 % coresiding students in Bulgaria, 48 % in Indonesia and Thailand (see Table 3).

We also used student questionnaire data on household composition to differentiate 3 types of parental situations: student lives with (1) two biological parents, (2) one biological single parent, (3) one biological parent and his/her opposite sex partner who is not biologically

related to the child. We excluded no-parent families from the analysis.[2] Hence, we only analyze three-generational households, i.e. households comprising of child(ren), parent(s), and grandparent(s). In our sample, about 80 % of students lived with both biological parents, 13 % with a single parent and about 7 % with a biological parent and a step-parent. The share of students living in intact families ranges from the low of 65 % in the USA and 69 % in Latvia to the high of 94 % in Macedonia, 93 % in Korea and Indonesia. The percentage living with a single parent is between 4 % in Indonesia, 5 % in Macedonia and Korea and 20 % in Latvia, 19 % in Chile, and 18 % in the USA, Russia, New Zealand, and Brazil (see Table 2).

Parental education is measured using ISCED categories (we use categories 2 to 6, since there very only few cases in category 1). We use the higher of mother's and father's education. We dichotomize this ordinal variable before entering it into the models, hence the models contain 4 education dummies. Parental occupation was measured with an open ended question about parents' main job. The answer was coded using ISCO codes and then transformed into ISEI. Again, we use the higher of both parents' ISEI (variable "HISEI" provided in the original PISA 2000 dataset). The average ISEI in the analytical sample is 48 (see Table 1), with national averages ranging from 35 in Thailand to 56 in Israel (see Table 2).

We also control for respondents' gender in the analysis (coded 1-male, 0-female). There are 51 % of girls in the analytical sample (see Table 1). The proportion ranges from 43 % in Korea to 60 % in Thailand (see Table 2).

[2] Given our research goals, three-generation households are perhaps of more interest, since these appear to be both a better indicator of the functioning of each specific family and an indicator of the organization of the family system at the societal level. Hence, we only differentiate two-parent, single-parent, one parent and step-parent families. We omit no-parent families from the analysis entirely.

We use one macro-level indicator of the level of development/modernization of each individual country. Modernization has been understood as movement towards democracy, national and welfare state, and higher levels of education, equality, industrialization, social mobility, wealth, general social tolerance, individualism, secularism (Divale and Seda 2000; Ciftci 2010; Marks 2009) and towards nuclear family (Popenoe 1987). It has often been measured using countries' GDP, however some authors pointed out that alternative measures should be used instead (Eurostat 2010; Afsa et al. 2008; UNDP 1990). One of these suggested alternatives is Human Development Index (HDI), measure of both economic and social development, which combines measures of health (life expectancy at birth), education (mean years of schooling of adults above 25 and expected years of schooling of children bellow 7), and living standard (GNI per capita, PPP $) (Human development report, N.d; UNDP 1990); "health and educational achievement [being] regarded as two major ingredients of development and progress" (Afsa et al. 2008: 13). The HDI ranges from 0 to 1 – with countries closer to one considered to be more developed (Human development report, N.d).

The HDI values for our countries were taken from the Human Development Reports website (http://hdrstats.undp.org/en/indicators/103106.html). These are year 2000 values ranging from 0.543 in Indonesia to 0.913 in Norway. For the purposes of our analysis we categorized the HDI into four categories using the values of 25th 50th and 75th percentile (0.7405; 0.8275; 0.8635). There were ten countries in each category.

Not all of the students answered all of the questions. Those whose answers were coded as any type of missing value (those who did not report their sex, number of siblings, parental education or occupation, co-residence with grandparents) were dropped from the analysis. This, combined with dropping the data from Japan, Netherlands and Lichtenstein gave us final count of 151377 observations (originally the dataset comprised of 228784 observations).

5. Method

Since the dependent variable is a test score, i.e. a numeric variable, regression analysis seems to be an appropriate analytical tool. Yet, one has to deal with the nested data structure that includes schools nested within countries and students nested within schools. It would be unreasonable to assume that students selected from one school are independent observations. Similarly, one shall not make the assumption of independence in the case of two schools selected within one country. We decided to use three-level hierarchical linear models to account for the clustered structure of the data. We estimated the models using STATA's "xtmixed" command.

6. Results

We present results of one three-level model of determinants of reading test scores in Table 4. The model contains as explanatory variables all main effects as well as a three-level interaction between sibship size, coresidence with grandparents and HDI (the model also contains all lower level terms required by the marginality principle).

The estimated main effects of the model are not surprising. Boys score about 24 point lower on the test scale than girls. Students from intact families perform better than students from single-parent or step-parent family environments. The mean net difference between a student from a two-parent and a single-parent family is -2.72 and between two-parent a step-parent family -4.86 (all these effects are highly statistically significant (p-values are lower than 0.0005).

The model also indicates strong positive and significant effects of parental education level on test scores. For instance, a student whose parents have university education is expected to

score 21 point higher on the reading test than a student whose parents have only primary education, net of other variables in the model. Similarly, parental occupational status has a strong positive effect on reading literacy. Each additional point on the ISEI scale increases, net of other factors, expected test score by 0.81 points. Hence, the expected net difference between a child of a secondary school teacher (ISEI = 71) and a farm worker (ISEI-16) in the reading literacy test is approx. 45 points (0.81*(71-16) = 44.55).

The main effect of coresidence appears to be negative in Table 4, but it is hardly meaningfully interpretable, since it refers to the expected test scores for students whose scores on all other covariates is 0. This is not a very meaningful number, then, since the ISEI scale range does not include zeros.

The main effect of the number of siblings is -2.68 indicating, that at the lowest level of development and for students not coresiding with their grandparents, each additional singling tends to decrease their test scores on average by 2.68 points. The negative effect of the number of siblings (among students who are not coresiding) tends to increase. In the second quartile of HDI it is -2.76, in the third quartile it is -3.52 and in the highest quartile it grows to -4.05 (see Table 4 for the respective interaction terms that produce these point estimates).

The slope associated with the number of siblings does not differ by grandparental coresidence at the lowest end of the HDI scale in our data. Among coresiding students, each additional sibling reduces, on average, their reading literacy test scores by 2.76 points, which by no means is different from 2,68 among the students that do not coreside.

Yet, as we move up the HDI scale, the differences in the slope associated with the number of siblings diverges between coresiding and non-coresiding students. This increase is visualized in Figure 1. Clearly, the difference between the two slopes increases with development. While it is 0.08 in the first quartile of HDI, it grows to 2.35 in the second quartile, 3,18 in the third

quartile, and 3.38 in the highest quartile of HDI. Among the most advanced nations, each additional singling decreased the expected test reading score by 4.05 points if there is no grandparent in the household and by 7.43 if a grandparent coresides with the student (see Figure 1).

7. Conclusions

We have documented that the effect of the number of siblings on reading test scores among 15-year olds in a sample of over 40 countries vary systematically with grandparental coresidence and with the level of social development as measured by the Human development index. The negative effect of family size was relatively modest and did not differ by coresidence in the least developed nations in our sample. Yet, at higher levels of HDI, the estimated net effects of family size tend to be more negative. The increase of the effect was greater among students that coresided with grandparents and relatively less (but still significant) among students that lived separately from their grandparents.

Our finding, then, do not fully confirm our initial hypotheses that grandparental coresidence would protect students from the negative effects of resource scarcity - produced for instance by larger sibship size – at lower levels of social development. Yet, it is possible that coresidence with grandparents indeed has this protective effect, but only at much lower levels of development. Our analysis was based on sample of relatively advanced societies that included OED countries and a handful of other, relatively advanced nations. The lowest value of the Human development index in our sample was 0.543 in Indonesia, with the average value being 0.802; i.e. it is possible that our data did not sufficiently represent contexts where the anticipated protective effect would play out fully.

Table 1. Descriptive statistics of variables used in the analysis. PISA 2000, selected countries. Number of cases N=151377.

Sex (proportion of girls)	50.7 %
Parental HISEI (mean)	47.9 (median 49)
Education of educated parent (mode)	Isced 5
Number of siblings (mean)	1.9
Family structure (proportion):	
Two biological parents	80.3 %
Single biological parent	13 %
One biological parent and their partner	6.8 %
Co-resident grandparent(s) (proportion)	19.8 %
Co-residence by parental situation	
intact families	20.3 %
single parent families	19.7 %
single parent and partner families	13.6 %
HDI in year 2000 (mean)	0.802 (median 0.833)

Table 2. Descriptive statistics of variables used in the analysis by country. PISA 2000, selected countries. Number of cases N=151377.

country	Sex (% of girls)	Parental HISEI (mean)	Parental ISCED (mean)	Number of siblings (mean)	HDI (year 2000)	N
Albania	54.1	46.2	5	2.0	0.691	3967
Argentina	51.4	45.2	4	2.6	0.749	2546
Australia	49	52.8	5	2.0	0.906	4650
Austria	51	49.5	4	1.6	0.839	3406
Belgium	49.8	50.2	5	1.7	0.876	4943
Brazil	51	42.9	4	2.4	0.665	3446
Bulgaria	48.4	49.8	5	1.0	0.715	3056
Canada	48	51.4	5	1.9	0.879	18811
Chile	54.3	40.8	5	2.2	0.749	3500
Czech Republic	53.8	49	5	1.5	0.816	4539
Denmark	49.7	50.3	5	1.9	0.861	3099
Finland	52.2	50.6	5	2.0	0.837	4355
France	51	48.6	5	1.8	0.846	2986
Germany	51.7	50.4	5	1.5	0.864	4232
Greece	48.7	47.5	5	1.4	0.802	2749
Hong Kong	49.2	42.5	4	1.5	0.824	3331
Hungary	49.9	49.7	5	1.4	0.775	3944
Iceland	49.7	53	5	2.5	0.863	2482
Indonesia	53.3	35.9	3	2.9	0.543	4664
Ireland	51.6	49	5	2.6	0.869	1796
Israel	57.8	56.1	5	2.9	0.856	2712
Italy	51.4	47.3	4	1.3	0.825	3720
Korea, Republic of	43.4	42.2	5	1.3	0.830	2840
Latvia	51.8	50.8	5	1.6	0.732	3086
Luxembourg	49.8	45.9	4	1.6	0.854	2358
Mexico	49.2	43.2	4	2.9	0.718	3231
New Zealand	50.5	53.2	5	2.2	0.878	2299
Norway	49.2	54.7	5	2.0	0.913	2404
Peru	51.3	41.4	4	3.0	0.674	3634
Poland	49.4	45.1	5	1.8	0.770	2959
Portugal	52.3	44.3	4	1.4	0.778	2638
Romania	55	47.5	5	1.4	0.704	3357
Russian Federation	50.4	49.7	5	1.7	0.691	4441
Spain	51.1	44.9	4	1.4	0.839	4220
Sweden	45.5	50.7	5	2.2	0.894	2629
Switzerland	49.9	49.2	5	1.6	0.873	4389
Thailand	59.5	34.6	3	2.1	0.626	3801
Macedonia	48.2	47.1	5	1.4	0.772	3089
UK	50.3	51.4	5	2.0	0.833	4682
USA	55.6	52.2	5	2.4	0.897	2386
Average/ total	50.7	47.9	5	1.9	0.802	151 377

Table 3. Family composition and co-residence with grandparents by country, PISA 2000. Analytical sample only.

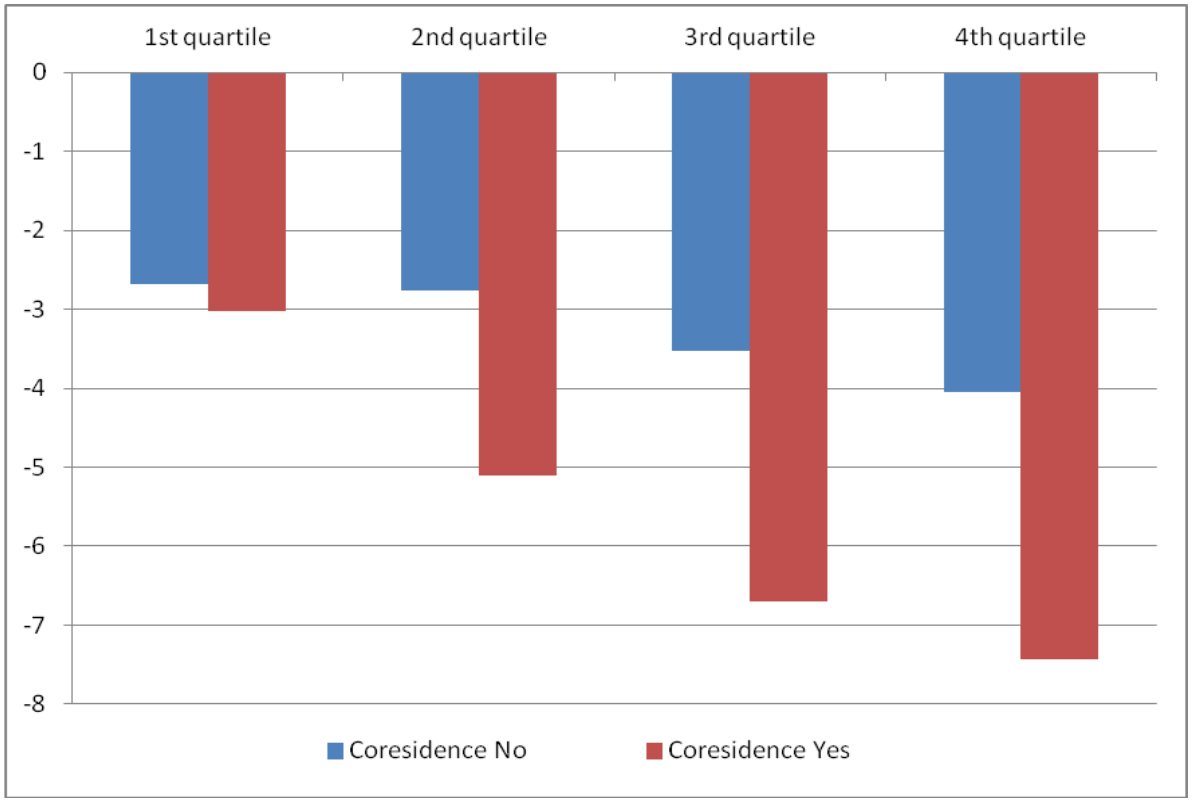
country	Nuclear family (%)	Single parent family (%)	Parent and partner family (%)	Co-residence (%)	Intact family with co-res* (%)	Single parent family with co-res* (%)	Parent and partner family w co-res* (%)	N
Albania	91.7	7.4	0.9	32.2	32.5	29.0	30.6	3967
Argentina	76.7	14.5	5.9	29.0	28.4	33.7	22.3	2546
Australia	74.5	16.0	9.5	5.3	5.3	5.9	4.3	4650
Austria	80.1	12.9	7.1	25.0	26.8	17.6	17.1	3406
Belgium	79.9	11.5	8.7	6.7	6.5	7.8	7.0	4943
Brazil	73.3	18.1	8.6	26.2	25.4	30.1	24.6	3446
Bulgaria	85.5	12.2	2.3	50.3	50.0	53.8	41.4	3056
Canada	76.3	13.7	10.0	9.5	9.5	10.1	8.3	18811
Chile	71.4	19.2	9.4	22.0	17.9	37.0	22.8	3500
Czech Republic	79.8	10.6	9.6	19.1	20.1	17.0	12.4	4539
Denmark	75.5	13.9	10.5	4.5	4.8	3.9	3.4	3099
Finland	76.4	16.6	7.1	2.4	2.7	1.7	0.7	4355
France	76.6	14.4	9.1	7.4	6.8	10.5	7.4	2986
Germany	77.8	14.6	7.7	19.7	21.4	15.6	10.8	4232
Greece	92.1	6.3	1.5	24.4	23.7	35.1	23.8	2749
Hong Kong	89.7	8.9	1.4	12.6	12.1	15.8	28.9	3331
Hungary	76.5	15.6	7.9	13.4	13.2	16.6	9.0	3944
Iceland	73.2	13.3	13.5	3.8	3.4	6.1	3.3	2482
Indonesia	92.8	4.3	2.9	48.2	48.1	45.0	56.6	4664
Ireland	87.4	10.1	2.5	10.9	10.9	11.5	9.1	1796
Israel	89.9	8.0	2.0	14.3	14.1	18.4	9.1	2712
Italy	84.0	14.0	2.0	32.0	33.3	26.3	19.2	3720
Korea, Republic of	92.8	5.9	1.3	27.9	27.8	30.5	21.1	2840
Latvia	68.5	20.0	11.6	30.8	29.8	34.6	29.7	3086
Luxembourg	83.0	9.2	7.9	16.2	16.8	13.4	14.1	2358
Mexico	82.6	13.8	3.6	28.6	27.5	34.7	31.9	3231
New Zealand	70.9	18.8	10.4	6.4	6.3	7.2	5.4	2299
Norway	77.0	12.9	10.1	9.3	9.3	10.0	8.3	2404
Peru	79.1	17.6	3.4	21.8	20.6	25.2	32.0	3634
Poland	89.2	8.1	2.8	18.9	18.8	21.8	13.6	2959
Portugal	84.3	10.6	5.1	25.3	24.8	30.7	22.2	2638
Romania	86.2	10.1	3.7	31.4	31.1	32.9	33.9	3357
Russian Federation	73.8	18.2	8.1	32.7	31.7	39.4	27.1	4441
Spain	86.7	11.6	1.7	26.2	26.5	25.4	20.6	4220
Sweden	72.2	17.3	10.5	3.7	3.6	4.0	4.0	2629
Switzerland	80.5	13.1	6.4	11.7	12.7	7.0	8.5	4389
Thailand	85.7	10.4	4.0	48.0	48.0	46.5	52.7	3801
Macedonia	93.8	5.4	0.8	46.6	46.6	47.6	34.6	3089
UK	76.1	14.3	9.7	6.9	7.1	6.9	4.9	4682
USA	64.9	18.3	16.9	16.2	17.2	15.4	13.2	2386
Average	80.3	13.0	6.8	19.8	20.3	19.7	13.6	151 377

*proportion of the household type with co-resident grandparent(s).

Table 4. Estimated parameters of a three-level hierarchical linear model of reading literacy. PISA 2000 (N=151377).

	Model 1
Sex (male)	-24.58 (0.42)
Family structure (intact as ref. cat)	
Single parent	-2.72 (0.60)
Parent and partner	-4.86 (0.81)
Education (ISCED 2 or lower is reference)	
Isced 3	3.78 (0.90)
Isced 4	15.71 (0.95)
Isced 5	19.26 (0.89)
Isced 6	21.18 (0.98)
Parental status of occupation (HISEI)	0.81 (0.02)
Co-residence with grandparent(s)	-12.40 (1.39)
Sibship size	-2.68 (0.35)
HDI (1st category as ref. cat)	
HDI_2	47.56 (15.52)
HDI_3	89.36 (15.54)
HDI_4	102.99 (15.51)
Interactions	
Sibship size*co-residence	-0.34 (0.53)
HDI_2*co-residence	7.14 (2.26)
HDI_3*co-residence	3.16 (2.56)
HDI_4*co-residence	-12.30 (2.57)
HDI_2*sibship size	-0.08 (0.56)
HDI_3*sibship size	-0.84 (0.55)
HDI_4*sibship size	-1.37 (0.48)
HDI_2*sibship size*co-residence	-2.35 (0.98)
HDI_3*sibship size*co-residence	-3.18 (1.12)
HDI_4*sibship size*co-residence	-3.38 (1.02)
_cons	382.24 (11.0)

Figure 1: estimated net effects the number of sibling on reading test scores by quartiles of the Human development index and coresidence with grandparents. PISA 2000, N=151377.



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