Single-Parent Family Forms and Children's Educational Performance in a Cross-Comparative Perspective: Effects of School's Share of Single-Parent Families

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ABSTRACT

Living in a single-parent family negatively affects children's educational performance compared to living with two biological parents, mainly due to a lack of the amount of family's financial, parental and social resources. In this paper, we aim to find out to what extent both characteristics of schools and countries, i.e. the share of single-parent families, affect this negative relationship. We use pooled data from the Organization for Economic Co-operation and Development (OECD), i.e. the Programme for International Student Assessment (PISA) 2000 and 2003, which contain information on 217,180 students at 12,169 schools in 26 countries. We found that attending a school with more children from single-parent families affects the educational performance of all children negatively, but attending such schools particularly harms children from single-mother families. Also in countries in which the number of single-parent families is higher, children living with only a mother perform worse at school.

INTRODUCTION

Families fulfill an important function in every society: most of the children in developed countries grow up in a family, although the form of that family might change during the life course. Generally, a family provides a child with opportunities to develop into a stable and independent person, for instance through enabling the child to attend school. The future success of children thus greatly depends on the household they grow up in. Nevertheless, a child is not in the position to choose its own family and has to accept if its family is not capable of offering him or her the best opportunities.

Traditionally, the word 'family' referred to a married couple with one or more children. Within this family, father usually had to work to earn his bread, while mother stayed at home to run the household and to take care of the children. This portrait of a family, also referred to as the traditional male breadwinner model (McDonald 1997; Lewis 2001), prevailed during the 1950s. At that time it was very common for young people to marry early and to have many children quickly (Martin and Kats 2003). Moreover, people hardly ever divorced, cohabitated or had children outside marriage. As a result, single parenthood was quite rare and in most cases it followed after the death of one of both biological parents. Although nowadays many households in many societies still fit the description of the male-breadwinner female-homemaker family (apart from, for instance, the US), family structures have changed enormously during the later decades of the 20th century with the introduction of some new single-parent family forms (Martin and Kats 2003). To a large extent, this change comes down to the fact that the universal two-parent families have made way for more single-parent families.

This trend in family structures coincides with changes in other demographic aspects that occurred from the 1960s until the late 1980s in developed countries: i.e. fertility rates dropped off, marriage rates decreased, and both divorce rates and the number of births to unmarried women increased (Sorrentino 1990; Lesthaeghe 1994). Together, these demographic trends are also known as the 'Second Demographic Transition' and they directly contributed to the rise of new single-parent family forms, especially to the rise of single-parent families. This implies not only a growing number of mother-headed households, but also that more and more father-headed families exist nowadays.

As a result of the growing number of divorces, decreasing marriage rates and increasing number of births outside marriage, every year many children are confronted with the negative effects of single-parenthood, such as economic deprivation, a decrease in the quality and quantity of parental contact and a decline in parental support and effective control (Amato and Keith 1991; Amato 2000). Not only divorce itself and the period following it have negative consequences for children, but already prior to the divorce such families are often characterized by a smaller amount of financial resources and more conflicts (Fischer 2007).

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Obviously, this has a detrimental effect on children's well-being and development, and, accordingly, on their performance at school. Previous research has already shown that children's educational achievement is negatively affected by parental divorce (Dronkers 1994, 1999; McLanahan & Sandefur 1994). Although there might be heterogeneity between parents who divorce and parents who do not divorce, which might partly explain the negative effect on educational performance of the involved children, there is no empirical evidence of such spurious effect of this heterogeneity (Frisco, Muller & Frank 2007). In brief, this effect comes down to the fact that the loss of one parent from the family, which can be interpreted as a decrease in the number of family's financial, parental and social resources leads to a deterioration of children's educational achievement. However, most of prior research has solely concentrated on the family context when studying the consequences of divorce. In addition, most of this research has focused on just one country.

In this paper, we study the effect of the single-parent family composition of schools on the educational performance of children from single-parent and two-parent families. This research aims to improve on previous studies by investigating the effect of share of single-parent families at school from a comparative perspective: i.e. in 26 OECD countries we study both the cross-national variation in the effect of single-parent family school's composition and the cross-national variation in the relationship between single-parent family forms and children's educational performance. The research question that we address is the following: *to what extent exists in all 26 OECD countries the same relation between single-parent family composition of schools and educational performance of children from single-parent and two-parent families, or does it vary by country, especially the country's share of single-parent families and income inequality?*

We start by examining how the negative effect of living in a single-parent family varies across schools. Even though a child lives with his family and hence spends a lot of time with his or her parents, a child also spends a large part of the day at school. As a result, the child will also be affected by school characteristics, like the school's composition of teachers and students. Previous research showed that the number of children with single parents at school negatively influences the achievement of its pupils (Pong 1998). This effect was partly explained in terms of the school's socio-economic status and social capital in the form of parental involvement. To make sure that the negative effect of school's share of single-parent families is not in fact a country effect, we control for several macro characteristics.

In addition to studying variation between schools, controlled for country level effects, we expect the effects of living in a single-parent family and school's share of single-parent families on children's educational performance to vary across countries. The number of studies that adopted a cross-national approach is scarce. From the few studies that have actually done this (Pong, Dronkers and Hampden-Thompson 2003; Garib, Martin Garcia and Dronkers 2007), it appeared that the effect of single-parenthood varies between countries. For

instance, these studies found that the achievement gap between children from single- and two-parent families is greater in countries that are characterized by more single-parent families.

To answer our research question, we pooled data from 26 industrialized countries on students' educational performance, as collected by the Organisation for Economic Co-operation and Development (OECD), i.e. the Programme for International Student Assessment (PISA) 2000 and 2003.[i] Analyzing the effect of single-parent family form on children's educational performance using this large-scale survey is unique and the considerable cross-national variation offers the opportunity to include important country-level characteristics in the analysis. Through cross-level interactions between single-parent family form and characteristics at the school and country level, we can investigate the variation across schools and countries in the effect of single-parent family form on children's educational performance. Our multilevel research design hence includes three levels, i.e. the student, school and country level, and, in this manner adopts a more comprehensive approach than previous studies did. In addition to the methodological progress that we achieve by using this research design, our approach is of societal relevance as we investigate how certain contexts (i.e. school and country) make the impact of living in a single-parent family on educational performance less or more severe.

THEORETICAL FRAMEWORK AND HYPOTHESES

Family Form and Educational Success

In order to adequately examine how the negative consequences of living in a single-parent family are affected by the school one attend and/or the country one lives in, we first shortly elaborate on the reason why children from single-parent families perform worse at school than children from two-parent families. McLanahan and Sandefur (1994) give an extensive description of the three types of resources (i.e. financial, parental and social) that are important in explaining the impact of living with a single parent on children's chances of future success. First of all, they underline the importance of financial resources and the loss of income that generally goes together with family disruption. In short, this is due to the fact that after a divorce two households need to be supported instead of only one and thus a lot of household expenses cannot be shared any longer, which is also called a loss of economies of scale. The most direct effect of this loss of income on educational performance of children is the fact that the quality of the school they attend generally is lower. The higher the income of parents, the more possibilities they have to live in neighborhoods with good public schools or to send their children to a private school of their preference. Income can also affect school outcomes through enabling a child to participate in extracurricular activities, like lessons after

school, special trips or summer camps. Such activities improve children's skills directly, but also indirectly via general intellectual stimulation, which affects subsequent learning.

Not only a loss of financial resources, but also a loss of parental involvement is generally associated with a divorce or separation. Parental involvement is supposed to positively affect children's educational outcomes (Park, Byun and Kim 2011). It mainly comprehends the time parents spend with their children on reading, helping with their homework, or by listening to the stories about their experiences at school, as well as the ability and willingness of parents to monitor and supervise children's social activities outside school, which reduces their opportunities to get in trouble. In addition, it refers to activities in relation to schools such as volunteering at school events, attending a parent–teacher organization, or contacting teachers and school officials (Park et al. 2011). After a divorce or separation, the quality and quantity of parental involvement decreases. For instance, the remaining parent is likely to experience high levels of stress and anxiety after the disruption. Also, single parents have to divide their time between work and home, and consequently can devote less time to their children compared to a situation in which two parents run a household. Moreover, single parents are not controlled and corrected in 'parenting' by a partner, which makes it less sure whether the remaining parent is behaving in appropriate ways. As a result of the loss of parental involvement, children from single-parent families will perform worse at school than children from two-parent families.

Finally, children from divorced or separated parents may experience a loss of social resources, more specifically, a loss of community resources (McLanahan and Sandefur 1994). This represents two things: first, it implies the fact that single-parent families are restricted to live in neighborhoods where the level of resources is lower, as a result of their reduced income. Second, it involves the fact that the connection of children to the community they are living in reduces after a divorce or separation. Strong community connections provide a child with social capital in the form of emotional support and information about the broader community. However, a divorce or separation often involves moving from one town to another or from one neighborhood to the other, which undermines or destroys the community ties. Even when a family does not move after a divorce, single parents may not find the time or energy to keep investing in personal relationships, because of stress or depression, and, consequently, lose friends without making new ones. As a result, single parents for instance have less information about which teachers are good and which are not, and they are less familiar with extracurricular activities, which might negatively influence children's educational performance.

Single-Parent Family School Composition Effects and Educational Success
The rise in the number of single-parent families in the last decades of the previous century implies that a growing number of children attends schools where a large part or even the

majority of the students lives in a single-parent family or stepfamily. In the literature, two explanations can be distinguished for the effect of school's single-parent family composition on children's educational performance: i.e. the decline of the community network of the school and the lower amount of teaching and learning time at school and at home.

According to Pong (1997) and Sun (1999) parental influence on children extends beyond their own child and reaches the communities in which they live and the schools belonging to these communities. As previous research has shown, the type of student attending the school appears to be one of the most important factors influencing the effectiveness of the school (Pong 1997; Pong 1998). Schools with a large concentration of children from single-parent families are usually characterized by a lower socioeconomic status and by less social capital (i.e. indicated by parents' social relations and networks with other parents). Therefore, all children attending such schools will perform less well, compared to children at schools with a smaller concentration of single-parent families.

In addition to this community network explanation for the negative contextual effect of family disruption on children's educational performance, Dronkers (2010) emphasizes the more difficult teaching and learning conditions in schools with a high proportion of pupils from single-parent families. The effectiveness of education depends on the amount of time that is available for both teaching and learning, which can be greatly diminished in schools where children have problems inside or outside the home that interrupt the teaching and learning process. Children of divorced parents have on average more emotional and other problems related to their parents' divorce (due to a lack of parental time and energy devoted to the socialization of the children, because the divorce and its often long-lasting after march requires that time and energy). If there are more pupils in a class with such problems related to their parental divorce, more learning and teaching time of the whole class will be used for non-academic goals and less learning and teaching time than necessary to reach a certain educational performance will remain. Conversely, in student populations with none or few children from single-parent families, there is less loss of teaching and learning time and thus a higher chance on sufficient time. In fact, the real learning and teaching time differs in these two situations, despite identical class schedules, and thus educational performance will differ between both situations.

Both lines of arguments lead to the hypothesis that *children from schools with a large concentration of students from single-parent families will perform less well than children from schools with a small concentration of students from single-parent families* (H1).

As shortly described above, Pong (1997) argues that the negative effect of the school's composition of children from single-parent families on academic achievement can be (partly) explained by the fact that schools predominantly attended by students from single-parent families are, on average, likely to be characterized by a lower socio-economic status. This is because single-parent families are usually poorer than two-parent families, but they also more

often live in neighborhoods with a low socioeconomic status, where schools are poorly financed and have fewer physical resources for learning, such as computers, which negatively effects students' educational performance (Pong 1997). So, according to this explanation, *the negative effect of the school's share of single-parent families on children's educational performance can be explained by the lower socio-economic composition of such schools* (H2). In contrast, the lower teaching and learning time explanation would assume that the socioeconomic composition of the school would hardly explain the effect of the single-parent's share in schools.

Schools with a higher share of single-parent families may have less educational resources and may be often situated in neighborhoods or districts with a low socioeconomic status, where in some countries (like the US) schools are poorly financed and have fewer physical resources for learning (Pong 1997). However, also in countries with equal funding of schools, irrespective of their neighborhood or district, it can be expected that teachers and administrators in such school environments have lower morale and are likely to hold lower expectations for the students. These schools will also have more problems in hiring qualified teachers. So, the next hypothesis is that *the negative effect of the school's share of single-parent families on children's educational performance can be explained by the lack of resources of such schools, like qualified teachers and less teachers pro student* (H3).

Pupils with fewer resources at home are more vulnerable for a lack of education or deficits in schooling. *[Zomerkamp effect aanhalen]* This leads to the first weak version of the fourth hypothesis*: the negative effect of the school's share of single-parent families on children's educational performance is larger for children from single-parent families than for children from two parent families* (H4a). The second stronger version of this hypothesis assumes that *the negative effect of the school's share of single-parent families on children's educational performance is absent for children from two parent families* (H4b).

Country Variations in the Relationship between Single-Parent Family Form and Educational Success

Previous research has often focused on the relationship between single-parent family form and children's educational performance within single countries. However, quite recently researchers have started to acknowledge that single parenthood has different implications in varying countries and this might subsequently result in cross-national differences in the consequences of single-parenthood (Pong, Dronkers & Hampden-Thompson 2003).

In this paper we will control our results for three possible macro features of societies: the share of single-parent families in a society, the income inequality and the gross national product per capita of a country. These macro characteristics might be related with the school's single-parent family share. Our purpose with the inclusion of these controls is to make sure that these macro-features are not responsible for the negative effect of school's single-parent

share and the negative effect of single-parent family forms on educational performance of children.

A very common idea, however, is that the negative effects of single-parent family forms on involved children are less strong in societies where non-traditional family forms are more common, because single-parent families will be less stigmatized by a hostile environment and the children experience the divorce or separation of their parents as a normal event. This leads to the hypothesis that *the negative effect of growing up in a single-parent family on children's educational performance will be less strong in societies with higher shares of single-parent family forms* (H5).

The same might hold for schools as they gain experience in handling parental divorce effects among their pupils. This leads to the sixth parallel hypothesis: *the negative effect of school's share of single-parent families on children's educational performance will be less strong in societies with higher shares of single-parent family forms* (H6).

METHODS

Data

For the test of our hypotheses, we make use of data from the Programme for International Student Assessment (PISA). PISA is a collaborative effort among countries that are member of the Organisation for Economic Co-Operation and Development (OECD) and it assesses how far students near the end of compulsory education (at age 15) have acquired some of the knowledge and skills that are essential for full participation in society (OECD 2002). Therefore, the main purpose of PISA is not to measure the extent to which students have mastered a specific school curriculum, but rather to examine to what degree they are able to apply their knowledge and skills to meet challenges in real life. The PISA survey was first conducted in 2000 and is repeated every three years. In this paper, we use pooled PISA data of 2000 and 2003. Each school in each wave is treated as a different school, although there might be some unknown overlap.

Although it is known from PISA in what type of family a child lives in, a disadvantage is that it lacks information about the cause of single parenthood or guardianship of one the parents. There might be three reasons for growing up in a single-parent family (with or without a guardian): first, divorce or separation; second, birth out of wedlock without a following marriage or cohabitation; and third, death of one of the parents. In most developed countries divorce or separation is the most common reason for single parenthood for 15-year old children, as their parents are mostly still too young to die: most women give birth before the age of 40, which makes that the oldest mother of a 15-year old pupil is 55 years old. In most developed countries the age of 55 is still below the average age of death of female adults. Men can be older when they become father (again), but in most cases they will not be

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older than 55, which makes that they are 70 when their youngest child is 15 years old. Although this comes closer to the average age of death of male adults, 70 years is still below that age. Because most theories about the negative effect of single parenthood relate to divorce and birth out of wedlock, we will select only those countries from the PISA data, in which the divorce rate with children is substantial and the average death age of adults is not too close to 55 or 70. For that reason, we have to exclude all Latin-American countries, which participated in the 2000 and 2003 PISA waves, as their average ages of death of adults come too close to these upper limits. Figure 1 provides information on the percentages children involved in divorce or separation (OECD 2008). A very low percentage of children involved in divorce and marriage is another reason to exclude that country from our analysis, even though it participated in PISA.

There is also an important advantage of the measurement of family form in PISA. Pupils were asked with whom they regularly lived at home, and they were offered a number of possible persons, whom they could all tick.[ii] The advantage of this question is that the real family form in the eye of the pupils is measured instead of the formal situation, as reported by interested parents or authorities. Parents who separated after cohabitation (instead of marriage) before the child reaches the age of 15 are measured in the same way as formally divorced parents. This feature is especially relevant for the north-western European countries with high levels of cohabitation with children (OECD 2008), and it makes PISA more valid than data containing only children from divorced, and not from separated parents. Since separation after cohabitation has more or less the same effect on children as compared to divorce after marriage (Dronkers & Härkönen 2008; Härkönen & Dronkers 2006), the PISA data provide a more accurate picture in countries where cohabitation with children exists. Married parents, who stopped living together before the 15-year old pupil participates in the PISA survey, are also treated in the same way as formally divorced parents. This feature is especially relevant for catholic countries like Italy, Ireland, Portugal and Spain, where separation without divorce is still common and divorce still difficult to obtain. The formulation of the family form question contains a risk of reporting parental divorce or separation by the 15-year old pupils, if in fact the father or the mother is only away for work for a long period (e.g. fishermen). We believe, however, that this risk is small, as pupils will mostly indicate that their father still lives at home due to the undesirability of parental divorce or separation in the eyes of children.

FIGURE 1 ABOUT HERE

For our analyses, we selected 26 OECD countries: i.e. Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, the United Kingdom and the United States. We do not consider this selection of countries to be representative of the world, but we selected the largest number of countries in which divorce or separation is the most important cause of single parenthood for 15-year old pupils. Nevertheless, the selected countries differ substantially in their combinations of the relevant aspects under investigation and the number of cases is large enough to warrant our analyses, as partly can be seen in Table 2. Together, the 26 countries represent 217,180 students (with a valid score on mathematical literacy), attending 12,169 different schools. All schools are included in our data, also schools with only pupils who live together with two biological parents.

Variables

An overview of the descriptive statistics of the variables included in the empirical analysis is presented in Table 1.

TABLE 1 ABOUT HERE

Dependent Variable. To measure the student's educational performance, we use mathematical literacy as the dependent variable in our study. Mathematical literacy is defined as: 'the capacity to identify, understand and engage in mathematics as well as to make well-founded judgments about the role that mathematics plays in an individual's current and future life as a constructive, concerned and reflective citizen'. Mathematical literacy can be divided into four concepts, i.e. quantity, space and shape, change and relationships, and uncertainty (OECD 2003b). The observed responses on the items on these scales have been used to construct five plausible mathematical values for each student by means of Item Response Modeling (OECD 2000). These five plausible scores provide an unbiased estimate of the answers on all items, although in reality the students have only answered a random selection of the items. We calculated the mean score on the five plausible mathematical values as the dependent variable *Mathematical Literacy*.[iii] The average score on this variable is 514.31.

Predictor Variables. As described earlier, *Family Form* is measured by asking who usually lives at home with the student, i.e. a mother, female guardian, father, male guardian or others. We created dummy variables indicating a two-parent family (mother and father) (79%), a single-mother family (15%) and a family consisting of a mother plus guardian (6%). We have

chosen to exclude other single-parent family forms as they were not very common in the countries involved.

At the school level we calculated the *School's Percentage of Children from Single-Parent Families* by counting all students at a certain school with a single mother or father, compared to the total number of students at school. This calculation was made before excluding students with missing values on one or more predictor variables from our data. Subsequently, we transformed this variable into a variable ranging from 0 to 1, after which we mean-centered it. This way, a scale remains ranging from -0.15 to 0.85. School's socio-economic composition is measured by computing the average *Index of Economic, Social, and Cultural Status (ESCS)* of all the children at school, who participated in PISA. This is a variable referring to the highest level of parental education (ISCED) and occupation (ISEI) and the number of home possessions. Also this variable is transformed into a 0-1 scale and mean-centered. The new scale ranges from -0.51 to 0.49. Through a principal questionnaire two other school characteristics are measured in PISA: i.e. *Shortage of Qualified Teachers* (a scale based on shortages in different subjects) and *Student-Staff Ratio*. Again, both indicators have been transformed into a 0-1 scale and are mean-centered (respectively ranging from -0.18 to 0.82 and -0.25 to 0.75).

At the country level we calculated the *Country's Percentage of Children from Single-Parent Families* by counting all students in that country with a single mother or father, compared to the total number of students at school. Also this calculation was made before excluding students with missing values on one or more predictor variables from our data. We transformed this variable into a variable ranging from 0 to 1, after which we mean-centered it (i.e. range of -0.35 to 0.65).

Control Variables. We included some independent variables as covariates. At the student level, we firstly included *Sex* (girl). As a control for selectivity we also included the *Level of Education* attended by the pupils. We distinguish two ISCED levels within secondary education: lower and higher, and a category of unknown educational level. This control variable takes into account the possible early selection of children of single parents into a lower educational level, as a consequence of lower earlier performance. The result of controlling for educational level might be that the effects of family form and school's percentage of single-parent families might be underestimated. However, we prefer this risk of underestimation above a too easy acceptance of hypotheses. *Immigrant Status* is measured as first generation, second generation and unknown. We also included two important family background characteristics of students to control for the amount of resources in a family. *Parental Occupational Status* is measured according to the International Socio-economic Index of Occupational Status (ISEI) (Ganzeboom et al. 1992). For every child living in a family with two parents (also in case of the single-mother family plus guardian) we used the

score of the parent with the highest occupational status. In case of a single-parent family, we used the score of the single parent. *Parental Educational Level* is measured according to the International Standard Classification of Education (ISCED) (United Nations Educational, Scientific, and Cultural Organization 1997). Again, we used the highest level of education if families consisted of two parents and the score of the single parent in case one of the parents was absent. Moreover, this variable is transformed into dummy variables indicating lower secondary education at most (20%), higher secondary education (46%), tertiary education (30%) and educational level unknown (4%). To measure the time parents usually spend on work, i.e. *Parental Working Hours*, we used answers to the questions what mother and/or father are currently doing, In two-parent families we calculated the minimum number of working hours of both parents, as it is an indication of the time that parents can spend at home with their children, instead of spending on work. This variable is transformed into dummy variables, i.e. non-working (31%), part-time job (20 hours) (22%) and fulltime job (40 hours) (47%).

At the school level we included *Type of Community* in which the school is located (village, small town, town, city, big city or other), and, at the country level we included GDP (per capita) (Purchasing Power Parity) and the distribution of family income in a country (i.e. GINI index), based on data from the World Bank.

CROSS-NATIONAL DIFFERENCES IN SINGLE-PARENT FAMILY FORMS AND THE SCHOOL'S SINGLE-PARENT FAMILY SHARE

In Table 2 we show the averages, percentages and standard deviations of five core variables for the three family forms in the 26 countries separately: i.e. mathematical literacy, parental occupational status, school's % single-parent families, school's ESCS and country's % single-parent families. Also the (absolute and relative) number of cases with valid scores is presented in this table.

TABLE 2 ABOUT HERE

In all countries the mathematical literacy score of pupils living in single-mother families is lower than those living with mother and father or guardian. Also, in nearly all countries the parental occupational status is lower of the mother in single-mother families, not only in traditional family societies like the Netherlands or Ireland, but also in Sweden and Finland where full-time working mothers are far more common and accepted. Children of single-mother families attend in almost all countries schools with higher percentages of single-parents, compared to children living with both parents in the same country. This suggests that

the results, which Pong (1997, 1998) found for the US, might also be relevant for other countries. The standard deviations of the school's % single-parent families are more or less equal between the three family forms, which suggests that pupils from all three family forms can be found in schools with different percentages children from single-parent families. The differences in the school's ESCS score differ less between the three family forms, but there is a tendency that children living with both parents attend schools with a higher ESCS average, although that is not true in all 26 countries.

The US also seems to be an exceptional country relative to the other 25 countries: the percentage of single-parent families among the 15-year old pupils clearly is far higher (20.61%), while Australia can boost only 18.38% and Finland 17.30%. Moreover, the concentration of single-parent families in schools with high percentages of single-parent families also seems to be strongest in the US: the difference in school's percentage single-parent families between a mother and father family versus a single mother is 12%, only Denmark has a comparable concentration (13%). For that reason we also show the same analysis without the US, to be sure that our results are not caused solely by this country (see Table 4).

MULTILEVEL RESULTS

Model design

Since we hypothesized effects on the individual (student) level and contextual (school and country) level, as well as cross-level interaction effects, we apply multilevel analysis techniques (Snijders and Bosker 1999). We distinguish three levels: the student level (level 1), school level (level 2) and country level (level 3). We discuss the results of the multilevel analysis for mathematical literacy, but the comparable outcomes for reading and scientific literacy are presented in Appendix I and II. Table 3 represents the multilevel regression models for mathematical literacy.

We start by estimating a model including only the dummy variables of single-parent family form (i.e. single mother and mother plus guardian (Model 1). The two parent family is used as reference category. In the second model, we also include all individual background characteristics and we control for the three country characteristics: country's % single-parent families, gross national product and income inequality (Model 2). In Model 3, we test hypothesis 1 by adding the schools' % single-parent family to the equation of Model 2. We estimated Model 3 without socio-economic status of the school and the community where the school is standing. In the next model, we add these other school features as well and test hypothesis 2 (Model 4). In Model 5 we test hypothesis 3 by adding the two indicators of the lack of educational resources of the school to Model 4. In Model 6 we also include the interaction terms between schools' % single-parent families and single-mother and mother &

guardian family form, in order to test hypothesis 4. Finally, in Model 7 we also include the interaction terms between country's % single-parent families and single-mother family form and schools' % single-parent families, in order to test hypotheses 5 and 6.

Results for all countries

Model 1 shows the expected negative effect of family form on educational performance: pupils living in single-mother families score nearly 14 points lower than pupils living with a mother and father, while those living with a mother plus guardian score on average 10 points lower. Model 2 shows that the individual background variables and the level of income-inequality of a country can explain a substantial part of the negative effect of family form. The effects of most of these individual background variables are not very surprising, and will not be discussed here: they are only controls for the correct estimation of the family form effects. Only the positive effect of parental working hours is worth to mention. Although we considered it as an indicator for the amount of time parents can spend with their children, and hence having a part-time or a fulltime job is expected to negatively affect children's educational performance, the effect might be positive due to the selectivity into work in comparison with having no work. On the other hand, parental part-time work has a stronger effect than full-time work, supporting the idea that having time for children is important for their educational performance.

Also after controlling for individual background variables and macro-income inequality, family form continues to have a significant negative effect on educational performance, which is as large as having part-time or full-time working parents. Single-mother family and mother & guardian family have more or less an equal effect, after these controls.

TABLE 3 ABOUT HERE

With Model 3 we test our first hypothesis (i.e. children from schools with a large concentration of students from single-parent families will perform less well than children from schools with a small concentration of students from single-parent families). It appears that there is a strong negative effect of the school's percentage single-parent family families. Each per cent increase in the number of single-parent families at a school decreases the educational performance of all pupils with nearly 0.8, thus 10% lowers the score with 7.6 points. Interestingly, the inclusion of the school's % single-parent families hardly affects the negative effect of the family form on educational outcomes. This clearly suggests that family form and school's % single-parent families are indicators of different processes.

In Model 4 we test the second hypothesis, which assumes that this negative effect of school's % single-parent families can be explained by the lower socio-economic composition of such schools. The results of Model 4 only partly support this second hypothesis. The socio-

economic composition of school has a strong positive effect on educational performance, but it only explains less than half of the original effect of school's % single-parent families. 10% more single-parent families at school still decreases the educational performance of pupils with 4.2 points. So, the inclusion of the school's socio-economic composition hardly affects the negative effect of the family form on educational performance. This clearly suggests that family form and school's socio-economic composition are indicators of different processes.

With Model 5 we test the third hypothesis, which assumes that the negative effect of school's % single-parent families can be explained by the lack of resources of such schools, like qualified teachers and less teachers pro student. The results from Model 5 clearly show that this third hypothesis has to be rejected. Only a shortage of teachers negatively affects student's educational performance, and both the negative effects of school's % single-parent families and the family form on educational performance hardly change by the inclusion of these school-characteristics.

Model 6 tests the fourth hypothesis (i.e. the negative effect of the school's share of single-parent families on educational performance is larger for children from single-parent families than for children from two parent families (H4a) or even absent for children from two parent families (H4b)). This fourth hypothesis can be accepted for the single-mother family: we find a substantial and significant coefficient for the interaction between school's % single-parent families and single-mother family. This means that the negative effect of the school's share of single-parent families is larger for children from single-mother families. However, this inclusion lowers the strength of school's % single-parent families on educational outcomes only partially. This means that the strong version of the fourth hypothesis (H4b) must be rejected. The negative effect of the school's share of single-parent families is not absent for children living with father and mother, but it is quite substantial (3.7 points less for 10% more single-parent families in school). The effect is even stronger for children living with single mothers (5.7 point less for 10% more single-parent families in school). The interaction between school's % single-parent families and mother & guardian family is positive but not significant, contrary to our fourth hypothesis. This suggest that the addition of a male guardian to the mother-family at least reestablishes the relations with the larger community and adds new social capital to the family and the school, although there remains a negative effect of school's share of single-parent families.

Model 7 tests our last two hypotheses (H5 and H6), which both assume that the negative effect of growing up in a single-parent family is less strong in societies where non-traditional family forms are more common. These hypotheses cannot be accepted given the results of model 7. Instead, the negative effects of both family forms become stronger in societies with more single-parent families, because the two added interaction variables are significant and negative, while the effects of both family forms are also still negative and virtually unchanged. The interaction term between country's % single-parent families and

school's % single-parent families is not significant, instead of the assumed positive coefficient of the interaction variable.

Results for all countries except the US

As we discussed earlier, the US is a kind of outlier, both in the percentage of single-parent pupils and in the concentration of children with single mothers in schools with high percentages of single-parent families. Therefore, we rerun our analysis for all countries except the US.

TABLE 4 ABOUT HERE

The results of the analysis for all 25 countries without the US are not very different, although the effects of the variables related with family forms are slightly less strong. All hypotheses rejected or accepted with the US included are all rejected or accepted if we exclude the US. This means that the results of Pong are not only correct for the US but for all societies with enough number of children involved in parental divorces and separations. There is only one exception: the sixth hypothesis is not rejected but accepted if we exclude the US from the analysis. We find a significant positive effect of the interaction between country's % single-parent families and school's % single-parent families. This implies that attending a school with many children from single-parent families is less negative for children's educational performance in societies with higher shares of single-parent family forms. On this point the US is an exception, because despite its high level of single-parent families the effect of school's % single-parent families has not declined like in the other societies.

CONCLUSION AND DISCUSSION

In this paper, we have studied the effect of the single-parent family composition of schools on the educational performance of 15-year old children of single-parent and two parent families. The aim of our study was to contribute to the existing knowledge about single-parent family forms and children's educational performance by investigating how the family form composition of schools and countries affect the negative relationship between living in a single-parent family and children's educational performance.

First of all, we studied how the share of children from single-parent families at school affects the educational performance of all children at that school. We can conclude that children attending schools with many children from single-parent families negatively influences their educational performance, even after controlling for the socio-economic composition status and urban environment of the schools. The negative effect of the share of children from single-parents families of schools could not be explained by the percentage of

single-parent families, GDP or level of income inequality within a country, as we compared this effect between 26 OECD countries and controlled for these macro characteristics, in order to avoid that the results are based on one country (like the US), which might be an exceptional case. The single country studies of Pong (1997; 1998) and Sun (1999) are thus confirmed in our analysis. The negative effect of the share of children from single-parents at school on educational performance, which they found for the US, is not unique for that country, but can be found in nearly all western countries. As a consequence, possible explanations for the negative effect should be general enough to be applicable in all countries and not only in the US.

We also found that a shortage of teachers at school negatively influences 15-year old pupils' educational performance, but this indicator of school resources could not explain the negative effect of the school's share of single-parent families. This is an important conclusion, because single-mother families often have to move into more modest houses and neighborhoods after divorce or separation. In some countries like the US, school resources are related to the fiscal resources of neighborhoods and districts. The negative effect of the school's share of single-parent families might reflect these differences in school resources, related to their environment. The fact that a lack of school resources could not explain why children at schools with many children from single-parent families perform less well makes this explanation less plausible, also because in many countries the relation between school resources and neighborhood or district is far less strong or even absent.

Although all children at schools with a higher share of children from single-parent families perform less well than children at schools with lower shares of children from disrupted families, the educational performance of children from single-mother families is even lower at such schools, compared to children from two parent families. Accordingly, the difference is smaller in schools with lower shares of single-parent families. So, children from divorced or separated parents are even more disadvantaged when many of their fellow students also have divorced or separated parents, compared to children with two biological parents.

Although we expected that the negative effect of single-parent family forms on children's educational performance would be smaller in societies with higher shares of single-parent family forms, this does not appear to be the case. On the contrary, the negative effect of both family forms becomes stronger in societies with more single-parent families. The same result was found by Pong, Dronkers and Hampden-Thompson (2003) and by Garib, Martin Garcia and Dronkers (2007) and it is consistent with the family conflict hypothesis (Amato & Keith, 1991). *[Aanvullen aan de hand van het overzichtsartikel van Amato]*

In addition, we found that the negative effect of the school's share of single-parent families on children's educational performance is not lower in societies with higher shares of single-parent family forms, when comparing all 26 societies (including the US). However, excluding the US leads to the conclusion that the negative effect of the school's share of

single-parent families is lower in societies with higher shares of single-parent family forms. This supports the assumption that as divorce and separation become more normal and accepted, schools have learned how to handle the consequences of divorce and separation for pupils. It is not clear, however, why the US is an exception. It might be that the continuing 'cultural wars' about family values in the US hinder schools to adjust themselves to the realities of having high numbers of pupils of single-parent families.

These last two conclusions underline the importance of rethinking the societal consequences of the still increasing levels of divorce and separation, especially when children are involved. Especially in the light of the growing confirmation of the old suggestion of William Goode (1962), i.e. that when the (social) costs of union dissolution are high, one needs extra resources to dissolve the union, while when they are low, one needs more resources to maintain a relationship (Härkönen & Dronkers, 2006). Therefore, it seems that strict divorce regimes bias the composition of union of the lower ranks of society. Lax divorce regimes, on the other hand, have the consequence of increasing dissolution risks, especially for those with less education. If this difference between divorce regimes is correct, divorce regimes can also have consequences for the effects on the well-being of children.

Two caveats need to be mentioned. The PISA data are cross-sectional data, which make them more vulnerable for unmeasured differences between children from various family forms and pupils on schools with different compositions of single-parent families. Unfortunately, there exist no longitudinal cross-national data, which would allow us to add preliminary indicators of early scholastic ability, or causes and timing of single-parent family form, and to control for an important part of the unmeasured variance. We believe that this disadvantage of the cross-sectional nature of the PISA data is balanced by the advantages of using these cross-sectional data.

Moreover, our data do not allow testing the two main possible explanation of the negative effect of the school's share of single-parent families: i.e. the decline of the community network of the school, and the lower amount of teaching and learning time at school and at home. There are indications for the fact that children of single parents make less use of teaching and learning time (they come for instance more often too late at school or skip classes (see Garriga, 2010)), but this is not enough evidence to decide for the second explanation of the single-parent school effect. Independent of the explanation of the school compositional effect, our analysis reveals that, next to the classical socio-economic school composition, school's share of single-parent families is another and independent school composition that should be taken into account when investigating school effects on the relationship between family form and children's educational performance.

Notes

[i] The PISA 2006 wave did not contain any information about the single-parent family form in which the pupils were living.

[ii] In the 2003 wave the precise question was "Who usually lives at <home> with you? a) Mother; b) Other female guardian (e.g., stepmother or foster mother); c) Father; d) Other male guardian (e.g., stepfather or foster father); e) Others (e.g. brother, sister, cousin, grandparents)." In the 2000 wave more options were offered.

[iii] In the appendix we also give the results for reading and scientific literacy as dependent variable. Effects of single-mother families are generally smaller on reading than on mathematics (Murray & Sandqvist 1990), because mothers stimulate in average language better than mathematics, while fathers who in average can stimulate math development are absent in single-mother families.

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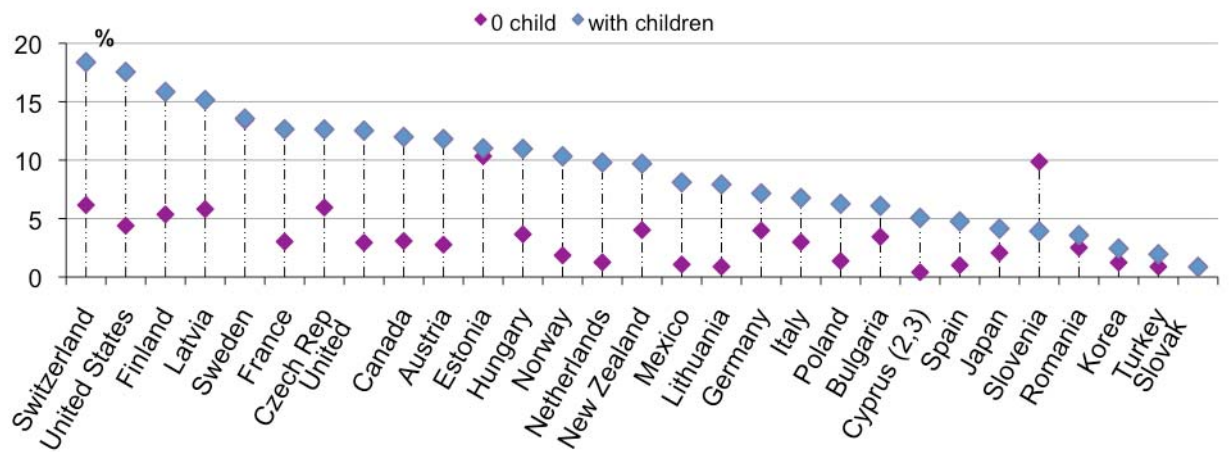
Figure l. Proportion of divorced or separated adults with or without children, 2005 (or latest year available)
Source: OECD (2008)

Table 1. Descriptive Statistics for Independent Variables and Mathematical Literacy

	Minimum	Maximum	Mean (SD)
Dependent Variables			
Mathematical Literacy	48.18	824.38	514.31 (89.99)
Student Level Independent Variables			
Family Form			
Mother & Father	0	1	0.79
Single Mother	0	1	0.15
Mother & Guardian	0	1	0.06
Sex (Girl)	0	1	0.50
Educational Level			
Lower Secondary Education	0	1	0.48
Higher Secondary Education	0	1	0.49
Unknown	0	1	0.08
Immigrant Status			
Native	0	1	0.80
Second Generation	0	1	0.12
First Generation	0	1	0.06
Unknown	0	1	0.03
Parental Educational Level			
Lower Secondary	0	1	0.20
Higher Secondary	0	1	0.46
Tertiary	0	1	0.30
Unknown	0	1	0.04
Parental Occupational Status	0	1	0.45 (0.22)
Parental Working Hours			
Non-Working	0	1	0.31
Part-Time	0	1	0.22
Fulltime	0	1	0.47
School Level Independent Variables			
School's % Single-Parent Families	-0.15	0.85	0.01 (0.10)
School's ESCS Index	-0.51	0.49	0.01 (0.12)
Community			
Village	0	1	0.11
Small Town	0	1	0.23
Town	0	1	0.31
City	0	1	0.18
Big City	0	1	0.08
Other	0	1	0.09
Teacher Shortage	-0.25	0.75	0.00 (0.20)
Student-Staff Ratio	-0.18	0.82	0.00 (0.06)
Country Level Independent Variables			
Countries % Single-Parent Families	-0.35	0.65	-0.01 0.21
GDP (per capita)	-0.34	0.66	0.00 (0.16)
GINI	-0.40	0.60	0.03 (0.25)

Source: Pooled PISA 2000 and 2003

Table 2: Description of the most important characteristics of the three family forms and their schools per country (standard deviation between parentheses)

Country	Family Form	Mathematical Literacy	Parental Occupational status	School's % Single-Parent Families	School's ESCS	Countries' % Single-Parent Families	N Valid Scores	% Within Family Form
Australia	Mother & Father	534.68 (90.56)	53.62 (15.72)	18.31 (8.57)	0.25 (0.45)	18.38	10392	74.85
	Single Mother	507.66 (93.27)	45.97 (15.76)	23.67 (9.07)	0.16 (0.44)		2452	17.66
	Mother & Guardian	511.06 (84.66)	49.66 (15.06)	20.07 (9.04)	0.11 (0.40)		1039	7.48
Austria	Mother & Father	515.80 (88.40)	47.78 (15.27)	12.70 (8.11)	0.06 (49.22)	12.58	5040	80.45
	Single Mother	508.80 (84.83)	44.15 (15.15)	19.44 (10.97)	0.04 (0.50)		843	13.46
	Mother & Guardian	500.37 (80.35)	48.66 (14.50)	14.09 (8.56)	0.02 (0.47)		382	6.10
Belgium	Mother & Father	546.32 (98.56)	51.17 (16.57)	12.84 (8.30)	0.16 (0.51)	12.58	8573	79.56
	Single Mother	506.67 (101.51)	43.84 (16.30)	19.38 (9.70)	0.05 (0.55)		1423	13.21
	Mother & Guardian	515.93 (96.95)	48.16 (15.41)	14.22 (8.06)	0.02 (0.51)		780	7.24
Canada	Mother & Father	532.41 (81.38)	51.69 (15.95)	13.67 (8.58)	0.35 (0.40)	12.99	26563	77.94
	Single Mother	511.27 (84.27)	45.81 (15.08)	20.24 (10.51)	0.34 (0.40)		4903	14.39
	Mother & Guardian	511.79 (79.58)	48.53 (15.06)	14.43 (8.76)	0.28 (0.37)		2617	7.68
Czech Republic	Mother & Father	53126 (94.77)	51.15 (14.35)	10.60 (7.03)	0.19 (0.48)	10.54	6678	78.95
	Single Mother	522.23 (92.79)	46.23 (15.35)	16.40 (8.04)	0.18 (0.49)		933	11.03
	Mother & Guardian	512.76 (92.68)	48.53 (13.61)	11.81 (7.15)	0.11 (0.45)		848	10.02
Denmark	Mother & Father	524.55 (82.55)	50.26 (15.32)	16.47 (11.63)	0.22 (0.38)	16.96	4119	74.62
	Single Mother	501.55 (84.52)	42.95 (14.73)	29.51 (17.97)	0.14 (0.44)		989	17.92
	Mother & Guardian	502.59 (82.82)	46.76 (14.93)	17.20 (13.15)	0.13 (0.36)		412	7.46
Finland	Mother & Father	545.79 (76.77)	51.28 (16.72)	16.50 (9.02)	0.19 (0.36)	17.30	5989	76.59
	Single Mother	534.67 (78.38)	43.57 (16.39)	23.03 (10.11)	0.23 (0.35)		1259	16.10
	Mother & Guardian	528.83 (77.86)	48.17 (15.93)	17.57 (9.19)	0.20 (0.32)		572	7.31
France	Mother & Father	524.40 (84.70)	49.35 (16.27)	14.99 (9.17)	-0.06 (0.51)	14.58	4296	76.14
	Single Mother	505.80 (86.70)	42.29 (16.24)	21.52 (10.36)	-0.13 (0.52)		927	16.43
	Mother & Guardian	509.66 (82.20)	47.72 (16.02)	16.32 (9.91)	-0.13 (0.50)		419	7.43
Germany	Mother & Father	513.53 (93.56)	50.09 (15.86)	13.75 (7.92)	0.22 (0.54)	14.38	5241	79.54
	Single Mother	503.60 (95.08)	44.62 (14.39)	19.55 (9.23)	0.14 (0.56)		902	13.69
	Mother & Guardian	508.05 (89.46)	49.97 (15.25)	15.05 (8.44)	0.13 (0.55)		446	6.77
Greece	Mother & Father	452.22 (91.91)	47.28 (17.22)	14.13 (11.63)	-0.14 (0.57)	12.41	4287	81.19
	Single Mother	429.63 (92.48)	44.36 (14.95)	27.07 (16.00)	-0.17 (0.59)		927	17.56
	Mother & Guardian	436.57 (87.98)	47.31 (17.57)	15.51 (11.81)	-0.12 (0.60)		66	1.25
Hungary	Mother & Father	496.85 (88.80)	49.33 (14.99)	15.58 (8.11)	-0.04 (0.57)	15.98	5067	76.63
	Single Mother	482.07 (88.14)	46.32 (14.65)	22.13 (12.75)	-0.12 (0.56)		1108	16.76
	Mother & Guardian	473.41 (88.13)	47.28 (14.66)	17.03 (9.09)	-0.15 (0.55)		437	6.61
Iceland	Mother & Father	520.06 (83.00)	53.83 (16.65)	11.45 (6.77)	0.66 (0.37)	11.58	3396	75.43
	Single Mother	515.51 (83.54)	46.93 (16.08)	15.99 (7.23)	0.69 (0.36)		551	12.24
	Mother & Guardian	504.86 (82.12)	51.26 (15.41)	12.02 (7.50)	0.64 (0.36)		555	12.33
Ireland	Mother & Father	513.49 (79.18)	48.96 (15.51)	12.05 (8.30)	-0.05 (0.41)	10.02	3849	84.39
	Single Mother	484.33 (80.95)	43.45 (14.68)	17.90 (9.09)	-0.14 (0.45)		575	12.61
	Mother & Guardian	495.25 (84.64)	48.02 (15.30)	13.25 (9.75)	-0.17 (0.40)		137	3.00
Italy	Mother & Father	494.88 (88.49)	47.45 (15.99)	13.07 (7.07)	-0.04 (0.53)	12.50	10949	84.65
	Single Mother	482.80 (90.89)	44.40 (15.83)	17.72 (8.32)	-0.05 (0.55)		1754	13.56
	Mother & Guardian	493.68 (78.62)	48.44 (15.84)	13.60 (7.27)	0.02 (0.52)		232	1.79
Luxembourg	Mother & Father	486.30 (88.50)	47.38 (16.37)	12.87 (5.03)	0.12 (0.55)	11.78	4164	81.28
	Single Mother	473.84 (87.60)	43.25 (15.43)	15.08 (5.28)	0.08 (0.55)		653	12.75
	Mother & Guardian	478.71 (82.99)	46.74 (15.36)	13.26 (4.97)	0.02 (0.54)		306	5.97
the Netherlands	Mother & Father	560.13 (84.74)	51.82 (15.86)	10.74 (7.92)	0.12 (0.42)	10.41	3969	83.89
	Single Mother	520.10 (89.38)	45.02 (14.32)	18.24 (9.97)	-0.01 (0.47)		525	11.10
	Mother & Guardian	527.44 (80.73)	49.94 (14.28)	12.74 (8.91)	0.03 (0.41)		237	5.01
New Zealand	Mother & Father	542.93 (91.47)	52.59 (15.58)	16.40 (8.56)	0.28 (0.40)	16.21	3924	73.59
	Single Mother	519.30 (96.06)	46.61 (14.38)	21.48 (8.96)	0.21 (0.40)		894	16.77
	Mother & Guardian	515.38 (84.15)	48.90 (15.50)	17.53 (8.71)	0.16 (0.39)		514	9.64
Norway	Mother & Father	510.39 (86.41)	55.41 (15.08)	19.43 (11.32)	0.59 (0.33)	16.87	3552	73.10
	Single Mother	482.44 (82.87)	47.03 (15.48)	26.72 (10.85)	0.60 (0.33)		974	20.05
	Mother & Guardian	484.91 (87.16)	51.88 (15.20)	18.15 (11.46)	0.52 (0.28)		333	6.85
Poland	Mother & Father	484.63 (88.26)	44.95 (14.76)	10.01 (6.83)	-0.24 (0.44)	10.24	5367	88.16
	Single Mother	469.13 (88.25)	43.34 (14.61)	15.27 (7.03)	-0.21 (0.44)		593	9.74
	Mother & Guardian	463.61 (100.19)	45.86 (14.51)	9.91 (6.74)	-0.23 (0.47)		128	2.10
Portugal	Mother & Father	468.93 (83.12)	43.57 (15.56)	12.13 (7.43)	-0.64 (0.64)	10.58	4623	83.36
	Single Mother	455.23 (84.32)	39.46 (16.99)	16.77 (7.77)	-0.56 (0.68)		745	13.43
	Mother & Guardian	460.49 (90.89)	45.15 (15.60)	13.04 (7.52)	-0.57 (0.63)		178	3.21

Table 2 (Continued)

Country	Family Form	Mathematical Literacy	Parental Occu-pational status	School's % Single-Parent Families	School's ESCS	Countries' % Single-Parent Families	N Valid Scores	% Within Family Form
Slovak Republic	Mother & Father	508.57 (87.39)	50.03 (15.91)	10.68 (6.64)	-0.01 (0.46)	11.31	5932	85.30
	Single Mother	500.53 (88.88)	46.29 (15.78)	15.67 (7.82)	-0.02 (0.45)		749	10.77
	Mother & Guardian	488.38 (88.34)	47.27 (16.37)	12.03 (7.76)	-0.05 (0.44)		273	3.93
Spain	Mother & Father	496.04 (81.51)	45.17 (16.40)	11.30 (6.70)	-0.23 (0.55)	10.71	10828	85.83
	Single Mother	480.53 (84.23)	40.18 (16.06)	16.36 (8.24)	-0.21 (0.53)		1475	11.69
	Mother & Guardian	487.38 (85.42)	45.37 (16.26)	14.14 (7.95)	-0.22 (0.53)		312	2.47
Sweden	Mother & Father	521,62 (88.73)	51.65 (15.92)	18.74 (9.75)	0.30 (0.34)	16.93	4047	73.72
	Single Mother	490.18 (91.49)	42.92 (16.14)	24.27 (9.83)	0.27 (9.83)		1065	19.40
	Mother & Guardian	497.17 (81.31)	47.86 (15.52)	18.56 (9.98)	0.27 (0.33)		378	6.89
Switzerland	Mother & Father	529.75 (90.27)	48.22 (15.96)	16.72 (10.87)	-0.07 (0.42)	15.67	7890	77.30
	Single Mother	509.41 (91.22)	43.23 (13.49)	26.09 (13.45)	-0.09 (0.42)		1855	18.17
	Mother & Guardian	507.18 (89.87)	48.63 (14.38)	16.20 (10.63)	-0.08 (0.41)		462	4.53
United Kingdom	Mother & Father	530.07 (87.09)	51.05 (16.21)	15.99 (9.20)	0.12 (0.45)	13.97	8384	74.06
	Single Mother	503.91 (88.33)	42.27 (15.07)	21.87 (9,69)	0.04 (0.43)		1949	17.22
	Mother & Guardian	514.09 (81.53)	48.71 (15.21)	17.25 (9.28)	0.03 (0.38)		988	8.73
United States	Mother & Father	504.25 (87.65)	55.40 (16.00)	20.89 (12.14)	0.33 (0.47)	20.61	3840	64.14
	Single Mother	458.42 (87.89)	47.16 (14.66)	32.24 (14.72)	0.17 (0.42)		1493	24.94
	Mother & Guardian	481.42 (84.22)	51.83 (15.33)	22.82 (13.14)	0.20 (0.44)		654	10.92

Source: Pooled PISA 2000 and 2003

Table 3. Multilevel Regression Models for Mathematical Literacy ($N_{students}$ = 217,180; $N_{schools}$ = 12,169; $N_{countries}$ = 26)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	508.06 **	459.61 **	459.94 **	472.32 **	472.39 **	472.51 **	472.60 **
Student Level Effects							
Family Form							
Mother & Father	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Single Mother	-13.76 **	-5.07 **	-4.31 **	-5.10 **	-5.10 **	-3.88 **	-3.95 **
Mother & Guardian	-10.16 **	-7.06 **	-7.00 **	-6.95 **	-6.95 **	-7.16 **	-6.90 **
Sex (Girl)		-14.29 **	-14.28 **	-14.50 **	-14.51 **	-14.52 **	-14.52 **
Educational Level							
Lower Secondary Education		ref.	ref.	ref.	ref.	ref.	ref.
Higher Secondary Education		48.54 **	48.10 **	43.19 **	43.13 **	43.08 **	43.14 **
Unknown		18.72 **	14.01 **	15.79 **	16.26 **	16.34 **	16.34 **
Immigrant Status							
Native		ref.	ref.	ref.	ref.	ref.	ref.
Second Generation		-7.51 **	-7.35 **	-7.75 **	-7.76 **	-7.76 **	-7.79 **
First Generation		-22.02 **	-21.77 **	-21.66 **	-21.67 **	-21.70 **	-21.74 **
Unknown		-23.50 **	-23.42 **	-23.23 **	-23.21 **	-23.24 **	-23.30 **
Parental Educational Level							
Lower Secondary		ref.	ref.	ref.	ref.	ref.	ref.
Higher Secondary		7.59 **	7.59 **	6.09 **	6.08 **	6.10 **	6.11 **
Tertiary		16.89 **	16.79 **	13.85 **	13.84 **	13.88 **	13.88 **
Unknown		-20.37 **	-20.26 **	-20.60 **	-20.61 **	-20.56 **	-20.57 **
Parental Occupational Status		57.72 **	57.93 **	51.85 **	51.85 **	51.82 **	51.74 **
Parental Working Hours							
Non-Working		ref.	ref.	ref.	ref.	ref.	ref.
Part-Time		5.41 **	5.42 **	5.04 **	5.04 **	5.03 **	5.00 **
Fulltime		2.43 **	2.46 **	1.96 **	1.96 **	1.94 **	1.92 **
School Level Effects							
School's % Single-Parent Families			-76.45 **	-41.56 **	-41.59 **	-36.66 **	-38.04 **
School's ESCS Index				277.86 **	275.24 **	275.02 **	274.95 **
Community							
Village/Small Town				ref.	ref.	ref.	ref.
Town				-5.02 **	-5.08 **	-5.12 **	-5.11 **
City				-10.99 **	-11.25 **	-11.30 **	-11.30 **
Big City				-14.45 **	-14.51 **	-14.57 **	-14.57 **
Other				4.82 **	5.11 **	5.13 **	5.20 **
School Resources							
Teacher Shortage					-10.67 **	-10.65 **	-10.63 **
Student-Staff Ratio					5.54	5.42	5.48
Interaction Effects (School Level)							
School's % Single-Parent Families * Single Mother						-22.06 **	-16.16 **
School's % Single-Parent Families * Mother & Guardian						12.91	20.26 **
Country Level Effects							
Country's % Single-Parent Families		19.75	28.62	2.19	2.16	2.05	4.11
GDP (per capita)		39.08	39.31	0.84	2.19	2.09	2.11
GINI		-41.58 *	-41.40 *	-10.01	-10.06	-10.05	-9.78
Interaction Effects (Country Level)							
Country's % Single-Parent Families * Single Mother							-7.76 **
Country's % Single-Parent Families * Mother & Guardian							-9.85 **
Country's % Single-Parent Families * School's % Single-Parent Families							-5.18
Variance Components							
Student Level	5116.80	4727.54	4727.70	4730.42	4730.60	4729.88	4729.04
School Level	2688.46	1920.03	1857.64	967.64	962.77	962.41	963.00
Country Level	715.17	758.07	749.33	646.29	633.87	631.37	631.91
Deviance	2497506	2477694	2477370	2471350	2471313	2471278	2471247

*p<.05. **p<.01.

Source: Pooled PISA 2000 and 2003

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Table 4. Multilevel Regression Models for Mathematical Literacy without the US ($N_{students}$ = 211,193; $N_{schools}$ = 11,748; $N_{countries}$ = 25)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	508.66 **	460.07 **	460.42 **	473.78 **	473.89 **	473.99 **	473.75 **
Student Level Effects							
Family Form							
Mother & Father	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Single Mother	-13.20 **	-4.61 **	-3.96 **	-4.75 **	-4.75 **	-3.75 **	-3.85 **
Mother & Guardian	-10.03 **	-6.90 **	-6.58 **	-6.86 **	-6.85 **	-7.01 **	-6.94 **
Sex (Girl)		-14.39 **	-14.38 **	-14.61 **	-14.62 **	-14.63 **	-14.63 **
Educational Level							
Lower Secondary Education		ref.	ref.	ref.	ref.	ref.	ref.
Higher Secondary Education		50.21 **	49.69 **	44.79 **	44.74 **	44.69 **	44.68 **
Unknown		21.43 **	17.06 **	18.64 **	19.14 **	19.21 **	19.42 **
Immigrant Status							
Native		ref.	ref.	ref.	ref.	ref.	ref.
Second Generation		-7.73 **	-7.59 **	-8.10 **	-8.08 **	-8.08 **	-8.09 **
First Generation		-22.38 **	-22.16 **	-22.13 **	-22.15 **	-22.16 **	-21.19 **
Unknown		-22.90 **	-22.94 **	-22.63 **	-22.61 **	-22.65 **	-22.68 **
Parental Educational Level							
Lower Secondary		ref.	ref.	ref.	ref.	ref.	ref.
Higher Secondary		7.72 **	7.71 **	6.24 **	6.23 **	6.25 **	6.25 **
Tertiary		16.61 **	16.52 **	13.63 **	13.61 **	13.64 **	13.64 **
Unknown		-20.50 **	-20.40 **	-20.75 **	-20.74 **	-20.71 **	-20.69 **
Parental Occupational Status		57.31 **	57.49 **	51.45 **	51.45 **	51.42 **	51.37 **
Parental Working Hours							
Non-Working		ref.	ref.	ref.	ref.	ref.	ref.
Part-Time		5.40 **	5.41 **	5.02 **	5.03 **	5.03 **	5.01 **
Fulltime		2.61 **	2.64 **	2.10 **	2.10 **	2.09 **	2.07 **
School Level Effects							
School's % Single-Parent Families			-67.89 **	-35.19 **	-35.21 **	-31.37 **	-34.01 **
School's ESCS Index				279.43 **	276.81 **	276.64 **	276.90 **
Community							
Village/Small Town				ref.	ref.	ref.	ref.
Town				-5.50 **	-5.58 **	-5.62 **	-5.66 **
City				-10.40 **	-11.69 **	-11.75 **	-11.73 **
Big City				-14.59 **	-14.67 **	-14.75 **	-14.60 **
Other				3.92 **	4.23 **	4.24 **	3.84 *
School Resources							
Teacher Shortage					-10.69 **	-10.67 **	-10.72 **
Student-Staff Ratio					7.21	7.07	7.17
Interaction Effects (School Level)							
School's % Single-Parent Families * Single Mother						-18.86 **	-16.13 **
School's % Single-Parent Families * Mother & Guardian						15.49 *	21.73 **
Country Level Effects							
Country's % Single-Parent Families		30.64	38.39	17.42	17.69	17.53	19.15
GDP (per capita)		42.25	42.41	5.25	6.72	6.61	6.74
GINI		-32.06	-31.98	4.52	4.73	4.66	5.03
Interaction Effects (Country Level)							
Country's % Single-Parent Families * Single Mother							-5.73 **
Country's % Single-Parent Families * Mother & Guardian							-11.14 **
Country's % Single-Parent Families * School's % Single-Parent Families							53.55 **
Variance Components							
Student Level	5096.70	4710.07	4710.30	4713.1	4713.27	4712.66	4712.24
School Level	2705.40	1919.12	1870.90	972.71	967.90	967.88	966.46
Country Level	732.40	778.91	769.90	636.27	620.22	618.49	613.40
Deviance	2427791	2408523	2408285	2402447	2402411	2402384	2402353

*p<.05. **p<.01.
Source: Pooled PISA 2000 and 2003

Appendix I. Multilevel Regression Models for Reading Literacy ($N_{students}$ = 261,554; $N_{schools}$ = 12,192; $N_{countries}$ = 26)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	502.34 **	432.75 **	432.88 **	442.84 **	442.96 **	443.09 **	443.14 **
Student Level Effects							
Family Form							
Mother & Father	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Single Mother	-9.81 **	-2.17 **	-1.49 **	-2.15 **	-2.15 **	-1.01 **	-1.02 **
Mother & Guardian	-5.88 **	-5.21 **	-5.16 **	-5.12 **	-5.11 **	-5.20 **	-4.77 **
Sex (Girl)		29.79 **	29.80 **	29.71 **	29.70 **	29.70 **	29.70 **
Educational Level							
Lower Secondary Education		ref.	ref.	ref.	ref.	ref.	ref.
Higher Secondary Education		45.01 **	44.66 **	40.33 **	40.28 **	40.25 **	40.27 **
Unknown		9.74 **	5.81 **	7.86 **	8.42 **	8.50 **	8.51 **
Immigrant Status							
Native		ref.	ref.	ref.	ref.	ref.	ref.
Second Generation		-5.65 **	-5.51 **	-5.91 **	-5.91 **	-5.91 **	-5.94 **
First Generation		-29.32 **	-29.10 **	-29.12 **	-29.13 **	-29.16 **	-29.21 **
Unknown		-20.89 **	-20.82 **	-20.95 **	-20.94 **	-20.98 **	-21.03 **
Parental Educational Level							
Lower Secondary		ref.	ref.	ref.	ref.	ref.	ref.
Higher Secondary		10.57 **	10.57 **	9.27 **	9.26 **	9.29 **	9.29 **
Tertiary		16.80 **	16.70 **	14.19 **	14.19 **	14.23 **	14.23 **
Unknown		-22.25 **	-22.15 **	-22.61 **	-22.61 **	-22.55 **	-22.55 **
Parental Occupational Status		59.83 **	60.01 **	54.69 **	54.68 **	54.65 **	54.60 **
Parental Working Hours							
Non-Working		ref.	ref.	ref.	ref.	ref.	ref.
Part-Time		4.45 **	4.45 **	4.12 **	4.12 **	4.12 **	4.09 **
Fulltime		2.22 **	2.24 **	1.80 **	1.81 **	1.79 **	1.77 **
School Level Effects							
School's % Single-Parent Families			-76.61 **	-42.30 **	-42.34 **	-36.94 **	-38.32 **
School's ESCS Index				277.98 **	274.91 **	274.67 **	274.63 **
Community							
Village/Small Town				ref.	ref.	ref.	ref.
Town				-3.63 **	-3.75 **	-3.80 **	-3.80 **
City				-8.77 **	-9.10 **	-9.15 **	-9.15 **
Big City				-11.11 **	-11.21 **	-11.26 **	-11.27 **
Other				11.03 **	11.49 **	11.54 **	11.54 **
School Resources							
Teacher Shortage					-11.24 **	-11.20 **	-11.20 **
Student-Staff Ratio					14.31 *	14.10 *	14.16 *
Interaction Effects (School Level)							
School's % Single-Parent Families * Single Mother						-23.97 **	-20.09 **
School's % Single-Parent Families * Mother & Guardian						14.03 *	21.81 **
Country Level Effects							
Country's % Single-Parent Families		26.58	35.38	9.23	9.20	9.11	10.77
GDP (per capita)		33.62	33.75	-4.14	-2.49	-2.65	-2.59
GINI		-18.25	-18.07	13.20	13.11	13.13	13.38
Interaction Effects (Country Level)							
Country's % Single-Parent Families * Single Mother							-5.33 **
Country's % Single-Parent Families * Mother & Guardian							-10.91 **
Country's % Single-Parent Families * School's % Single-Parent Families							-0.09
Variance Components							
Student Level	5256.90	4726.01	4725.59	4729.17	4729.34	4728.84	4727.90
School Level	2894.40	1962.86	1905.59	978.21	972.33	972.68	972.22
Country Level	508.60	597.35	595.66	496.98	486.18	572.51	484.39
Deviance	3012688	2981835	2981501	2975025	2974977	2974930	2974899

*p<.05. **p<.01.

Source: Pooled PISA 2000 and 2003

Appendix II. Multilevel Regression Models for Scientific Literacy ($N_{students}$ = 217,513; $N_{schools}$ = 12,166; $N_{countries}$ = 26)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	504.72 **	449.65 **	449.94 **	463.06 **	463.18 **	463.36 **	463.49 **
Student Level Effects							
Family Form							
Mother & Father	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Single Mother	-12.96 **	-3.59 **	-2.86 **	-3.73 **	-3.73 **	-2.02 **	-2.13 **
Mother & Guardian	-8.70 **	-5.53 **	-5.46 **	-5.43 **	-5.42 **	-5.56 **	-5.39 **
Sex (Girl)		-8.57 **	-8.56 **	-8.71 **	-8.72 **	-8.73 **	-8.72 **
Educational Level							
Lower Secondary Education		ref.	ref.	ref.	ref.	ref.	ref.
Higher Secondary Education		48.72 **	48.33 **	43.53 **	43.47 **	43.40 **	43.49 **
Unknown		21.17 **	16.98 **	15.80 **	16.44 **	16.55 **	16.54 **
Immigrant Status							
Native		ref.	ref.	ref.	ref.	ref.	ref.
Second Generation		-9.09 **	-8.94 **	-9.38 **	-9.38 **	-9.39 **	-9.43 **
First Generation		-30.73 **	-30.47 **	-30.25 **	-30.27 **	-30.32 **	-30.38 **
Unknown		-22.54 **	-22.46 **	-22.20 **	-22.18 **	-22.23 **	-22.31 **
Parental Educational Level							
Lower Secondary		ref.	ref.	ref.	ref.	ref.	ref.
Higher Secondary		9.92 **	9.90 **	8.23 **	8.22 **	8.25 **	8.26 **
Tertiary		20.27 **	20.15 **	16.85 **	16.84 **	16.89 **	16.88 **
Unknown		-22.22 **	-22.12 **	-22.65 **	-22.65 **	-22.60 **	-22.61 **
Parental Occupational Status		62.90 **	63.08 **	56.30 **	56.29 **	56.25 **	56.15 **
Parental Working Hours							
Non-Working		ref.	ref.	ref.	ref.	ref.	ref.
Part-Time		5.21 **	5.21 **	4.80 **	4.80 **	4.79 **	4.75 **
Fulltime		2.08 **	2.10 **	1.55 **	1.56 **	1.53 **	1.51 **
School Level Effects							
School's % Single-Parent Families			-66.93 **	-30.28 **	-30.24 **	-22.21 **	-23.66 **
School's ESCS Index				285.64 **	282.49 **	282.18 **	282.08 **
Community							
Village/Small Town				ref.	ref.	ref.	ref.
Town				-6.04 **	-6.17 **	-6.24 **	-6.21 **
City				-11.92 **	-12.27 **	-12.34 **	-12.32 **
Big City				-15.89 **	-15.98 **	-16.06 **	-16.09 **
Other				10.49 **	10.89 **	10.89 **	11.02 **
School Resources							
Teacher Shortage					-12.07 **	-12.03 **	-11.99 **
Student-Staff Ratio					12.82 *	12.67 *	12.80 *
Interaction Effects (School Level)							
School's % Single-Parent Families * Single Mother						-32.06 **	-23.07 **
School's % Single-Parent Families * Mother & Guardian						4.05	9.64
Country Level Effects							
Country's % Single-Parent Families		18.97	26.74	-0.02	-0.06	-0.21	2.39
GDP (per capita)		13.73	13.98	-26.02	-24.33	-24.48	-24.42
GINI		-25.33	-25.18	6.70	6.60	6.67	6.98
Interaction Effects (Country Level)							
Country's % Single-Parent Families * Single Mother							-11.68 **
Country's % Single-Parent Families * Mother & Guardian							-7.65 **
Country's % Single-Parent Families * School's % Single-Parent Families							-10.67
Variance Components							
Student Level	5821.96	5396.28	5396.15	5399.41	5399.59	5398.35	5397.05
School Level	2838.22	1964.79	1919.55	979.42	973.21	972.51	973.08
Country Level	441.94	496.99	492.18	462.20	450.26	447.15	448.66
Deviance	2528614	2509159	2508924	2502856	2502809	2502755	2502709

*p<.05. **p<.01.

Source: Pooled PISA 2000 and 2003

Appendix III. Multilevel Regression Estimates for Mathematical Literacy per Country

Country	Single Mother	Mother & Guardian	School's % SPF	School's % SPF*SM	School's % SPF*M&G	$N_{students}$	$N_{schools}$
Australia	-4.28	-8.98 **	-10.18	-41.26 *	42.57	13883	552
Austria	2.96	-4.30	-41.75 **	29.16	30.54	6265	397
Belgium	-5.63 **	-3.85	-84.79 **	-14.72	50.42	10776	486
Canada	-4.26 **	-9.39 **	-14.42	-21.59	14.37	34083	2188
Czech Republic	1.89	-3.99	9.13	-26.33	-21.31	8459	479
Denmark	-6.59	-8.01 *	-1.04	3.43	-20.05	5520	427
Finland	1.01	-9.84 **	43.83 **	-39.38	-59.58	7820	352
France	3.94	1.19	-30.13	-32.47	-34.61	5642	346
Germany	4.42	10.22 **	-52.88 **	35.47	90.50	6589	426
Greece	-9.22 **	-6.93	4.86	-4.09	108.79	5280	324
Hungary	-0.32	-4.01	12.73	-0.48	29.99	6612	436
Iceland	6.29	-10.92 **	9.35	-13.52	15.59	4502	255
Ireland	-11.60 **	-11.03	-47.70 **	-11.37	32.98	4561	284
Italy	-4.63 **	-0.33	-7.87	-17.02	-22.34	12935	573
Luxembourg	0.61	6.98	133.12 *	-117.18 *	68.59	5123	53
the Netherlands	-2.21	-3.11	-119.48 **	-13.57	31.65	4731	250
New Zealand	-1.43	-15.53 **	-38.74 *	-54.18	79.70	5332	326
Norway	-7.78	-20.94 **	5.06	-35.68	88.87 *	4859	355
Poland	-11.67 **	-6.21	-32.66	11.18	70.83	6088	293
Portugal	-4.13	5.61	-26.43	51.06	-42.04	5546	301
Slovak Republic	-1.69	-7.56	-2.00	-9.94	-83.32	6954	281
Spain	-4.73 *	0.85	-43.25 *	-30.65	18.63	12615	568
Sweden	-12.86 **	-19.73 **	-12.6	9.09	59.34	5490	338
Switzerland	0.70	-6.69 **	-44.93 **	-39.79 **	-6.71	10207	718
United Kingdom	-2.22	-4.79	-98.35 **	-9.31	50.44 *	11321	740
United States	-11.78 **	-9.14 **	-95.65 **	-9.61	3.93	5987	421

*p<.05. **p<.01.

Source: Pooled PISA 2000 and 2003

Note: Models also include Gender, Educational Level, Immigrant Status, Parental Educational Level, Parental Occupational Status, Parental Working Hours, School's ESCS Index, Community, Teacher Shortage and Student-Staff Ratio.