Educational Achievement Gap between Single- and Two-parent-household Children: An International Comparison

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Partial Draft – September 2007

Abstract

Research in the U.S. has shown that children growing up in a two-parent household do better that those in single-parent household on a number of outcomes, educational in particular. In this paper, we use a cross-national study of educational achievement to test whether this finding applies to all countries. We find an almost universal, significant difference in favor of children from two-parent households, but the educational gap appears largest in the U.S. These gaps are typically reduced in half when controlling for family characteristics, in particular income which we predict from another set of international surveys. In two-level models where we include national indicators that may affect school performance, we find a number of significant factors, but the effects are typically small compared to household-level effects.

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Child welfare rests primarily on two institutions: the family and the State. Extensive research has documented the impact of the family on child outcomes. One of the most consistently documented differences in child outcomes is between children from single-parent and two-parent families. To the extent that parents draw resources from the market and the State toward their children, the size of the gradient between single-parent and two-parent families should depend in part on the characteristics of the market (and the possible advantage of two-parent families) and on State policies that may benefit all parents (thus alleviate market-driven inequalities) or benefit various family structures differentially.

While much research convincingly addresses the first issue, much less attention has been devoted to the second with the notable exception of an article by Pong, Dronkers and Hampden-Thomson (2003). Analyzing the achievement gap between third- and fourth-graders in single-parent and in two-parent families across 11 countries, the authors find the gap to be largest in the United States and family policies that equalize resources between the two types of families contribute to reduce the achievement gap. The authors also report that the gap is smaller in countries where single families are more prevalent.

In this paper, we attempt to replicate these results by looking at an older population of, mostly, seventh- and eighth-graders, increasing the number of countries to 14. We try to improve on the demographic indicators used in the model. When Pong and colleagues used cross-sectional vital statistics, we use demographic indicators recently made available, derived from retrospective family surveys and life table techniques, and that better represent childhood experiences of various family structures (Heuveline, Timberlake and Furstenberg 2003). Most importantly, we try to circumvent the limitation of these data on households' economic situation

by predicting household income from household structure separately for each country of residence.

Method

Data

We are using three sets of data in this paper. The first source of data is from The Trends in International Mathematics and Science Study (TIMSS) conducted in 1995 by the International Association for the Evaluation of Educational Achievement (IEA). The 1995 TIMSS was conducted across 41 countries, and had been the largest, most complex IEA study to date and the largest international study of educational achievement ever undertaken (online user guide of TIMSS, pp.1-3).[5] The study was conducted among three populations independently: population 1 includes students enrolled in the two adjacent grades that contained the largest proportion of 9-year-old students at the time of testing — third- and fourth-grade students in most countries, population 2 students enrolled in the two adjacent grades that contained the largest proportion of 13-year-old students at the time of testing — seventh- and eighth-grade students in most countries, and population 3 students in their final year of secondary education. Each participating country conducted the survey on population 2, but populations 1 and 3 were optional. In this paper, we use population 2 data, in part to maximize the number of countries. During the survey, in addition to testing booklets for students' mathematical and scientific skills, three separate questionnaires were distributed to collect background information about the school, the teachers, and the students respectively. In our study only data from student questionnaire were used, which contains information about students' demographics and home environment that were generally regarded as highly associated with students test scores.

[5] http://timss.bc.edu/timss1995i/database/UG_1and2.pdf

The sample selection was conducted in at least two stages. The first-stage was school sample selection. The standard for sampling precision required that all population samples have an effective sample size of at least 400 students for the main criterion variables, which resulted in at least 150 schools being selected per target population. The sample-selection method used for first-stage sampling was based on a systematic probability-proportional-to-size (PPS) technique. The second-stage was classroom and student sampling. Generally, in each school, one classroom was sampled from each target grade, although some countries opted to sample two classrooms at the upper grade in order to be able to conduct special analyses. Most participants tested all students in selected classrooms, and in these instances the classrooms were selected with equal probabilities. The few participants who chose to sub-sample students within selected classrooms sampled classrooms with PPS. As an optional third sampling stage, participants with particularly large classrooms in their schools could decide to sub-sample a fixed number of students per selected classroom. This was done using a simple random sampling method whereby all students in a sampled classroom were assigned equal selection probabilities.

The second type of datasets consists of those used to predict key family features that are not captured in the TIMSS. The most important one is household income. As described below, they are variables on assets that allow us to derive an index of household assets. This index could be missing important economic differences, and to the extent that those are known to be related to household structures (e.g., single- v. two-parent households), poor measurement in this area could lead us to incorrectly attribute educational differences due to parental income to household types. To alleviate this problem we use the Luxembourg Income Study (LIS), to estimate household income from household type separately for each of the countries. Second, cross-national data also lump important differences in parental involvement together in measuring

living arrangement at one point in time. For instance, an eighth-grader living with his single mother at the time of the survey could have been living so since birth (out-of-wedlock), or only for a year following parental separation. To the extent that countries differ in the relative prevalence of divorce and out-of-wedlock fertility (Heuveline et al. 2003), if these two routes to living with a single mother at the time of the survey differed with respect to their impact on educational achievement, we could end up estimating international differences in the effect of single parenting on educational outcomes. To partially correct for this, we use the Family and Fertility Survey data to estimate the average time spent with one or both parents based on household structure at age 12 in different countries.

The third source of data is a country-level dataset constituted through a review of published work in print and electronic format. The dataset includes first variables documenting the social and institutional context in which individual students and their families operate. These variables include 10 indicators of state welfare policies, such as family and child allowances, tax and benefit transfers, and maternal and parental leave policies. These are the policies that may impact the economic and social capitals available to the students. In addition to these policy variables, 3 demographic variables characterize the incidence of different family formation and disruption behavior, and the prevalence of different family structure. Both demographic and policy variables refer to the late 1980s and mid-1990s, to approach as much as possible the survey date of 1995 (see Appendix for sources).

Variables and measures

Direct individual-level measures

Academic achievement is the dependent variable of this study, refers to child's math and science test scores. Here we use the first plausible value of math or science score provided by TIMSS.

TIMSS reports students' academic achievement based on scale scores derived from Item Response Theory (IRT) scaling so that all students have a common scale or series of scales for their performance even when have been administered different items of test. Due to time constraint, each student was administered relatively few items within each of the content areas of each subject, therefore a multiple imputation or "plausible values" methodology (Mislevy 1991; Mislevy, Johnson, and Muraki 1992) was employed to achieve broad coverage and reliable indices of student proficiency in both subjects. Because of potential errors that may be involved in the imputation process, TIMSS produced not one but five imputed values for each student in mathematics and science. However, we found out that the internal correlation between the five plausible values are very high[6], and regression with different plausible values resulted in similar outcomes. Hence, we present below results using the first plausible value only.

Family structure variables are our major individual-level independent variables. We are particularly interested in looking at the academic gaps between students from single-parent families and those from two-parent families. For this purpose we define 4 types of family structures, namely, single parenthood, stepfamilies, guardian families, and two-parent families. The student questionnaire includes four questions about co-residence with the mother, the father, a stepmother, and a stepfather. Based on these four questions, we define as in a *single-parent* family, students residing with only one parent, either the student's father or mother, but without any stepparent. *Stepfamily* refers to families with students living with either a stepmother or a

[6] For math scores, the correlation coefficients between the 5 plausible values with all 14 countries' data pooled together range from .8766 to .8782; country specifically, the correlation coefficients range from .8221 to .9130, however within each country the gap between the highest correlation coefficient and the lowest one is less than .01 except for Belgium-Flemish (.0135). For science scores, the correlation coefficients of the 5 plausible values with pooled data range from .7983 to .8011; country specifically, the correlation coefficients range from .6895 to .8677, while within each country the gap between the highest correlation coefficient and the lowest one is again very small (the largest one is again for Belgium-Flemish and as low as .0165).

stepfather. A student not living with any parent or stepparent is defined as living in a *guardian family*. Finally, *two-parent family* corresponds to the family with both their mother and father.[7]

In addition to family structure, control variables include characteristics of the students and their family background. They include a dummy variable for *gender* and two dummy variables, "*Age < 12*" and "*Age >16*", to control for the effects from either relatively younger or older age than those of the majority students (between 12 and 16) at the time of the test. Due to the differences between national educational, the similar-age students' grade can vary substantially. Most countries select students from grade 7 and 8 as corresponding to the target population of children at age 13, but two countries in our sample (Sweden and Switzerland) actually select 3 grades (6, 7, and 8) of students, while another country (New Zealand) selects a different couple of grades (8 and 9) as population 2. Another dummy variable, *Upper grade*, controls for such differences in grades. We categorize the highest grade (grade 9 for New Zealand and 8 for other countries) as the upper grade. Another 6 variables indicate students' household background. *Mother's education, Father's education, Number of books*, *Percent of listed number of possessions*, *Immigrant status*, and *Household size* are used to proxy monetary and non-monetary family resources available to support student's schooling. We use "percent of listed number of possessions" rather than the absolute number of possessions because different countries list different number of items, ranging from 4 to 16.

Indirect estimation of individual-level measures

We first derive an estimate of *income* based on family structure at the time of the survey in each of the country. Using LIS data, we estimate the average household income for each family

[7] The questionnaire does not make specify whether the mother and father are to be interpreted as the biological mother and the biological father. Additional questions about stepmother and stepfather seem to indicate this was the intention, but some students may have been confused by this as some (though not too many) students responded to live together with mother and stepmother, or father and stepfather at the same time. We include those few cases in the stepfamily category.

structure and country. We then translate it into a comparable income using purchasing power parities (PPPs). We treat household income as a missing variable and thus impute for each child the average income for the family structure and country in which she lives.

We follow a similar imputation procedure for the number of years that a child has spent with both parents based on family structure at the time of the survey in each of the country. We use the FFS data to estimate the expected number of years lived with both parents based on family structure around age 12 in each country. Since we cannot always estimate it at exact age 12, we actually estimate a ratio of years with both parents to age, and impute for each child the average *proportion with both parents* for the family structure and country where she lives.

Country-level measures

The country-level variables include both demographic indicators and state welfare policy variables. Since we focus on single-parent family, the 3 demographic indicators measure the prevalence of this living arrangement and incidence of family formation and disruption behavior leading to it: *Incidence of birth to single mother*, *Incidence of parental divorce or separation by age 15* and *Child-year lived without both parents*. The 10 state policy variables are indicators of policies that support family income as well as parental time investment. These include policies targeting single parents as well as broader coverage of clients (*general social expenditure*), and policies for parental time (*maternity or parental leave*, for instance) as well as normal time. These indicators were not easily derived from a large number of countries and led to restrict our sample to 14 countries.

Analytical Strategy

We first use Ordinary Least Squares (OLS) regression for each of the 14 countries to investigate independently the relationship between single parenthood and students' math and science test

scores. We then pool the 14 countries' data and explore the potential variations among those countries. We try two different statistical models for the pooled data. First, we use a fixed-effects model to see whether there are variations across countries. We create one dummy variable for each of the country other than United States (leaving it as reference category for comparison). We then create 13 interaction items—each of the dummy country variables and the single parenthood variable. Such a fixed-effects model is equivalent to a saturated hierarchical model (HLM) without random effects. With this model we are able to compare the achievement gaps between children from single parenthood families and those from two-parent families in the United States and other countries. Second, we use a two-level random effect HLM model (Raudenbush & Bryk, 2002) to analyze the effects of state policies as well as national demographic characteristics on the students' academic achievements. The unit of analysis for the first-level model is student, and that of the second-level is the country in which students are nested:

$$(\text{Math/Science Test Scores})_{ij} = \beta_{0j} + \beta_{1j}\,(\text{Family Structure})_{ij} + \beta_{2j}\,(\text{Other})_{ij} + R_{ij,} \qquad (1)$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01}\,(\text{Family Policy})_j + \gamma_{02}\,(\text{Demographic Context})_j + U_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}\,(\text{Family Policy})_j + \gamma_{12}\,(\text{Demographic Context})_j + U_{1j.} \qquad (2)$$

As mentioned above, here we specify some of the coefficients as random. We assume that the parameter residuals U_{0j} and U_{1j} are independent from γs. We are most interested in estimating γ_{11} and γ_{12}, which are the effects of family policies and demographic context on the achievement gap between single-parent and two-parent families (β_{1j}). By introducing family policy variables and demographic variables into the model simultaneously, we are able to control for the possible confounding effects between them.

Results

Results from OLS regression analysis

Table 1 reports the results of our OLS regression analysis concerning the associations between single-parent family and students' math or science scores. We run the regression for each country separately. As shown in the table, we have two models for each country: Model 1 includes 3 family structure variables (i.e., single parenthood, stepfamily, and guardian family, leaving two-parent family as the reference category) and 4 control variables indicating students' gender, age, and grade level. In addition to those variables in model 1, model 2 includes 6 variables representing family resources: mother's education, father's education, number of books, percent of number of possessions, immigrant status, and household size.

Model 1 results suggest in most countries a significantly negative association between single parenthood and test scores, for both math and science. The positive coefficients are few and all non-significant.[8] The United States exhibits the largest achievement gaps between students from single-parent and from two-parent families, reaching about a third of a standard deviation (SD) in math and in science. Both sets of numbers far exceed those of the next country — New Zealand (with achievement gaps between one fifth and one fourth of a SD in math and in science).

The pattern of negative association between single parenthood and test scores is reduced some after controlling for the TIMSS family resource variables, most notably for the U.S.. As shown in Table 1, model 2, however, most effects significant in model 1 remain significant in

[8] Austria, Latvia, and Slovenia exhibit small positive gaps for either or both math and science scores, but none of them is statistically significant.

model 2 with the same (negative) signs,[9] and all non-significant effects in model 1 are non-significant in model 2 as well.

Results from fixed-effects models

Table 2 presents results from the fixed-effects model. The fixed-effects model is applied because regression analysis from each country separately cannot definitely demonstrate the achievement gaps between students from single parenthood and two-parent family across countries. With all 14 countries' data pooled together, we could check the achievement gaps across countries by the interaction terms. As the OLS models reported in table 1, two models are estimated, the second one including family resource variables.

Since the United States is the reference country, the coefficient of family structure variables indicates the association between family structure and test scores in the United States, while the intercept is the average test score of students from two-parent families in the United States. For instance, without controlling for family resources, the intercept of model 1 for math is 473.375, the average math score for students from two-parent families in the United States, and the achievement gap in math between students from single- and two- parent families is 34.524. The table shows that there indeed exist significant achievement gaps between students from single parenthood and two-parent families for both math and science in the United States. Controlling for family resources only reduces the magnitude of these gaps, but they remain quite large and statistically significant and in the order of a quarter of a SD. For instance, for math scores, after controlling for TIMSS family resource variables, the magnitude of achievement gaps between single parent and two-parent families declines from 34.524 to 24.741, however, both figures are quite large and statistically significant. Similarly, for Science scores, the

[9] There are a few exceptions. Before controlling for family resources variables, Belgium-Flemish exhibits significant negative gap for both math and science, and Czech, Germany and Hungary exhibit significant negative gap for science. All these effects are non-significant after controlling for family resource variables.

corresponding change is from 36.616 to 25.984, again both the achievement gaps are large and significant.

In Model 3, the imputation of household income, however imprecise as it may be in our procedure, further reduces the educational gap between children in single- and two-parent households to about one fifth of a SD. The gap in math is then estimated at -20.225 in math and -21.277 in science, about 40% less than their value without control (-34.524 and -36.616 respectively). Interestingly, the addition of income does not eliminate the effect of other household characteristics, including household possessions. This is consistent with the fact that the survey attempted to measure possessions that potentially affected learning directly, not just wealth indicators (e.g., personal computer).

In Model 4, the addition of the predicted number of years lived with both parents eliminates the effect of single parenthood. This may appear partly tautological, but it suggests that the educational gap between children in single- and two-parent household results entirely from the latter ones' better material conditions in the household and access to both parents, without necessarily any additional effect (e.g., stigma) of being in a single-parent household. This is very different from the results for children in step-family households. Their absolute gap with children in two-parent households is initially smaller than the gap for children in single-parent households. Controlling for income has relatively little impact for children step-family households, and controlling for time without both parent almost none. In Model 4, the gap for children from step-family households thus remains significant and negative, suggesting that these children do less well than the material household conditions and the past access to both parents would suggest.

The international comparisons show that American children from two-parent households are outscored by their peers in most countries in Math (the country coefficients are only negative for Italy and Latvia), but are doing better in Science than their peers in quite a few countries (Canada, France, Italy, Latvia, and New Zealand). But the notable international pattern in table 2 for Model 1, is that all interaction terms are positive and significant, which suggests that each of the 13 countries listed in the table has significantly smaller achievement gaps between students from single-parent and two-parent families than those of the United States. The interaction terms are still positive, although smaller and in some case down to no longer being significant, when controls are added in Models 2 to 4.

Results from random effects hierarchical linear models

In this paper, our main interest is the extent to which state welfare policies may affect the achievement gaps between students from single-parent and two-parent families. In both the OLS and the fixed-effects models, our estimates show the significant association between family resources (even as coarsely measured as here) and students' test scores. State policies may mediate the relationship between resources owned by the students' families and their achievement.

Table 3 displays our country-level indicators. Large cross-country variations are visible in the policy realm as much as in average demographic behaviors. Family or child allowances to support low-income families did not exist in Slovenia, and they only accounted to 2.47% of the average male wages in manufacturing in Canada, whereas in France and Belgium, they amounted to 25.23% and 20.87% respectively, constituting the two highest among the 14 listed countries. France and Belgium also had the highest enrollment rates at age 4. Their high rates of enrollment, 100% for France and 97% for Belgium, contrasted sharply with Switzerland's 29%

and Canada's 43%. In addition, Belgium and Germany provided the highest benefits in tax and security to lone parents, which were unavailable to parents in several countries (Austria, France, New Zealand, and Sweden). Sweden, however, offered the longest maternity leave (65 weeks), more than 3 times longer than in the second country (Italy, 20 weeks), and more than 5 times longer than in the United States (12 weeks), the least generous country in that respect. As for demographic behavior, the incidence of birth to single (out-of-partnership) mother in Belgium (1.5) is in stark contrast with the incidence in the United States (16.2), where it is more than 10 times larger. Although the variations are not as big as the above one, the incidence of parental divorce/separation by age 15 and child-year without both parents still demonstrate a five and six times range from the lowest to highest, respectively.[10]

We first check the effects of those policy and demographic indicators on single parenthood family one by one, by introducing only one variable a time as the only predictor of the slope of single parenthood (i.e., achievement gaps between students from single parenthood and two-parent families) in the country level model. At the individual level, we introduce all family structure variables, family resource variables as well as control variables for age, gender, and grade level. Table 4 presents the results. For the sake of simplicity, we only report selected country-level coefficients. β_{1j} in the table is the achievement gaps between students from single parent and two-parent families, and γ_{11} and γ_{12} represent effects of policy and demographic indicators respectively. All significant and negative values of β_{1j} suggest that achievement gaps remain substantial even after controlling for those policy and demographic indicators one by one separately.

[10] For incidence of parental divorce/separation by age 15, Slovenia has the lowest incidence of 6.8, and United States has the highest rate of 35.1; Italy has the smallest value (0.81) of child-year without both parents, whereas United States again has the biggest value (5.12).

Since the achievement gaps are negative, a positive sign of the coefficient of policy and demographic indicator would mean the alleviation of achievement gaps, and on the contrary, a negative sign indicates an increase of achievement gaps. For instance, the coefficient for *family or child allowance* on math achievement gaps is 0.354, which suggests that in countries where family or child allowances are 10% higher (in terms of male manufacturing wage), the achievement gaps are about 3.54 points less, a figure that contributes to offset more than one forth of the negative effects of single parenthood family (-12.033). Nearly all the indicators of family policies have similarly significant but relatively small effects, compared to the size of the achievement gap. For demographic indicators, all the three variables have significant effects on both Math and Science achievement gaps. The negative sign for the coefficients indicate that the increase of the value of those variables would deteriorate (enlarge) the achievement gaps.

In order to control for the potential confounding effects of demographic indicators, we also use HLM models by introducing both family policy variables and demographic indicators into the country-level model simultaneously. We have two sets of models concerning this: we first introduce child-year without both parents with each of the family policy variables together, and then we introduce the incidence of birth to single mother and incidence of parental divorce/separation by age 15 together with each of the policy variables. Table 5a, 5b, and 5c report those results respectively.

Table 5 indicates that even after controlling for the effect of any of the demographic indicator, *family or child allowances, tax and benefit transfers* and *maternity leave benefits* remain significant or marginally significant factors for both math and science achievement gaps. And (Marginally) significant effects could also be found in *Social expenditure per GDP* and *total expenditure on education (%)* on math as well as *expenditure on family allowances* on science

achievement gaps. This pattern of significant and non-significant effects among family policies does not change too much even after controlling for the effects of another two demographic indicators: *incidence of birth to single mother* and *incidence to parental divorce/separation by age 15*, except that *expenditure on family allowances* exhibit strongly positive and significant effects on both math and science gaps, as shown in table 6.

Comparing the results of table 4 with tables 5 and 6, we do find some evidence of confounding effects between demographic and family policy variables: before controlling for demographic indicators, we do not find any significant effects of *total expenditure on GDP* on students' math achievement gaps (Table 4), but the effects become marginally significant after controlling for either one (Table) or two (Table 6) demographic variables. Conversely, before controlling for demographic variables, we find (marginally) significant effects of *expenditure on family allowances* and *parental leave* on Math gaps, and of *Parental leave, maternity leave in weeks, social expenditure on GDP,* and *enrolment rates at age 4* on Science gaps, and after controlling for demographic variables these effects became non-significant. Even more strikingly, *parental leave* shows positive effects without controlling for effects of demographic indicators, whereas after taking them into account, regardless of from one indicator (Table 5) or two indicators (Table 6), the effects become negative (except the effects on Science gap in Table 6), though they are not statistically significant anymore.

However, we could still conclude that some family policies do have significant effects on achievement gaps between students from single parenthood and two-parent families even after controlling for the possible confounding effects between demographic characteristics and family policies. Taking a look at the results of Table 4, Table 5, and Table 6 together, we could find that some family policy variables (e.g., *family or child allowances* and *maternity leave benefits*)

exhibit the same pattern (either positive or negative) of significant associations with the achievement gaps, and including or excluding demographic indicators of possible confounding effects would only bring slight fluctuations of the magnitude of the associations. These findings suggest that while achievement gaps between different family types are relatively universal, State policies can significantly alleviate these gaps.

Discussion

Our cross-national findings confirm well-established findings for the U.S. First, children from single-parent household do not perform as well in school as children from two-parent households. Second, controlling for material conditions in the households reduces this gap by nearly one half (McLanahan and Sandefur 1994). Third, children from step-family household do better than those in single-parent households but worse than those in two-parent households.

At the household-level, we add to this literature that when we estimate the number of years children have spent with both parents by the time of the survey, there appears to be no residual for children from single-parent households, but still a negative residual for those from step-family household. This is again consistent with the literature on step-families that suggests that compared to those in single-parent households, children in step-family households benefit from improved material conditions, but do not do as well as those material conditions alone would predict (Cherlin and Furstenberg 1994). It is, to our knowledge, a new finding that children from single-parent households do not do worse, on average, than their material conditions and reduced access to one of their parents predicts, suggesting no additional stigma to a family structure than has become quite prevalent.

At the country-level, we find first that children from single-parent households in the U.S. suffer a greater educational gap with children in two-parent households than their peers in any

other countries. American children from two-parent households, meanwhile, do worse than their peers in other countries in Math, but are closer to the average in Science (ranking 9th out of 14th). The achievement of American children is even less favorable when considering material household conditions that are on average better than in other countries.

Finally, we find that national policy indicators appear to have significant but small impacts on the size of the educational gap between children in single- and in two-parent households. The gap does appear to be reduced by indicators denoting more "generous" welfare states, but the size of the effect suggests than even a drastic increase in benefits or transfers would alleviate only partially the achievement gap.

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Table 1. Within-Country Ordinary Least Squares Regression Predicting Math and Science Achievement From Single Parenthood

	Model 1		Model 2	
Countries	β	Effect Size	β	Effect Size
Math Achievement				
Austria	0.273	0.003	0.735	0.008
Belgium-Flemish	-10.004***	0.123	.988	0.012
Canada	-18.719***	0.220	-15.832***	0.188
Czech	-16.795***	0.180	-11.933***	0.130
France	-11.201***	0.144	-13.590***	0.177
Germany	-13.006***	0.149	-10.538**	0.123
Hungary	-10.372**	0.112	-10.347*	0.113
Italy	-22.324***	0.245	-27.304***	0.307
Latvia	-1.054	0.013	-5.431	0.066
New Zealand	-21.790***	0.239	-20.289***	0.227
Slovenia	0.700	0.008	-4.062	0.046
Sweden	-14.287***	0.161	-12.525***	0.144
Switzerland	-10.438***	0.117	-8.024***	0.091
United States	-33.783***	0.367	-25.144***	0.276
Science Achievement				
Austria	3.839	0.039	.977	0.010
Belgium-Flemish	-7.790**	0.102	-4.589	0.060
Canada	-14.356***	0.153	-10.272***	0.111
Czech	-9.560	0.111	-3.560	0.042
France	-9.155***	0.116	-16.084***	0.208
Germany	-5.538	0.056	-3.364	0.035
Hungary	-11.142**	0.122	-6.529	0.073
Italy	-17.835***	0.202	-18.663***	0.216
Latvia	1.199	0.014	-4.469	0.052
New Zealand	-26.095***	0.259	-24.966***	0.253
Slovenia	2.488	0.028	-.990	0.011
Sweden	-12.442***	0.132	-8.698*	0.093
Switzerland	-1.299	0.014	3.819	0.042
United States	-36.243***	0.336	-27.098***	0.256

Note: For result of France, the variable of migrant is missing.
* p<0.10; ** p<0.05; *** p<0.01.

Table 2: Ordinary Least Squares Regression Analysis for Variables Predicting Math and Science achievement, all 14 countries combined

Variables	Math				Science			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Constant	474.405***	386.950***	378.724***	336.187***	509.082***	424.962***	416.388***	378.256***
	(453.80)	(193.49)	(121.46)	(39.36)	(460.33)	(201.71)	(126.77)	(42.04)
single	-34.524***	-24.741***	-20.225***	6.277	-36.616***	-25.984***	-21.277***	2.480
	(16.82)	(12.37)	(8.45)	(1.14)	(16.86)	(12.34)	(8.44)	(0.43)
stepfam	-24.244***	-18.410***	-18.317***	-17.554***	-17.500***	-11.075***	-10.978***	-10.295***
	(25.24)	(19.69)	(19.58)	(18.55)	(17.22)	(11.24)	(11.14)	(10.33)
guardian	-41.298***	-30.224***	-29.359***	-3.255	-37.257***	-23.928***	-23.027***	0.373
	(17.60)	(12.94)	(12.50)	(0.60)	(15.01)	(9.72)	(9.30)	(0.07)
age12	6.167	-5.092	-5.239	-5.270	3.451	-7.726	-7.879	-7.907
	(0.95)	(0.81)	(0.83)	(0.84)	(0.50)	(1.16)	(1.19)	(1.19)
age16	-55.089***	-37.698***	-37.685***	-37.666***	-46.731***	-26.478***	-26.464***	-26.447***
	(17.79)	(12.46)	(12.46)	(12.46)	(14.26)	(8.31)	(8.31)	(8.30)
female	-5.686***	-6.633***	-6.634***	-6.665***	-16.122***	-17.224***	-17.225***	-17.253***
	(10.68)	(12.79)	(12.79)	(12.85)	(28.61)	(31.52)	(31.53)	(31.58)
upgrade	37.941***	37.865***	37.860***	37.850***	38.887***	38.516***	38.512***	38.503***
	(69.41)	(71.57)	(71.56)	(71.55)	(67.25)	(69.11)	(69.10)	(69.09)
edu_m		4.115***	4.031***	4.052***		3.554***	3.466***	3.485***
		(16.38)	(15.97)	(16.06)		(13.43)	(13.04)	(13.11)
edu_f		5.565***	5.126***	5.210***		4.794***	4.336***	4.412***
		(22.70)	(18.53)	(18.81)		(18.56)	(14.88)	(15.12)
booknmb		15.357***	15.328***	15.331***		17.203***	17.173***	17.175***
		(63.87)	(63.72)	(63.74)		(67.92)	(67.76)	(67.78)
posspct		11.879***	11.904***	11.809***		14.511***	14.537***	14.452***
		(6.81)	(6.82)	(6.77)		(7.89)	(7.91)	(7.86)
migrant		-17.111***	-17.073***	-17.073***		-26.726***	-26.687***	-26.687***
		(16.06)	(16.02)	(16.03)		(23.81)	(23.77)	(23.78)
homesize		-2.792***	-2.784***	-2.791***		-3.804***	-3.796***	-3.802***
		(16.39)	(16.34)	(16.38)		(21.20)	(21.15)	(21.18)
inc1000			0.166***	0.134***			0.174***	0.144***
			(3.44)	(2.75)			(3.40)	(2.81)
parpct				55.686***				49.918***
				(5.35)				(4.55)
austria	47.915***	57.974***	61.560***	55.981***	28.703***	37.688***	41.427***	36.425***
	(30.73)	(37.96)	(33.29)	(26.37)	(17.40)	(23.42)	(21.26)	(16.29)
belgium	83.694***	90.682***	93.689***	83.968***	27.673***	33.068***	36.202***	27.489***
	(55.12)	(61.56)	(54.69)	(33.63)	(17.23)	(21.31)	(20.06)	(10.45)

canada	21.835***	19.589***	22.104***	14.962***	-8.864***	-12.511***	-9.889***	-16.292***
	(18.34)	(16.95)	(16.16)	(7.83)	(7.04)	(10.28)	(6.87)	(8.09)
czech	52.497***	54.822***	61.866***	54.143***	33.626***	33.325***	40.668***	33.746***
	(36.15)	(37.56)	(24.60)	(18.67)	(21.89)	(21.67)	(15.35)	(11.05)
france	32.873***	40.544***	45.150***	40.340***	-39.324***	-33.421***	-28.620***	-32.932***
	(21.40)	(26.45)	(22.18)	(18.13)	(24.20)	(20.70)	(13.35)	(14.05)
germany	14.428***	24.847***	28.776***	26.341***	1.084	9.705***	13.800***	11.618***
	(9.23)	(16.10)	(14.99)	(13.35)	(0.66)	(5.97)	(6.82)	(5.59)
hungary	36.658***	35.559***	43.425***	33.958***	21.931***	17.598***	25.797***	17.311***
	(24.35)	(24.05)	(15.94)	(10.46)	(13.77)	(11.30)	(8.99)	(5.06)
italy	-12.427***	5.895***	10.424***	-0.872	-38.456***	-22.452***	-17.731***	-27.857***
	(7.80)	(3.72)	(5.06)	(0.30)	(22.81)	(13.46)	(8.17)	(8.97)
latvia	-7.016***	-15.655***	-11.613***	-18.588***	-56.493***	-68.142***	-63.929***	-70.182***
	(4.13)	(9.30)	(5.66)	(7.64)	(31.42)	(38.43)	(29.56)	(27.40)
newzland	8.463***	7.394***	11.416***	5.513**	-8.988***	-11.024***	-6.832***	-12.123***
	(5.73)	(5.12)	(6.14)	(2.55)	(5.75)	(7.25)	(3.49)	(5.33)
slovenia	31.316***	38.816***	44.556***	34.794***	26.569***	32.053***	38.036***	29.286***
	(20.49)	(26.12)	(19.93)	(12.06)	(16.43)	(20.47)	(16.15)	(9.64)
sweden	38.699***	35.796***	39.566***	32.604***	23.072***	17.850***	21.778***	15.538***
	(28.19)	(26.67)	(22.83)	(15.05)	(15.89)	(12.63)	(11.93)	(6.81)
switland	68.016***	76.647***	78.620***	69.763***	12.576***	19.795***	21.852***	13.912***
	(53.13)	(60.76)	(56.73)	(32.31)	(9.29)	(14.90)	(14.97)	(6.12)
int_aut	33.991***	21.109***	19.135***	17.487***	39.667***	24.776***	22.719***	21.242***
	(8.82)	(5.67)	(5.08)	(4.63)	(9.72)	(6.32)	(5.73)	(5.34)
int_bfl	22.818***	13.877***	12.860***	7.414*	27.694***	17.675***	16.615***	11.734**
	(5.09)	(3.22)	(2.98)	(1.67)	(5.84)	(3.90)	(3.65)	(2.51)
int_can	14.393***	8.227***	6.913***	4.915*	20.690***	13.673***	12.303***	10.512***
	(5.27)	(3.11)	(2.58)	(1.82)	(7.16)	(4.90)	(4.36)	(3.69)
int_csk	15.877***	6.799*	3.735	0.765	25.590***	15.510***	12.317***	9.654**
	(4.01)	(1.78)	(0.95)	(0.19)	(6.11)	(3.85)	(2.98)	(2.31)
int_fra	20.479***	13.180***	10.966***	3.387	25.213***	14.876***	12.568***	5.774
	(5.03)	(3.31)	(2.72)	(0.79)	(5.86)	(3.55)	(2.96)	(1.28)
int_deu	20.280***	10.564***	9.102**	7.168*	28.162***	17.005***	15.481***	13.747***
	(5.33)	(2.85)	(2.44)	(1.91)	(6.99)	(4.36)	(3.94)	(3.48)
int_hun	22.136***	13.611***	9.870**	7.193	25.156***	17.485***	13.585***	11.186**
	(4.61)	(2.90)	(2.05)	(1.48)	(4.95)	(3.53)	(2.67)	(2.19)
int_ita	13.182***	3.930	1.041	4.973	19.641***	9.381*	6.371	9.895*
	(2.64)	(0.81)	(0.21)	(1.00)	(3.72)	(1.83)	(1.23)	(1.89)

int_lva	30.090***	20.036***	15.533***	13.104***	35.343***	23.972***	19.277***	17.100***
	(7.65)	(5.21)	(3.82)	(3.21)	(8.49)	(5.92)	(4.51)	(3.97)
int_nzl	14.688***	9.459***	4.922	3.507	12.816***	6.827*	2.097	0.829
	(4.27)	(2.83)	(1.37)	(0.97)	(3.52)	(1.94)	(0.55)	(0.22)
int_svn	35.310***	21.639***	18.333***	26.864***	38.502***	23.780***	20.334***	27.981***
	(8.06)	(5.13)	(4.24)	(5.83)	(8.31)	(5.36)	(4.47)	(5.77)
int_swe	19.915***	15.487***	13.935***	12.748***	24.190***	19.290***	17.672***	16.608***
	(5.85)	(4.69)	(4.18)	(3.81)	(6.72)	(5.54)	(5.03)	(4.72)
int_che	22.922***	13.398***	11.431***	9.441***	34.447***	24.046***	21.995***	20.211***
	(7.45)	(4.50)	(3.77)	(3.09)	(10.58)	(7.66)	(6.88)	(6.28)
Observations	103145	100307	100307	100307	103145	100307	100307	100307
Adjusted R-squared	0.13	0.20	0.20	0.20	0.12	0.19	0.19	0.19

Absolute value of t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3. Demographic Characteristics and Family Policies, by Country

Country Level Variables	AUT	BFL	CAN	CSK	DEU	HUN	ITA	NZL	SVN	SWE	CHE	USA
Birth to single mother, incidence	13.6	1.5	8.3	5.4	15.2	4.4	2.2	12.6	6.8	5.5	3	16.2
Divorce/Separate by age 15, incidence	26.2	15.5	26.2	29.4	24.1	22.9	8.7	36.4	6.8	28.5	19.7	35.1
Child-year w/out both parents	3.94	1.41	3.39	3.18	3.99	2.4	0.81	5.08	1.25	3.16	1.7	5.12
Family or child allowances	19.77	20.87	2.47	11.55	10.18	18.65	7.88	9.32	0		16.68	8.32
Tax and benefit transfers	18.11	23.05	11.33		14.57		7.88	2.46	7.09		10.25	11.62
Exp. on family allowance	2.23	2.14	0.78		0.92		0.46	0.67	0		4.88	0.24
Benefits in tax and security to lone parents	0	-64			-42		-7	0		0		-24
Parental leave	0	2			1		2	0		2		0
Maternity leave benefits (%)	100	80	55		100		80	0		75		0
Maternity leave in weeks	16	15	15		14		20	14		65		12
Social expenditure per GDP	25.61	26.62	18.13	18.81	25.20		24.38	20.85		33.91	17.95	14.95
Total expenditure on education (%)	6.05	4.84	5.8	4.55	4.54	4.6	4.65			6.73	5.51	5.2
Enrollment rates at age 4	73	97	43	77	84		96	95		67	29	59

Note: AUT = Austria; BFL = Belgium (Flemish); Can = Canada; CSK = Czech; DEU = Germany; HUN = Hungary; ITA = Italy; NZL = New Zealand; SVN = Slovenia; SWE = Sweden; CHE = Switzerland; USA = United States.
See Appendix for source of each variable.

Table 4. Hierarchical Linear Models Predicting Math and Science Achievement Gap Between Single- and Two- Parent Families From Each Family Policy or From Each Demographic Context Variable

	Math		Science	
Model with a Family Policy Variable	γ_{11}	(β_{1j})	γ_{11}	(β_{1j})
Family or child allowances	0.354***	-12.033***	0.498***	-8.683***
Benefits in tax and security to lone parents	0.035	-12.781***	-0.003	-13.243***
Exp. on family allowance	1.767***	-11.220***	3.563***	-9.654***
Tax and benefit transfers	0.587***	-9.991***	0.738***	-7.920***
Parental Leave	2.872**	-11.805***	5.106***	-11.895***
Maternity leave benefits	0.122***	-9.731***	0.181***	-9.541***
Maternity leave in weeks	0.146***	-10.969***	0.176***	-11.411***
Social Expenditure per GDP	0.640***	-10.997***	0.651***	-7.956***
Total Expenditure on Edu (%)	3.999***	-11.414***	3.794***	-6.721***
Enrolment Rates at age 4	-0.023	-11.896***	-0.117***	-9.432***
Model with a Demographic Variable	γ_{12}	(β_{1j})	γ_{12}	(β_{1j})
Birth to single mother, incidence	-0.466***	-11.520***	-0.956***	-8.322***
Div/Sep by age 15, incidence	-0.410***	-10.898***	-0.661***	-7.394***
Child-year w/out both parents	-2.294***	-11.122***	-4.192***	-7.633***

Note: GDP = gross domestic product. Each coefficient comes from a hierarchical linear model in which the corresponding family policy or demographic variable and all individual-level variables are included. β_{1j} is the coefficient of single parenthood (i.e., the achievement gap between single-parent and two-parent families). γ_{11} is the coefficient of family policy predicting the achievement gap, and γ_{12} is the coefficient of demographic context predicting the achievement gap.
*p<0.1. **p<0.05. ***p<0.01.

Table 5. Hierarchical Linear Models Predicting Math and Science Achievement Gap Between Single- and Two-Parent Families From Each Family Policy Together with One Demographic Context Variable

5A. Country Level Equations, Each with a Family Policy Variable and Birth to single mother

	Math		Science	
Model with a Family Policy Variable	γ_{11}: Family Policy	γ_{12}: Birth to single mother	γ_{11}: Family Policy	γ_{12}: Birth to single mother
Family or child allowances	0.292**	-0.330*	0.343**	-0.831***
Benefits in tax and security to lone parents	0.040	-0.484**	0.006	-0.736***
Exp. on family allowance	1.411**	-0.186	2.658***	-0.474**
Tax and benefit transfers	0.541***	-0.401**	0.632***	-0.913***
Parental Leave	1.854	-0.196	6.049**	0.182
Maternity leave benefits	0.127***	0.088	0.179***	-0.041
Maternity leave in weeks	0.120*	-0.199	0.102	-0.554**
Social Expenditure per GDP	0.578***	-0.242	0.447***	-0.798***
Total Expenditure on Edu (%)	3.716***	-0.327*	3.156**	-0.735***
Enrolment Rates at age 4	0.002	-0.421**	-0.067	-0.862***

5B. Country Level Equations, Each with a Family Policy Variable and Div /sep by age 15

	Math		Science	
Model with a Family Policy Variable	γ_{11}: Family Policy	γ_{12}: Div/sep by age 15	γ_{11}: Family Policy	γ_{12}: Div/sep by age 15
Family or child allowances	0.308**	-0.421***	0.426***	-0.663***
Benefits in tax and security to lone parents	0.093	-0.405***	0.099	-0.711***
Exp. on family allowance	1.144*	-0.359***	2.637***	-0.533***
Tax and benefit transfers	0.396*	-0.372***	0.412*	-0.637***
Parental Leave	1.701	-0.185	2.384	-0.431**
Maternity leave benefits	0.184***	0.447**	0.226***	0.322
Maternity leave in weeks	0.138**	-0.309**	0.160***	-0.608***
Social Expenditure per GDP	0.558***	-0.254**	0.436***	-0.670***
Total Expenditure on Edu (%)	4.719***	-0.443***	5.005***	-0.745***
Enrolment Rates at age 4	-0.008	-0.369***	-0.087**	-0.725***

5C. Country Level Equations, Each with a Family Policy Variable and Child-year w/out both parents

	Math	Science

Model with a Family Policy Variable	γ_{11}: Family Policy	γ_{12}: Child-year w/out both parents	γ_{11}: Family Policy	γ_{12}: Child-year w/out both parents
Family or child allowances	0.260*	-2.015***	0.318**	-3.846***
Benefits in tax and security to lone parents	0.072	-2.303***	0.060	-3.833***
Exp. on family allowance	0.940	-1.706**	2.180***	-2.853***
Tax and benefit transfers	0.445**	-1.950***	0.460**	-3.817***
Parental Leave	0.838	-1.574	1.632	-2.688
Maternity leave benefits	0.152***	1.395	0.197***	0.750
Maternity leave in weeks	0.115**	-1.515*	0.111*	-3.189***
Social Expenditure per GDP	0.558***	-1.352**	0.422**	-3.799***
Total Expenditure on Edu (%)	4.138***	-1.967***	4.060***	-3.779***
Enrolment Rates at age 4	0.007	-2.004***	-0.057	-4.026***

Table 6. Hierarchical Linear Models Predicting Math and Science Achievement Gap Between Single- and Two-Parent Families From Each Family Policy Together with Two Demographic Context Variables

Country Level Equations, Each with a Family Policy Variable and Two Demographic Variables						
		Math			Science	
Interaction: Single-Parenthood * (Family Policy)	γ_{11}: Family Policy	γ_{13}: Div /sep by age 15	γ_{14}: Birth to Single Mother	γ_{11}: Family Policy	γ_{13}: Div /sep by age 15	γ_{14}: Birth to Single Mother
Family or child allowances	0.355**	-0.567***	0.338	0.411***	-0.619***	-0.103
Benefits in tax and security to lone parents	0.084	-0.332	-0.138	0.100	-0.716***	0.010
Exp. on family allowance	2.073***	-0.643***	0.745**	3.470***	-0.789***	0.668*
Tax and benefit transfers	0.379*	-0.435**	0.132	0.453**	-0.485***	-0.319
Parental Leave	1.185	-0.175	-0.112	4.253	-0.469**	0.407
Maternity leave benefits	0.191***	0.639**	-0.332	0.234***	0.558*	-0.408
Maternity leave in weeks	0.196***	-0.537**	0.483	0.226***	-0.867***	0.547
Social Expenditure per GDP	0.559***	-0.259	0.010	0.410**	-0.511***	-0.301
Total Expenditure on Edu (%)	5.065***	-0.557**	0.184	4.774***	-0.668***	-0.123
Enrolment Rates at age 4	-0.004	-0.314*	-0.103	-0.077*	-0.579***	-0.276

Note: GDP = gross domestic product. For each subject, each row represents one hierarchical linear model in which the corresponding family policy variable, demographic variable, and all individual-level variables are included.

*p<0.1. **p<0.05. ***p<0.01.

Table 7. Hierarchical Linear Models Predicting Math and Science Achievement Gap Between Single- and Two- Parent Families From Two Family Policy Together with One Demographic Context Variables

7A. Country Level Equations, Each with Two Family Policy Variables and Birth to Single Mother

Interaction: Single-Parenthood*(Family Policy)*(Birth to Single Mother)	Math			Science		
	γ_{11}: First Policy	γ_{13}: Second Policy	γ_{14}: Birth to Single Mother	γ_{11}: First Policy	γ_{13}: Second Policy	γ_{14}: Birth to Single Mother
Maternal Leave Benefits & Total Expenditure on Education (%)	0.125***	3.566**	0.246	0.173***	3.262*	0.096
Maternal Leave Benefits & Parental Leave	0.145***	-4.847	-0.641	0.195***	-2.962	-0.416
Maternal Leave Benefits & Exp. on family allowance	0.053	6.513***	0.241	0.132***	4.022	0.056
Total Expenditure on Education (%) & Parental Leave	4.071**	0.252	-0.198	3.521**	3.105	-0.014
Total Expenditure on Education (%) & Exp. on family allowance	2.845	2.079***	0.109	2.833	3.197***	-0.156
Parental Leave & Exp. on family allowance	1.552	9.099***	0.451	7.160**	10.986***	1.065**

7B. Country Level Equations, Each with Two Family Policy Variables and Div/Sep by Age 15

Interaction: Single-Parenthood*(Family Policy)*(Birth to Single Mother)	Math			Science		
	γ_{11}: First Policy	γ_{13}: Second Policy	γ_{14}: Div/Sep by Age 15	γ_{11}: First Policy	γ_{13}: Second Policy	γ_{14}: Div/Sep by Age 15
Maternal Leave Benefits & Total Expenditure on Education (%)	0.155***	1.967	0.325	0.190***	2.503	0.165
Maternal Leave Benefits & Parental Leave	0.178***	0.419	0.467*	0.224***	0.767	0.391
Maternal Leave Benefits & Exp. on family allowance	0.092*	5.725**	0.280	0.168***	3.502	0.217
Total Expenditure on Education (%) & Parental Leave	7.041***	-2.720	-0.651**	7.388***	-2.315	-0.877***
Total Expenditure on Education (%) & Exp. on family allowance	3.958*	1.303*	-0.238	4.991**	2.405***	-0.481**
Parental Leave & Exp. on family allowance	-2.858	7.966***	-0.218	-4.371	7.991***	-0.631

Note: GDP = gross domestic product. For each subject, each row represents one hierarchical linear model in which the corresponding family policy variable, demographic variable, and all individual-level variables are included.

*p<0.1. **p<0.05. ***p<0.01.

Appendix Description of Country-Level Variables

Country-Level Variables	Description	Source
Birth to single mother, incidence	Proportion of a birth cohort born to an unmarried, non-cohabiting mother, early 1990s	Heuveline and Timberlake (2003)
Divorce/Separate by age 15, incidence	Estimated life-table proportion of a birth cohort that will experience parental separation by age 15 at early 1990s rates	Ibid.
Child-year w/out both parents	Estimated life-table number of years not spent cohabiting with both parents between birth and age 15 at early 1990s rates	Ibid.
Family or child allowances	Monthly family allowances for the first, second, and third child (in national currency), in proportion of average male monthly earnings, 1986-1995 average	Gauthier (2005)
Tax and benefit transfers	Value of tax and benefit transfers of one-earner-two-parent two-child families in proportion of average male monthly earnings, 1986-1995 average	Ibid.
Expenditure on family allowance	Total expenditure on family allowances as a percentage of the countries' gross domestic product	Ibid.
Benefits in tax and security to lone parents	Differences in tax and social security per month paid by lone parents compared with payments by married couples, 1994, for parents with average earnings and with two children aged 7 and 8	Bradshaw et al. (1996), Table 5.4
Parental leave	Generosity of package of leave (for either mother or father); arrangements indicated by high, medium, or low	Bradshaw et al. (1996), Table 4.4
Maternity leave benefits	Benefits as a percentage of female worker	Lesthaeghe (2000)

(%)	salary, 1996	
Maternity leave in weeks	Maternity leave duration in weeks. Figure for the USA is given in year 2001. for all other countries, the figures are given in year 1996	Lesthaeghe (2000) Table 4; figure for Canada , Phipps (1999), p. 58; for USA, clearinghouse (2001)
Social expenditure	Social expenditure as a percentage of GDP, 1995	OECD (2005)
Educational expenditure	Total educational public expenditure as a percentage of GDP, 1995	Ibid.
Enrollment rates at age 4	Enrollment at age 4 in educational institutions, 1998	Ibid.

Note: GDP = gross domestic product.