# Parental Absence and Student Academic Performance in Cross-National Perspective*

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## Abstract

Living arrangements with parents shape children's experiences and the resources available to them, and parental absence greatly influences children's welfare and educational outcomes. This study utilizes data from 59 countries to investigate the academic vulnerability of students to parental absence, and how this vulnerability varies according to individual- and national-level factors. Findings reveal substantial regional and national variation. Father absence is much more common than mother absence, but mother absence tends to have stronger correlation with children's academic performance. The correlation between mother absence and student academic performance is stronger among male students, students with higher family SES and more ICT resource at home, and first-generation immigrant students. Results also indicate that national economic development and transformation of employment structure helps alleviate the negative correlation between parental absence and student academic performance, while urbanization and changes of immigration structure help address consequences of father absence but not mother absence.

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## INTRODUCTION

The living arrangements of children in many places in the world have shifted in recent decades, due to changing formal family structures and the rise of parental labor migration (Child Trends, 2013; United Nations, 2017). Living arrangements with parents shape children's experiences and the resources available to them, and parental absence may greatly influence children's welfare and educational outcomes (Lu & Treiman, 2011; McLanahan, Tach, & Schneider, 2013; Zhang, Behrman, Fan, Wei, & Zhang, 2014). Therefore, it is crucial for researchers and policy makers to examine consequences of parental absence to understand the mechanisms and effectively reduce inequality.

However, previous research on the relation between parental absence and children's education outcomes have three limitations. First, it tends to focus on father absence as it is more common, therefore consequences of mother absence and potential gender dynamics is underexplored. Secondly, previous research rarely examines possible interactions between parental absence and other dimensions of family inequalities, such as socioeconomic status, immigration status, and access to ICT resources. Therefore, it fails to identify differential vulnerability across disadvantaged groups. Thirdly, current literature tends to focus on U.S. or use non-U.S. national or subnational data, failing to examine variations across national and social contexts. Considering the primary reason for parental absence may be different between developed and developing countries (Lu & Treiman, 2011), variations in national contexts such as economic development, employment structure, and migration structure can be crucial in understanding the correlation between parental absence and student academic outcomes.

This study addresses these limitations by utilizing international education survey data to explore cross-national variation of parental absence and its correlation with student academic performance. Using data from 59 countries from the Program for International Student Assessment (PISA) and other international organizations, we first analyze national and regional variations of father and mother absences. We next apply multilevel regression models to investigate the academic vulnerability of students to parental absence, and how this vulnerability varies according to individual- and national-level factors.

## BACKGROUND

### *Parental absence across the world*

Although two-parent families are becoming less common over the past few decades, they still constitute a majority of families across the world. The United Nations 2017 report of household size and composition show that across 124 countries with valid data, nearly three quarters of households with children are two-parent families (United Nations 2017). The median proportion of two-parent households is about 73% among households with children under 15 years old. The median proportion of single-parent households is about 21% for single-mother families and 3% for single-father families (United Nations 2017).

There are substantial cross-regional and cross-national variations in parental absence. Children are most likely to live with both parents in Asia and the Middle East, while less likely to live with both parents in the Americas, Europe, Oceania, and Sub-Saharan Africa (Child Trends 2013). In Asia and the Middle East, over 80% of children live with two-parent families. In the Americas, about one-half to three-quarters of children live with both parents, ranging from 53% in Colombia to 78% in Canada. In North America, Oceania, and Europe, about one-fifth children live in single-parent families. United States has a particularly high level of single parenthood (27%). In South Africa, only 36% of children live with both parents, reflecting high incidence of adult mortality caused by AIDS and a high percentage of labor migration (Child Trends 2013).

### *Consequences of parental absence*

Studies in the U.S. have found that two-parent families tend to have greater resources, higher income, and more time to invest into children (Gibson-Davis, 2008; Suárez-Orozco, Rhodes, & Milburn, 2009). They are also better in providing emotional support, involving in children's education, and facilitating children's academic performance (Sarez-Orozco et al. 2009). However, while in developed countries, divorce may be the primary reason for parental absence, in developing countries, migration is often the primary reason for parental absence (Lu & Treiman, 2011). Parental absence caused by migration may be linked to higher family income and spending on educational resources (Zhang et al. 2014; Lu and Treiman 2011). Therefore, the actual results of parental absence may depend on other aspects of family processes and the social context.

Many previous studies find evidence of parental evidence to negatively affect various aspects of children's lives, including mental and physical wellbeing, school performance, educational and occupational outcomes, and marriage and family processes. In this paper, we focus on the correlation between parental absence and adolescents' academic outcomes. Research in the U.S. finds that children living in single-parent families experience developmental and educational disadvantages compared to two-parent families, including lower academic performance at school, lower educational achievement, and more delinquent behaviors at school (Astone & McLanahan, 1991; Hernandez, 2004; Suárez-Orozco et al., 2009). There has been strong evidence of father absence on educational attainment, especially on high school graduation and education attainment measured by years of schooling (McLanahan et al., 2013). Parental absence also has effects on GPA and number of courses failed (Frisco, Muller, & Frank, 2007).

Most studies of parental absence in the U.S. focus on father absence as it is more common. In one rare study examining effects of both father and mother absence, Heard (2007) found that father absence is more likely to increase the risk of school disciplinary problems, while mother absence is more likely to reduce college expectations. Both father and mother absences are found to reduce student academic performance, and the effect can be long-term. It has also been found that parental absence affects boys more than girls in academic outcomes and delinquent behaviors (Conway, Christensen, & Herlihy, 2003).

Research using non-U.S. data, on the other hand, show more mixed results. For example, a study using German data finds no significant effect of parental absence on high school graduation or track placement (Francesconi, Jenkins, & Siedler, 2010). A study using data from rural China finds that only absence of both parents is associated with significantly lower cognitive achievement, while absence of one parent is not significantly associated with children's cognitive development (Zhang et al. 2014). A study on mother migration in the Philippines finds that left-behind children of migrant mothers are more likely to fall behind in school performance compared to children left behind by migrant fathers, and controlling for remittances does not change this results (Cortes, 2015). Using Cape Area Panel Study (CAPS) data from South Africa, Marteleto et al. (2016) find that parental absence leads to poorer educational outcomes for coloured[1] adolescents but not for blacks. They thus suggest that the effect of parental absence may rely on racial, cultural, and social conditions. Further, the negative effect of parental absence due to migration in South Africa is found to be largely cushioned by inflows of remittances (Lu and Treiman 2011).

### *Research questions*

There are three important limitations of previous literature on correlations between parental absence and student academic outcomes:

First, while research on parental absence largely focuses on father absence (McLanahan et al., 2013; McLanahan & Teitler, 1998; Sigle-Rushton & McLanahan, 2004), studies examining mother absence remain minimal. As a result, the gender dynamics of parental absence is not yet clear.

Secondly, there has been very little work on potential intersectionality between parental absence and other dimensions of inequality, such as family socioeconomic status and immigration status (McLanahan et al. 2013). Considering low-SES children and migrant children experience higher levels of parental absence, they may respond to parental absence differently, and these differential responses may serve to mitigate or exacerbate educational inequalities related to parental absence.

Thirdly, most studies use regional or national data, while very few use cross-national survey data to examine consequences of parental absence from a comparative perspective. While the majority of researchers focus on divorce as the major cause of parental absence (e.g. McLanahan & Teitler, 1999), the underlying macro processes of economic development, employment structure, migration, and urbanization have long been neglected. Therefore, it remains unclear whether the association between parental absence and student academic performance vary across national economic and social contexts.

To address these gaps in current literature on correlation between parental absence and student academic outcomes, this paper examines the following research questions using data from the Program for International Student Assessment (PISA) 2012:

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[1] A non-Black ethnic group with diverse ancestral backgrounds, including Europeans, Malays, and Indonesians.

1. What is the current scope and variation of father and mother absence for 15-year old students across different countries?

2. How is father and mother absence related students' academic achievements, and how does this correlation vary according to individual-level factors, such as gender, family SES, ICT resource, and immigration status?

3. How does the association between father/mother absence and student academic achievement vary according to national-level factors, such as economic development, employment structure, urbanization, migration, ICT resource, gender equality, and country-level parental absence?

## DATA AND METHOD

### *PISA 2012*

PISA is a cross-national study administered by the Organization for Economic Co-operation and Development (OECD). It measures the ability of 15-year-old students to use their knowledge and skills learned at school. It has three major domains: mathematics, reading, and science. PISA surveys take place every three years. In 2012, it was conducted in 34 OECD countries and 31 partner countries/economies. We keep only countries/economies with complete information at the macro level and students with complete information at the individual level. Our final sample includes 405,736 students in 59 countries/economies.

### *Student-level Variables*

We use PISA test scores in mathematics, reading, and science as our dependent variables. PISA provides five scores called plausible values drawn from the posterior distributions of scaled scores. All plausible values are used in the analyses presented in this study and standard errors are adjusted according to instructions in the PISA technical manual.

Our independent variables at focus, *father/mother absence*, are two dichotomous variables derived from the question "Who usually lives at home with you?" If the student ticked "No" for "Mother (including stepmother or foster mother)", then *mother absence* is coded as 1, otherwise 0. If the student ticked "No" for "Father (including stepfather or foster father), then *father absence* is coded as 1, otherwise 0.

A series of individual-level covariates are also included in the analysis, including:

*Female*: A dichotomous variable coded as 1 if the student is female and 0 if male.

*Index of economic, social and cultural status (ESCS*): A composite index derived from student's home possessions, the highest parental occupation, and the highest parental education expressed as years of schooling.

*Immigration status (IMMIG)*: A categorical variable with three possible values: native, second-generation, and first-generation.

*ICT resource at home (ICTRES)*: A composite index derived from students' reports on whether they had the following at home: educational software; a link to the Internet; and a computer they can use for schoolwork.

For a summary of descriptive statistics of individual variables, please see Appendix A.

***National-level Variables***

*GDP per capita in 2012* is collected from the World Bank databank. Data are based on purchasing power parity (PPP) and in current international dollars, making it possible to compare across countries. Data are log transformed before standardizing to approximate normal distribution.

*Employment in agriculture, industry, and service sectors*: these indicators are collected from the International Labor Organization database and are calculated as percentages of total employment. The agriculture sector consists of activities in agriculture, hunting, forestry, and fishing. The industry sector consists of mining and quarrying, manufacturing, construction, and public utilities (electricity, gas, and water). The service sector consists of wholesale and retail trade; restaurants and hotels; transport, storage, and communications; financing, insurance, real estate, and business services; and community, social, and personal services.

*Net migration ratio* is defined as the ratio of net migration to total population. Net migration is defined as the net total of migrants, that is, the annual number of immigrants minus the annual number of emigrants, including both citizens and noncitizens. Net migration data are five-year estimates from 2007-2012 and are collected from the United Nations Population Division. Total population is the estimate in 2012 and is collected from the World Bank databank.

*Urban population* is the World Bank estimate based on data from the United Nations Population Division. It is defined as the percentage of people living in urban areas and used as a measure of urbanization.

*Gender Inequality Index (GII)* is from the Human Development Report by the United Nations Development Program (UNDP). It is a composite index derived from measures of gender inequalities in three aspects: 1) reproductive health, measured by maternal mortality ratio and adolescent birth rates; 2) empowerment, measured by proportion of parliamentary seats occupied by females and proportion of females and males with at least some secondary education among adults aged 25 years and older; and 3) economic status, measured by female and male labor force participation rate of populations aged 15 years and older. The final index ranges from 0 to 1 and a higher value indicates a higher level of gender inequality.

*National ICT resource* is calculated by aggregating the individual-level *ICT resource indicator (ICTRES)* from the PISA 2012 dataset.

*National percentage of father/mother absence* is aggregated from the individual-level *father/mother absence* variables in the PISA 2012 dataset. When calculating national averages from the dataset with a complex survey design, balanced repeated replication weights are used as suggested by the PISA technical manual.

For a complete list of country-level variables, please see Appendix B. For a correlation matrix plot between all country-level variables, please see Appendix C.

### *Analytical Strategies*

To address our first research question, we present descriptive statistics to show the scope and variation of parental absence across different countries. To address our second research question, which is the effects and variation of effects of parental absence at the student level, we next estimate separate linear regression models for each country. We use parental absence indicators and other student-level variables to predict student's test scores in mathematics, reading, and science. We then use the pooled data to apply linear regression models with student-level variables and country fixed effects to estimate correlation between parental absence and student academic performances in general. To examine how correlation between parental absence and student academic performance varies according to student-level factors, we add interaction terms between parental absence and student-level variables into the base model.

To address our third research question, which is how correlation between parental absence and student academic performance varies according to country-level factors, we add cross-level interaction terms between each country-level variable and the father/mother absence indicator into the models. We include only one cross-level interaction term in each model to ensure clear interpretation. A sample equation can be specified as follows:

$$TestScore_{ij} = \beta_0 + \beta_1 ParentalAbsence_{ij} + \beta_2 ParentalAbsence_{ij} * CountryVariable_j + \alpha Country_j + \gamma StudentCovariates_{ij}$$

where i indicates the individual and j indicates the country; $\beta_0$ estimates the intercept, $\beta_1$ estimates the main effect of father or mother absence, $\beta_2$ estimates the interaction effect between parental absence and a country-level variable, $\alpha Country_j$ represents the country fixed effects, and $\gamma StudentCovariates_{ij}$ is a vector of student-level covariates. All national-level variables are standardized within sampled countries to facilitate interpretation of the interaction effects. We use balanced repeated replication weights in our analysis as suggested by the PISA technical manual. For robustness check, we add the interaction term between logged GDP per capita and father/mother absence to this equation to control for the effect of economic development in the cross-level interaction.

## FINDINGS

### *Regional patterns of parental absence*

[FIGURE 1 ABOUT HERE]

Figure 1 shows the scope and variation of parental absence across different countries and regions. In general, father absence is more common than mother absence in all countries: our calculation shows the overall father absence is 15.94% and mother absence is 6.36%. There are also observable regional differences. Eastern Asian and Northern, Southern, and Western European countries tend to have relatively lower percentages of parental absence (lower than 20%). Eastern European, South-Eastern Asian, and Northern and Southern American countries tend to have higher percentages of parental absence. Northern African (Tunisia) and Western Asian countries (Qatar and Jorden) tend to have higher levels of mother absence. Indonesia and

Thailand face with the highest level of parental absence: over 30% of 15-year-old students do not live with their fathers and over 20% do not live with their mothers. Colombia has the highest level of father absence (over 35%) and the third highest of mother absence (near 20%). Please see Appendix B for a full list of country-level estimates of parental absence.

***Predicting test scores across countries***

[FIGURES 2A, 2B, 2C ABOUT HERE]

Figures 2A, 2B, and 2C shows the correlation between father/mother absence and student academic performances on math, reading, and science scores respectively. Results are estimated with bivariate regression models using father/mother absence to predict test scores; country-fixed effects are included in all models. Standard errors of the estimates are not shown in the figures but can be found in Appendix D.

In general, parental absence has a significant negative effect on students' test scores. Therefore, in the figures, countries towards the lower and left are those with stronger correlation between parental absence and student academic performances. Mother absence tends to have a greater effect than father absence in most countries. The patterns of parental effects on three subjects are quite similar. We observe very large correlation between parental absence and student academic performance in West-Asian and North African countries, especially in United Arab Emirates and Qatar; Tunisia, Jordan, and Turkey are not far from them. Estonia and Latvia are at the top right corner, showing smallest correlation between parental absence and student academic performances, and they are accompanied by Peru. Curiously, Croatia shows a low correlation between father absence and student academic performance but a medium correlation between mother absence and student academic performance. Greece shows the highest correlation between mother absence and student academic performance and a low-to-medium level of father absence effect.

***Student-level analysis with pooled data***

[TABLE 1 ABOUT HERE]

Table 1 shows base models predicting student test scores in math, reading, and science with individual-level variables and country-fixed effects. Columns 1-3 shows models with father absence as a predictor, and columns 4-6 shows models with mother absence as a predictor.

Results are consistent with findings from the previous section: parental absence has a significantly negative effect on student performance in all three subjects, and mother absence has almost twice the effect of father absence after controlling for other student-level variables.

When it comes to other student-level variables, females achieve lower scores in math s but much higher scores in reading than males. There is no significant gender difference in science test scores. Family ESCS is positively correlated with test performance: one unit increase in ESCS is associated with approximately 24 to 25 points increase in test scores. Home ICT resource is also positively correlated with test scores. For immigration status, first-generation immigrates are significantly disadvantaged in all three subjects compared to native students, and second-generation immigrants are disadvantaged in science but not math and reading compared to native students.

[TABLE 2 ABOUT HERE]

Table 2 presents the coefficients and corresponding standard errors of student-level interaction terms from regression models predicting test scores. Each cell represents a separate model, and each model adds one interaction term between parental absence and another student-level variable into the base model as presented in Table 1. Country fixed effects are included in all models. Main effects are not shown due to page limits, and they do not change much after adding the interaction terms.

The interaction terms between female and parental absence show consistently positive effects. This means males are more affected by father and mother absence than females. The interaction terms between family ESCS and father absence do not show significant effect, meaning that the correlation between father absence and student academic performance does not vary according to family ESCS. However, there are significantly negative interaction effects between family SES and mother absence, showing that students with higher family ESCS are more affected by mother absence compared with students with lower family ESCS. [explain a bit more]. Similar patterns are observed for home ICT resource: no significant interaction effect between home ICT resource and father absence but significantly negative interaction effects are observed between home ICT resource and mother absence, showing stronger correlation between mother absence and student academic performances among students with a higher level of home ICT resource.

For immigration status, no significant difference in correlation between parental absence and student academic performances is observed between native students and second-generation students. However, large and significantly negative interaction effects are observed between first-generation immigration status and mother absence for all three subjects. This means that the negative effect of mother absence is much stronger among first-generation students compared to native students.

***Effects of country-level factors***

[TABLE 3 ABOUT HERE]

We next examine how correlation between parental absence and student academic performance varies according to country-level factors. Table 3 presents the coefficients and corresponding standard errors of cross-level interaction terms from regression models predicting test scores. Each cell represents a separate model, and each model adds one interaction term between parental absence and a country-level variable into the base model as presented in Table 1. Country fixed effects are included in all models, therefore main effects of country-level variables are not estimated since they are country-invariant.

The patterns are quite consistent across the three academic subjects, but considerate differences are found between father and mother absence. The correlation between father absence and student performance is stronger in countries with a lower GDP per capita (except for science test scores), higher percentage of employment in agriculture sector, lower percentage of employment in service sector, higher net migration ratio[2] (except for reading test scores), lower urban population, higher gender inequality index, higher percentage of father absence, and lower level of national ICT resource. In general, these are less-developed, less-industrialized, and less-urbanized countries.

The correlation between mother absence and student academic performance, on the other hand, is stronger in countries with higher percentage of employment in industry and higher net migration ratio (except for reading test scores). Other country-level factors are not associated with variations in correlation between mother absence and student academic performance across countries.

[2] Net migration ratio is defined as total number of immigrants less total number of emigrants, and then divided by total population. Therefore, a higher net migration ratio indicates relatively more immigrants and fewer emigrants.

***Robustness test***

[TABLE 4 ABOUT HERE]

As a robustness test, we add the interaction term between parental absence and logged GDP per capita into all models listed in Table 3 (except for the first set of models with GDP per capita itself in the interaction term) to address possible collinearity between GDP per capita and other country-level variables. This is equivalent to controlling for the effect of GDP per capita on the correlation between parental absence and student academic performance when estimating the effect of other country-level variables. Results are presented in Table 4.

In general, the patterns are consistent with findings in Table 3. The correlation between father absence and student academic performance on all three academic subjects is stronger in countries with a higher percentage of agriculture employment, lower percentage of service employment, and lower level of ICT resource. These effects are still significant or even stronger after controlling for GDP per capita, showing that if we hold general economic development constant, employment structure, migration structure, and ICT resources matters even more for the correlation between father absence and student academic performance.

The correlation between mother absence and student academic performance is still stronger in countries with a higher percentage of industry employment and the magnitude does not change much after controlling for GDP per capita. In addition, the previously insignificant effect of agriculture and service employment becomes significant after controlling for GDP per capita. Net migration ratio only matters for the correlation between mother absence and student academic performance on Math and urban population only matters for Science.

A curious case is that after controlling for GDP per capita, the correlation between mother absence and student academic performance becomes weaker in countries with a higher level of gender inequality. In other words, with the same level of economic development, students are affected less by mother absence if they are in a country with high gender equality. This may be explained by the lesser social and economic status of women in those societies.

These results indicate that general economic development and employment structure upgrade may help alleviate the negative effect of parental absence on student academic performance. On the other hand, urbanization, changes in migration structure, and development of ICT resource may address the problems associated with father absence but less so about mother absence.

## DISCUSSION AND CONCLUSION

Findings from this study reveal substantial regional and national variation of parental absence as well as its correlation with student academic outcomes. Parental absence is less common in East Asia and Northern, Southern, and Western Europe. Eastern Europe, South-Eastern Asia, and Americas tend to have higher percentages of parental absence. In general, parental absence is found to negatively correlated with students' performance. This correlation is strongest in West Asia and North Africa. Findings also indicate that father absence is much more common than mother absence, but mother absence tends to have stronger correlation with children's academic performance.

Correlation between parental absence and student academic performance varies according to student gender, family socioeconomic status, home ICT access, and immigration status. In particular, the correlation between mother absence and student academic performance is stronger among male students, students with higher family SES and more ICT resource at home, and first-generation immigrant students. This differential vulnerability indicate differential responses to parental absence across various inequality dimensions.

In addition, correlation between parental absence and student academic performance varies according to country-level factors, including economic development, employment structure, migration structure, urbanization, ICT resource, gender inequality index, and percentage of parental absence, and so on. In general, the correlation is stronger in less-developed, less-industrialized, and less-urbanized countries. Results indicate that general economic development and transformation of employment structure at the national level may help alleviate the negative correlation between parental absence and student academic performance. On the other hand, urbanization and changes of immigration structure may help address consequences of father absence but not mother absence.

This study contributes to current discussions of consequences of family separation and parental absence by providing a global comparative perspective. Results can inform targeted policies to address student disadvantages and education inequality in an era of mass migration and demographic transition. One limitation of using the PISA 2012 dataset is that we cannot identify reasons of parental absence. Parental absence may be caused by divorce, separation, death, imprisonment, migration, and many other reasons, and different forms of parental absence can influence children through different mechanisms, thus bringing distinct consequences. Another limitation is that when identifying parental absence, PISA 2012 does not distinguish biological parents from stepparents or foster parents, which does not allow us to further explore nuances within differential family processes. Future surveys and research should further distinguish reasons of parental absence to examine potential variations.

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**TABLE 1: Student-Level Regression Models Predicting Test Scores**

| | *Father Absence* | | | *Mother Absence* | | |
|---|---|---|---|---|---|---|
| | (1) Math | (2) Reading | (3) Science | (4) Math | (5) Reading | (6) Science |
| *Parental Absence* | -13.972*** | -13.819*** | -13.203*** | -29.349*** | -29.355*** | -26.143*** |
| | (0.911) | (0.927) | (0.873) | (1.354) | (1.393) | (1.297) |
| *Female* | -9.654*** | 32.633*** | -0.118 | -10.007*** | 32.280*** | -0.434 |
| | (0.746) | (0.733) | (0.667) | (0.740) | (0.731) | (0.664) |
| *Family ESCS* | 25.381*** | 24.842*** | 24.389*** | 25.135*** | 24.592*** | 24.190*** |
| | (0.572) | (0.572) | (0.536) | (0.565) | (0.563) | (0.533) |
| *Home ICT resource* | 6.104*** | 5.267*** | 4.425*** | 6.037*** | 5.195*** | 4.390*** |
| | (0.509) | (0.441) | (0.478) | (0.498) | (0.435) | (0.472) |
| *Immigration Status (Native as Reference Level)* | | | | | | |
| *Second-Generation* | -5.022 | -0.494 | -16.345*** | -5.354* | -0.830 | -16.622*** |
| | (2.638) | (2.191) | (2.579) | (2.674) | (2.233) | (2.609) |
| *First-Generation* | -14.880*** | -16.584*** | -23.622*** | -14.582*** | -16.290*** | -23.338*** |
| | (3.008) | (3.215) | (3.162) | (2.909) | (3.121) | (3.082) |
| *Country Fixed Effects* | Yes | Yes | Yes | Yes | Yes | Yes |
| *R2* | *0.402* | *0.364* | *0.393* | *0.405* | *0.368* | *0.395* |

Note: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Number of observations=405736. Number of countries/economies=59. ESCS=Index of economic, social and cultural status. Each column is a separate model predicting student test scores with individual-level variables. Country-fixed effects are included in all models.

**TABLE 2: Coefficients of Student-Level Interaction Terms from Regression Models Predicting Test Scores**

| *Interaction With* | *Father Absence* | | | *Mother Absence* | | |
|---|---|---|---|---|---|---|
| | Math | Reading | Science | Math | Reading | Science |
| *Female* | 7.424*** | 7.193*** | 7.420*** | 6.755** | 5.848* | 7.374*** |
| | (1.527) | (1.855) | (1.718) | (2.107) | (2.807) | (2.221) |
| *Family ESCS* | -1.660 | -0.323 | -1.634 | -8.046*** | -6.682*** | -7.142*** |
| | (0.876) | (0.869) | (0.919) | (1.133) | (1.256) | (1.141) |
| *Home ICT resource* | 0.413 | 1.336 | 0.122 | -3.813*** | -2.808** | -3.552*** |
| | (0.743) | (0.765) | (0.738) | (0.969) | (1.045) | (0.965) |
| *Immigration Status (Native as Reference Level)* | | | | | | |
| *Second-Generation* | 4.177 | 6.315 | 7.073 | -1.393 | 5.781 | 0.622 |
| | (5.089) | (4.324) | (5.055) | (8.906) | (10.199) | (8.771) |
| *First-Generation* | -2.065 | -3.174 | -0.762 | -20.526** | -25.765** | -23.817** |
| | (5.081) | (5.289) | (5.386) | (6.489) | (9.350) | (7.735) |

Note: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Number of observations=405736. Number of countries/economies=59. ESCS=Index of economic, social and cultural status. Each cell represents the coefficient and corresponding standard error of the student-level interaction term in a regression model predicting student's test score. Each cell represents a separate model, and each model includes exactly one interaction term. Individual level covariates are included in all models, including student gender, family ESCS, ICT resource at home, and immigration status. Country-fixed effects are included in all models. Main effects are not shown.

**TABLE 3: Coefficients of Cross-Level Interaction Terms from Regression Models Predicting Test Scores**

| *Interaction with* | *Father Absence* | | | *Mother Absence* | | |
|---|---|---|---|---|---|---|
| | Math | Reading | Science | Math | Reading | Science |
| *Logged GDP per capita* | 2.606* | 2.673* | 1.985 | 0.817 | 1.800 | 2.197 |
| | (1.276) | (1.275) | (1.232) | (1.736) | (1.723) | (1.557) |
| *Agriculture Employment* | -2.935** | -3.153*** | -2.038* | -0.462 | -0.788 | -0.937 |
| | (0.893) | (0.899) | (0.820) | (1.062) | (1.101) | (0.964) |
| *Industry Employment* | 0.207 | 0.348 | 1.401 | -10.782*** | -10.779*** | -8.548*** |
| | (1.537) | (1.564) | (1.751) | (2.219) | (2.161) | (2.122) |
| *Service Employment* | 3.275** | 3.501** | 2.116* | 1.548 | 1.934 | 1.899 |
| | (1.060) | (1.079) | (0.995) | (1.285) | (1.344) | (1.182) |
| *Net Migration Ratio* | -4.179* | -3.231 | -3.949* | -5.669** | -3.972 | -4.364* |
| | (1.987) | (1.958) | (1.827) | (2.154) | (2.143) | (1.948) |
| *Urban Population* | 3.527** | 3.467** | 2.103* | 0.441 | 0.439 | 0.851 |
| | (1.093) | (1.092) | (0.961) | (1.195) | (1.293) | (1.103) |
| *Percentage of Parental Absence* | -2.014* | -2.752** | -2.143* | 0.488 | -0.583 | -0.307 |
| | (0.887) | (0.916) | (0.873) | (0.993) | (1.009) | (0.953) |
| *ICT Resource* | 2.834** | 3.306** | 2.140* | -0.219 | 0.670 | 0.289 |
| | (1.043) | (1.069) | (0.995) | (1.434) | (1.454) | (1.319) |
| *Gender Inequality Index* | -2.784** | -3.406** | -2.639* | 1.362 | -0.433 | -0.535 |
| | (1.066) | (1.105) | (1.081) | (1.605) | (1.605) | (1.561) |

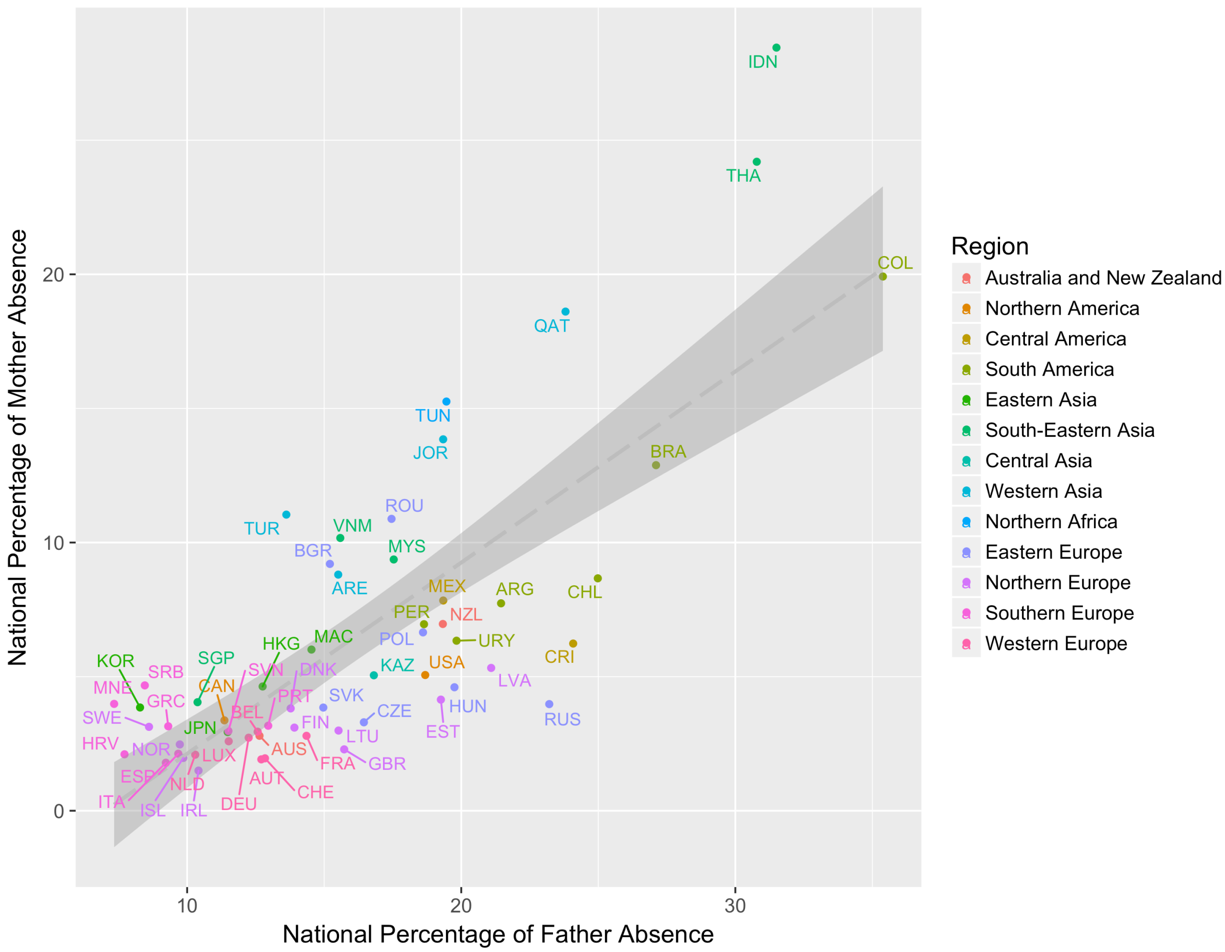
Note: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Number of observations=405,736. Number of countries/economies=59. For models involving Gender Inequality Index, number of observations=396,274, and number of countries/economies=57 (excluding Hong Kong and Macau).
Each cell represents the coefficient and corresponding standard error of the cross-level interaction term in a regression model predicting student's test score. Each cell represents a separate model, and each model includes exactly one interaction term. Individual level covariates are included in all models, including student gender, family ESCS, ICT resource at home, and immigration status. Country-fixed effects are included in all models, thus country-level variables are not included except for the cross-level interaction term. All country-level variables are standardized within sampled countries/economies.

**TABLE 4: Coefficients of Cross-Level Interaction Terms from Regression Models Predicting Test Scores, Controlling for GDP per capita**

| *Interaction with* | *Father Absence* | | | *Mother Absence* | | |
|---|---|---|---|---|---|---|
| | Math | Reading | Science | Math | Reading | Science |
| *Agriculture Employment* | $-5.425^{***}$ | $-6.165^{***}$ | $-3.300^{**}$ | -1.777 | $-2.189^{*}$ | $-2.231^{*}$ |
| | (1.105) | (1.054) | (1.053) | (0.972) | (1.038) | (0.917) |
| *Industry Employment* | 0.424 | 0.571 | 1.568 | $-10.309^{***}$ | $-10.305^{***}$ | $-8.123^{***}$ |
| | (1.512) | (1.537) | (1.723) | (2.270) | (2.212) | (2.167) |
| *Service Employment* | $5.621^{***}$ | $6.338^{***}$ | $2.752^{**}$ | $3.217^{**}$ | $3.693^{**}$ | $3.492^{**}$ |
| | (1.048) | (1.083) | (1.049) | (1.183) | (1.278) | (1.133) |
| *Net Migration Ratio* | $-9.892^{***}$ | $-8.819^{***}$ | $-8.500^{***}$ | $-4.186^{*}$ | -2.422 | -3.032 |
| | (1.023) | (1.097) | (1.041) | (1.726) | (1.828) | (1.649) |
| *Urban Population* | $3.334^{**}$ | $3.143^{**}$ | 1.470 | 1.890 | 1.891 | $2.225^{*}$ |
| | (1.020) | (1.018) | (0.991) | (1.074) | (1.187) | (1.041) |
| *Percentage of Parental Absence* | -1.052 | $-2.174^{*}$ | -1.773 | -0.215 | -1.469 | -1.053 |
| | (0.900) | (0.940) | (0.956) | (0.947) | (0.971) | (0.937) |
| *ICT Resource* | $5.751^{**}$ | $8.473^{***}$ | $-3.300^{**}$ | 1.242 | 2.385 | 1.715 |
| | (1.932) | (1.913) | (1.053) | (1.360) | (1.420) | (1.295) |
| *Gender Inequality Index* | -1.933 | $-3.321^{*}$ | $-2.786^{*}$ | $4.395^{**}$ | 2.137 | 2.572 |
| | (1.333) | (1.293) | (1.404) | (1.650) | (1.636) | (1.828) |

Note: Standard errors in parentheses. $^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$.
Number of observations=405,736. Number of countries/economies=59. For models involving Gender Inequality Index, number of observations=396,274, and number of countries/economies=57 (excluding Hong Kong and Macau).
Each cell represents the coefficient and corresponding standard error of the cross-level interaction term in a regression model predicting student's test score. Each cell represents a separate model, and each model includes exactly one interaction term. Individual level covariates are included in all models, including student gender, family ESCS, ICT resource at home, and immigration status. Country-fixed effects are included in all models, thus country-level variables are not included except for the cross-level interaction term. The interaction term between parental absence and logged GDP per capita is included in all models to control for possible effects of general economic development on the parental absence effect. All country-level variables are standardized within sampled countries/economies.

**FIGURE 1: Scatterplot of National Percentages of Father and Mother Absence**




Note: National percentages of father and mother absence are aggregated from PISA 2012 student-level data. Country codes are ISO-3 character codes. Please see Appendix A for corresponding country names.

**FIGURE 2A: Scatterplot of Parental Absence Effect on Math Scores**

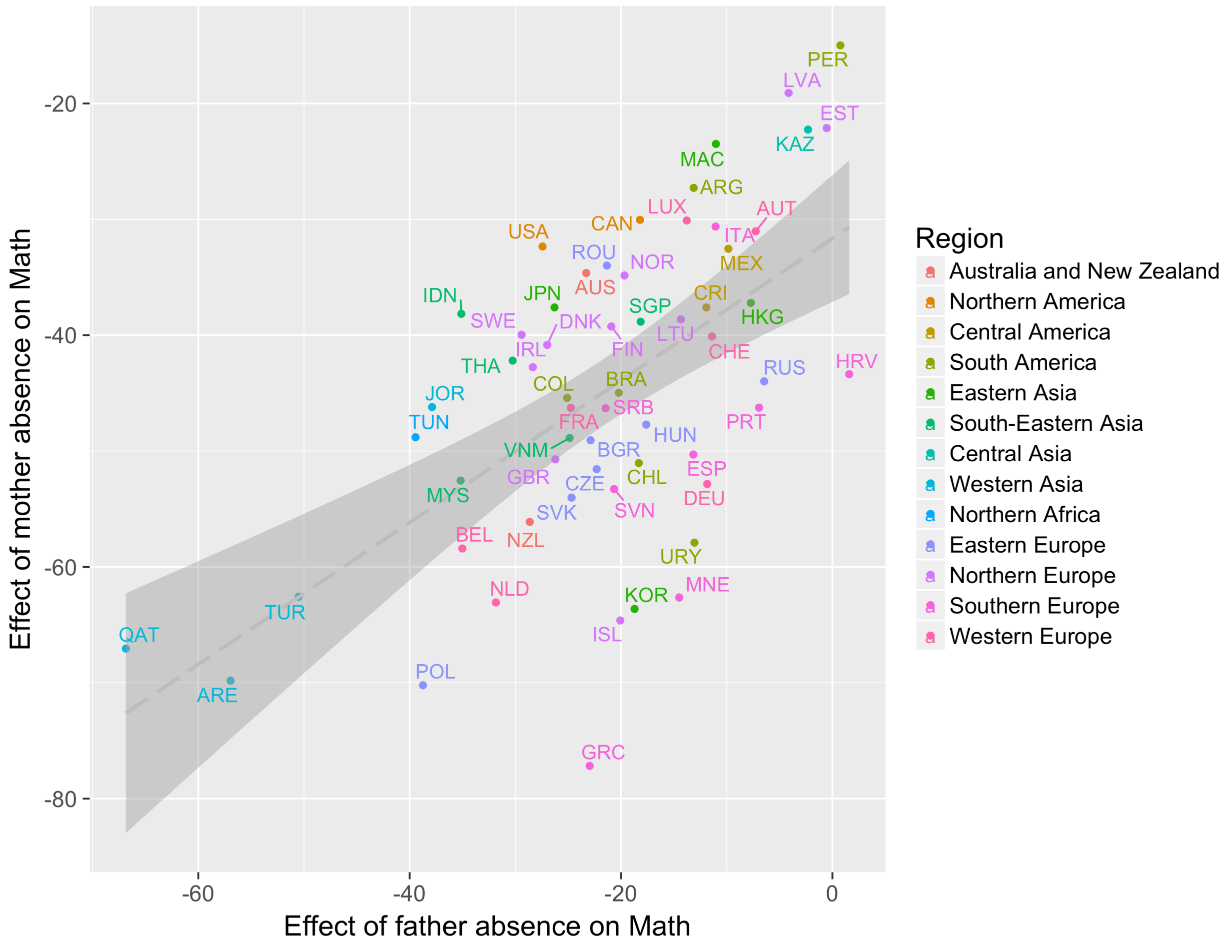


**FIGURE 2B: Scatterplot of Parental Absence Effect on Reading Scores**

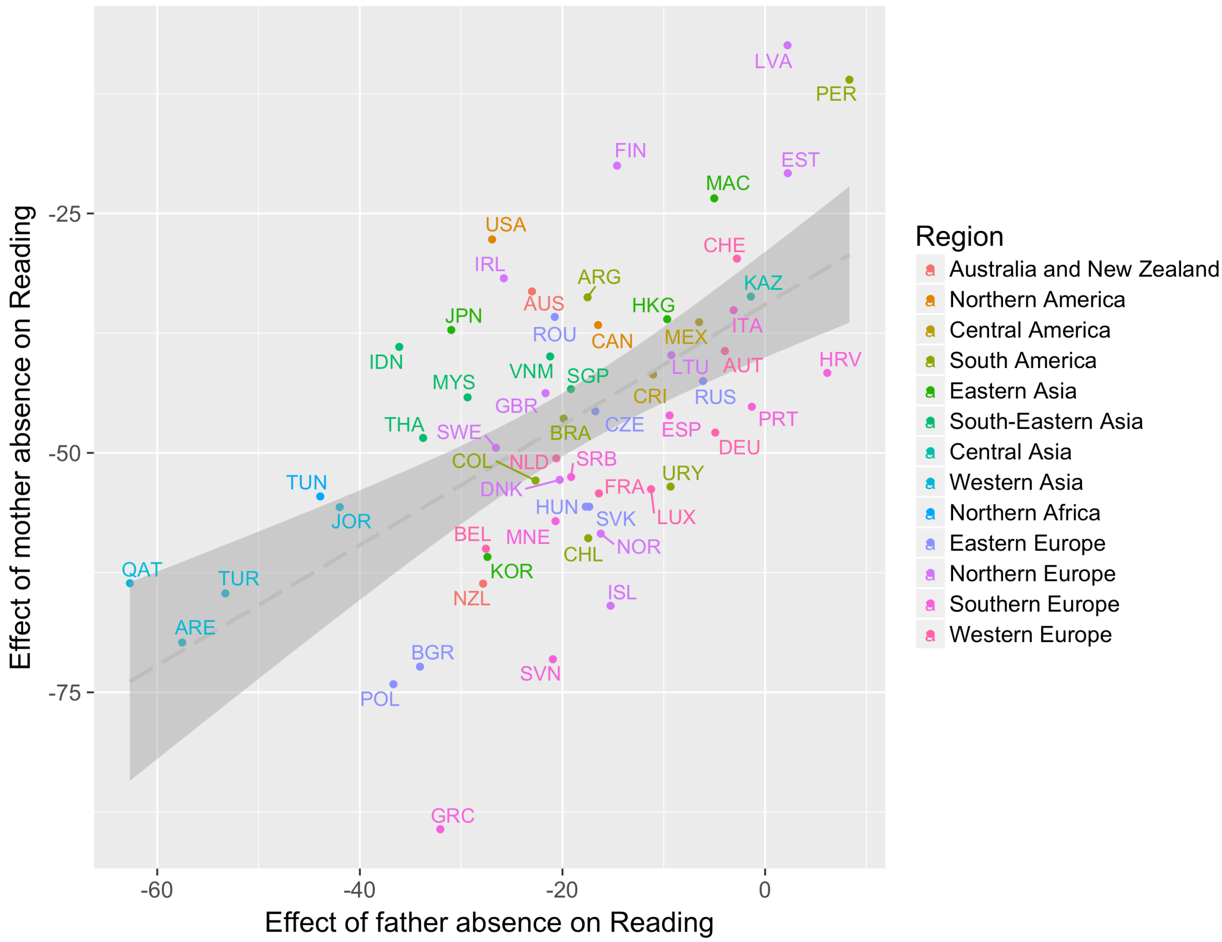
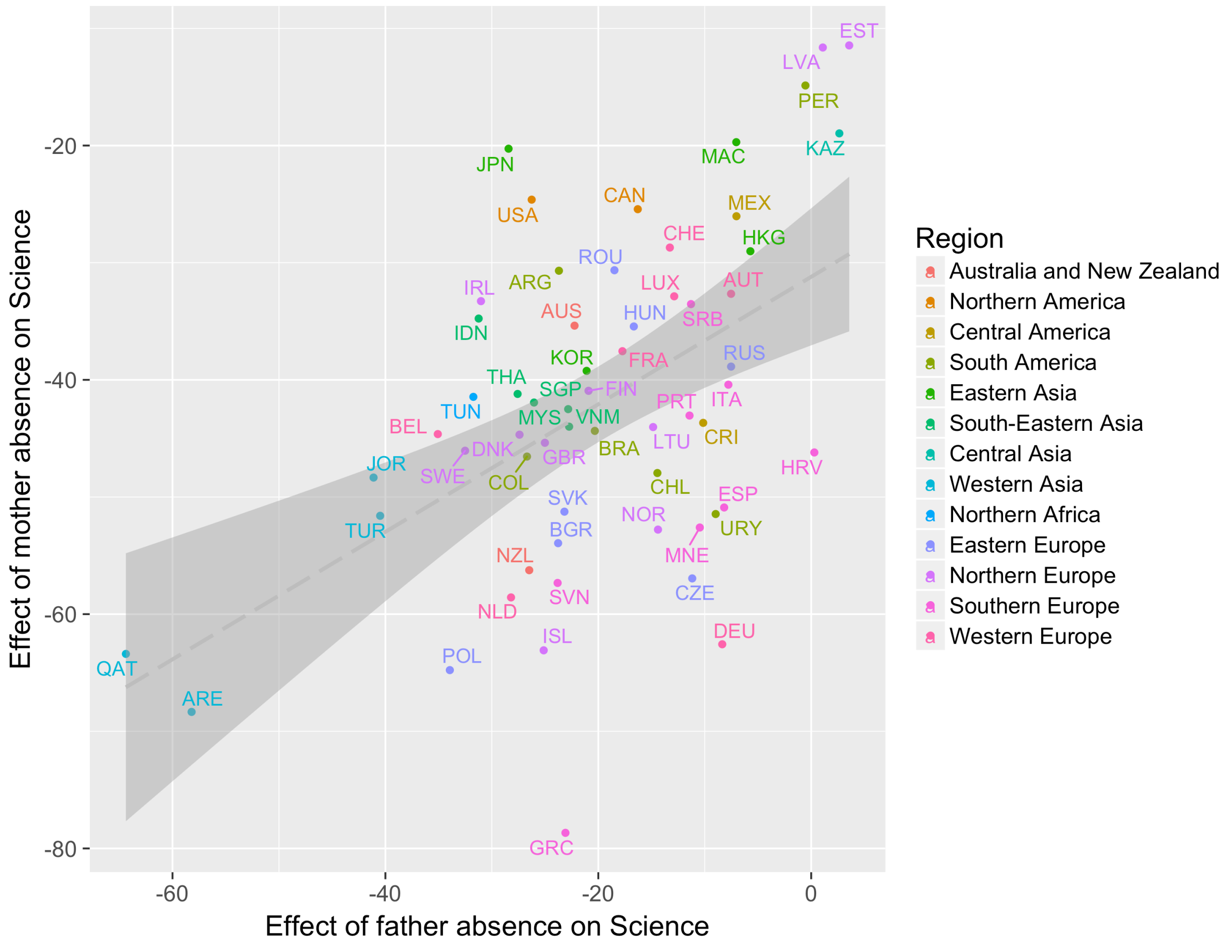


**FIGURE 2C: Scatterplot of Parental Absence Effect on Science Scores**




Note for Figures 2A, 2B, and 2C: Country codes are ISO-3 character codes. Please see Appendix A for corresponding country names. Please see Appendix D for corresponding bivariate regression estimates and standard errors.

## APPENDIX A: Descriptive Statistics of Individual-Level Variables by Country

| *Country* | *Code* | *Sample Number* | *Female (%)* | *ESCS* | | *Immigration Status (%)* | | | *Math* | | *Reading* | | *Science* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | SD | 1st-Generation | 2nd-Generation | Native | Mean | SD | Mean | SD | Mean | SD |
| *United Arab Emirates* | ARE | 9805 | 51.34 | 0.35 | 0.70 | 33.10 | 23.43 | 43.47 | 440.82 | 86.09 | 449.46 | 89.63 | 455.53 | 89.13 |
| *Argentina* | ARG | 4777 | 51.00 | -0.68 | 1.26 | 1.46 | 2.24 | 96.29 | 398.10 | 70.12 | 406.01 | 87.25 | 415.34 | 77.95 |
| *Australia* | AUS | 12461 | 48.85 | 0.28 | 0.61 | 10.22 | 12.59 | 77.20 | 512.11 | 90.81 | 519.13 | 90.13 | 529.30 | 93.98 |
| *Austria* | AUT | 4394 | 50.19 | 0.09 | 0.71 | 5.40 | 10.94 | 83.66 | 509.46 | 88.96 | 493.52 | 87.12 | 509.71 | 87.57 |
| *Belgium* | BEL | 7854 | 50.16 | 0.17 | 0.83 | 6.99 | 7.73 | 85.27 | 521.81 | 97.19 | 516.38 | 94.67 | 512.59 | 94.20 |
| *Bulgaria* | BGR | 4506 | 48.95 | -0.23 | 1.11 | 0.17 | 0.31 | 99.52 | 448.64 | 87.67 | 448.61 | 109.07 | 456.39 | 94.80 |
| *Brazil* | BRA | 15524 | 52.06 | -1.17 | 1.42 | 0.30 | 0.36 | 99.34 | 397.30 | 73.41 | 416.84 | 78.41 | 411.08 | 72.36 |
| *Canada* | CAN | 19248 | 50.54 | 0.44 | 0.73 | 12.76 | 16.78 | 70.46 | 523.94 | 83.91 | 529.99 | 83.95 | 531.48 | 84.62 |
| *Switzerland* | CHE | 10324 | 50.32 | 0.18 | 0.79 | 6.67 | 17.47 | 75.86 | 535.05 | 89.83 | 513.23 | 84.43 | 519.32 | 85.48 |
| *Chile* | CHL | 6239 | 52.00 | -0.55 | 1.28 | 0.69 | 0.19 | 99.12 | 427.95 | 77.03 | 446.71 | 72.49 | 450.10 | 75.28 |
| *Colombia* | COL | 7135 | 51.70 | -1.22 | 1.40 | 0.07 | 0.18 | 99.76 | 386.21 | 69.84 | 414.06 | 76.40 | 408.07 | 70.23 |
| *Costa Rica* | CRI | 3942 | 52.69 | -0.94 | 1.54 | 2.20 | 3.15 | 94.65 | 412.51 | 64.33 | 445.81 | 67.62 | 434.59 | 64.56 |
| *Czechia* | CZE | 5076 | 49.21 | -0.05 | 0.56 | 1.75 | 1.31 | 96.94 | 502.35 | 90.69 | 496.56 | 82.69 | 511.97 | 84.58 |
| *Germany* | DEU | 3727 | 50.22 | 0.23 | 0.85 | 2.49 | 10.50 | 87.01 | 524.62 | 92.41 | 520.39 | 85.18 | 535.59 | 89.73 |
| *Denmark* | DNK | 6885 | 50.07 | 0.44 | 0.70 | 2.82 | 5.88 | 91.30 | 504.43 | 77.30 | 501.13 | 78.68 | 503.36 | 86.31 |
| *Spain* | ESP | 23421 | 49.33 | -0.17 | 1.05 | 8.00 | 1.49 | 90.51 | 488.43 | 83.55 | 491.90 | 85.30 | 500.54 | 80.18 |
| *Estonia* | EST | 4300 | 50.76 | 0.12 | 0.65 | 0.66 | 7.37 | 91.97 | 524.81 | 77.08 | 519.72 | 75.86 | 544.73 | 75.08 |
| *Finland* | FIN | 7980 | 49.84 | 0.39 | 0.59 | 1.70 | 1.39 | 96.90 | 524.67 | 79.60 | 530.47 | 86.64 | 551.52 | 85.19 |
| *France* | FRA | 4171 | 51.75 | -0.02 | 0.63 | 4.51 | 9.82 | 85.68 | 501.88 | 93.10 | 513.20 | 101.82 | 505.71 | 94.45 |
| *United Kingdom* | GBR | 11086 | 50.97 | 0.31 | 0.64 | 7.15 | 5.55 | 87.30 | 503.27 | 88.21 | 508.67 | 88.69 | 524.28 | 91.29 |
| *Greece* | GRC | 4809 | 50.64 | -0.06 | 0.99 | 6.15 | 4.21 | 89.64 | 456.27 | 83.06 | 480.59 | 91.30 | 469.67 | 81.96 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Hong Kong SAR, China* | HKG | 4403 | 46.75 | -0.79 | 0.94 | 14.11 | 20.58 | 65.31 | 565.12 | 92.08 | 547.63 | 81.18 | 558.32 | 78.66 |
| *Croatia* | HRV | 4766 | 49.15 | -0.33 | 0.73 | 3.74 | 8.32 | 87.94 | 473.51 | 84.90 | 486.68 | 81.88 | 493.46 | 79.99 |
| *Hungary* | HUN | 4473 | 52.49 | -0.23 | 0.92 | 0.78 | 1.04 | 98.18 | 482.41 | 89.06 | 493.56 | 86.12 | 499.69 | 84.37 |
| *Indonesia* | IDN | 4924 | 49.87 | -1.80 | 1.23 | 0.11 | 0.08 | 99.81 | 380.81 | 66.10 | 402.95 | 67.43 | 386.89 | 61.88 |
| *Ireland* | IRL | 4528 | 48.65 | 0.16 | 0.70 | 8.21 | 1.68 | 90.11 | 507.47 | 79.70 | 528.88 | 80.29 | 527.73 | 85.46 |
| *Iceland* | ISL | 3176 | 50.04 | 0.80 | 0.65 | 2.82 | 0.71 | 96.47 | 498.25 | 86.49 | 488.89 | 89.65 | 483.88 | 92.28 |
| *Italy* | ITA | 29084 | 48.62 | -0.05 | 0.94 | 5.28 | 1.97 | 92.75 | 488.65 | 88.98 | 493.89 | 91.05 | 496.88 | 88.16 |
| *Jordan* | JOR | 5868 | 53.76 | -0.42 | 1.04 | 2.85 | 10.76 | 86.38 | 395.51 | 70.67 | 412.66 | 78.14 | 419.90 | 73.64 |
| *Japan* | JPN | 6014 | 47.87 | -0.06 | 0.51 | 0.13 | 0.20 | 99.67 | 540.35 | 89.22 | 542.50 | 91.38 | 551.05 | 88.94 |
| *Kazakhstan* | KAZ | 5413 | 50.61 | -0.31 | 0.56 | 6.71 | 9.33 | 83.97 | 433.20 | 66.24 | 394.03 | 68.60 | 425.73 | 67.84 |
| *South Korea* | KOR | 4638 | 46.67 | 0.04 | 0.54 | 0.02 | 0.01 | 99.97 | 559.21 | 93.79 | 540.31 | 80.13 | 541.34 | 76.83 |
| *Lithuania* | LTU | 4143 | 50.28 | -0.10 | 0.82 | 0.21 | 1.31 | 98.49 | 484.22 | 84.38 | 482.50 | 80.68 | 500.39 | 79.89 |
| *Luxembourg* | LUX | 4752 | 49.81 | 0.08 | 1.21 | 17.54 | 29.18 | 53.27 | 493.80 | 91.34 | 492.24 | 98.40 | 495.41 | 97.52 |
| *Latvia* | LVA | 3649 | 50.28 | -0.22 | 0.80 | 0.35 | 4.10 | 95.55 | 496.72 | 77.97 | 494.45 | 79.32 | 508.31 | 73.55 |
| *Macau SAR, China* | MAC | 5059 | 48.99 | -0.88 | 0.75 | 15.40 | 50.04 | 34.57 | 541.61 | 88.37 | 511.41 | 76.88 | 523.03 | 73.26 |
| *Mexico* | MEX | 28109 | 51.26 | -1.06 | 1.62 | 0.69 | 0.41 | 98.89 | 421.57 | 68.13 | 431.86 | 72.11 | 421.90 | 63.94 |
| *Montenegro* | MNE | 4251 | 50.47 | -0.23 | 0.78 | 2.83 | 2.76 | 94.41 | 414.86 | 77.77 | 427.76 | 84.74 | 415.37 | 78.03 |
| *Malaysia* | MYS | 4664 | 51.86 | -0.70 | 1.00 | 0.08 | 1.72 | 98.20 | 426.15 | 76.57 | 402.80 | 77.69 | 424.76 | 72.92 |
| *Netherlands* | NLD | 4184 | 49.01 | 0.25 | 0.59 | 2.61 | 7.66 | 89.73 | 527.25 | 87.57 | 515.38 | 87.22 | 526.68 | 89.11 |
| *Norway* | NOR | 4285 | 49.10 | 0.48 | 0.56 | 4.52 | 4.60 | 90.88 | 493.95 | 85.87 | 510.59 | 91.38 | 500.17 | 92.32 |
| *New Zealand* | NZL | 4052 | 49.77 | 0.05 | 0.66 | 16.78 | 9.34 | 73.87 | 504.29 | 95.58 | 517.53 | 99.06 | 521.09 | 98.74 |
| *Peru* | PER | 5093 | 50.97 | -1.19 | 1.53 | 0.15 | 0.27 | 99.58 | 375.67 | 79.08 | 390.98 | 86.68 | 380.08 | 71.15 |
| *Poland* | POL | 4462 | 51.62 | -0.20 | 0.81 | 0.02 | 0.16 | 99.82 | 519.44 | 87.05 | 520.37 | 82.30 | 527.88 | 81.62 |
| *Portugal* | PRT | 5115 | 49.71 | -0.46 | 1.42 | 3.32 | 2.73 | 93.95 | 493.73 | 88.87 | 493.66 | 85.86 | 494.91 | 82.57 |
| *Qatar* | QAT | 9084 | 51.57 | 0.45 | 0.78 | 36.02 | 17.56 | 46.42 | 388.79 | 94.50 | 402.54 | 102.66 | 397.36 | 98.49 |
| *Romania* | ROU | 4641 | 51.13 | -0.45 | 0.89 | 0.13 | 0.03 | 99.85 | 448.43 | 77.11 | 442.64 | 83.48 | 443.11 | 73.01 |
| *Russia* | RUS | 4550 | 50.77 | -0.09 | 0.57 | 3.12 | 7.42 | 89.46 | 488.38 | 81.47 | 480.93 | 83.63 | 491.40 | 79.06 |
| *Singapore* | SGP | 5185 | 49.43 | -0.24 | 0.83 | 11.99 | 5.98 | 82.03 | 577.60 | 101.27 | 546.33 | 95.51 | 555.25 | 100.09 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Serbia* | SRB | 4131 | 50.88 | -0.27 | 0.81 | 1.84 | 6.62 | 91.54 | 455.04 | 85.76 | 452.26 | 85.84 | 449.79 | 81.25 |
| *Slovakia* | SVK | 4234 | 47.65 | -0.15 | 0.84 | 0.28 | 0.37 | 99.35 | 490.26 | 95.02 | 470.93 | 96.88 | 478.50 | 95.46 |
| *Slovenia* | SVN | 5546 | 48.74 | 0.07 | 0.76 | 2.15 | 6.49 | 91.36 | 504.55 | 87.90 | 484.55 | 87.48 | 517.59 | 85.91 |
| *Sweden* | SWE | 4224 | 50.28 | 0.29 | 0.66 | 5.64 | 8.33 | 86.03 | 485.35 | 85.80 | 491.59 | 96.70 | 492.62 | 91.01 |
| *Thailand* | THA | 5660 | 56.39 | -1.34 | 1.39 | 0.02 | 0.63 | 99.34 | 431.22 | 78.62 | 444.07 | 73.69 | 447.21 | 71.46 |
| *Tunisia* | TUN | 3960 | 53.48 | -1.16 | 1.58 | 0.08 | 0.32 | 99.60 | 392.29 | 74.08 | 407.94 | 81.80 | 402.18 | 71.99 |
| *Turkey* | TUR | 4429 | 49.90 | -1.44 | 1.22 | 0.25 | 0.63 | 99.12 | 452.56 | 87.84 | 479.74 | 80.81 | 466.95 | 74.96 |
| *Uruguay* | URY | 4313 | 53.40 | -0.84 | 1.31 | 0.31 | 0.12 | 99.58 | 420.66 | 82.33 | 423.06 | 85.74 | 427.50 | 86.11 |
| *United States* | USA | 4377 | 49.54 | 0.21 | 0.95 | 6.77 | 15.17 | 78.06 | 488.30 | 85.70 | 504.99 | 85.69 | 504.71 | 88.46 |
| *Vietnam* | VNM | 4633 | 53.59 | -1.81 | 1.25 | 0.02 | 0.09 | 99.89 | 513.67 | 81.86 | 509.92 | 68.51 | 530.18 | 72.47 |
| ***All*** | | ***405736*** | ***50.58*** | ***-0.58*** | ***0.50*** | ***2.76*** | ***4.70*** | ***92.54*** | ***461.74*** | ***98.20*** | ***470.67*** | ***95.20*** | ***471.39*** | ***96.32*** |

Note: For country-level data on father/mother absence and ICT resource, please see Appendix B.

## APPENDIX B: List of Country-Level Variables

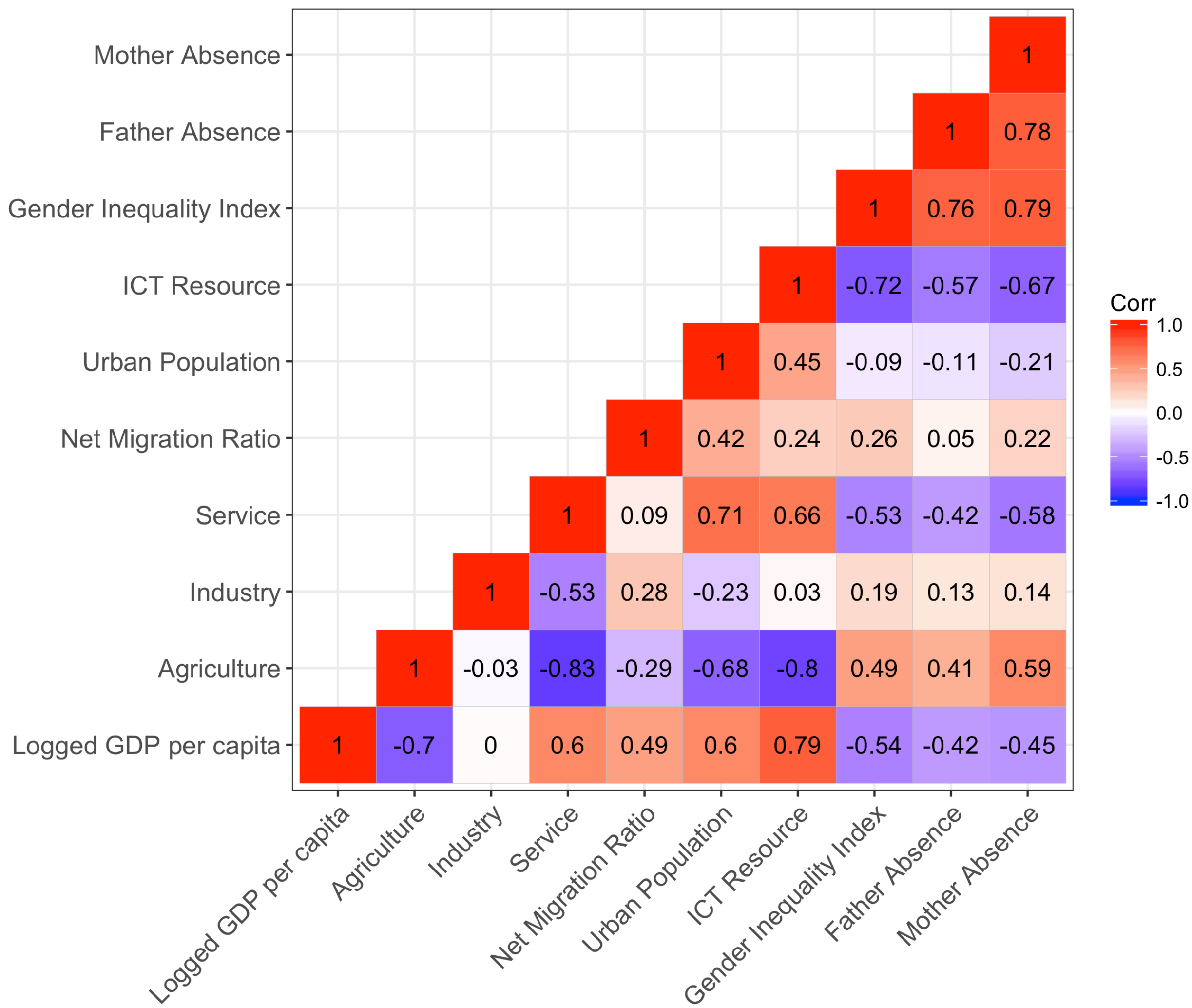
| *Country* | *Region* | *GDP per capita (1,000 International Dollars)* | *Agriculture Employment (%)* | *Industry Employment (%)* | *Service Employment (%)* | *Urban Population (%)* | *Net Migration Ratio (%)* | *ICT Resource* | *Gender Inequality Index* | *Father Absence (%)* | *Mother Absence (%)* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *United Arab Emirates* | Western Asia | 60.91 | 3.80 | 22.50 | 73.70 | 84.68 | 5.39 | 0.22 | 0.25 | 15.51 | 8.80 |
| *Argentina* | South America | 19.58 | 3.10 | 24.00 | 72.90 | 91.30 | 0.07 | -0.68 | 0.37 | 21.45 | 7.73 |
| *Australia* | Australia and New Zealand | 42.59 | 3.00 | 19.80 | 77.20 | 89.02 | 4.01 | 0.56 | 0.13 | 12.64 | 2.79 |
| *Austria* | Western Europe | 46.46 | 4.90 | 26.20 | 68.90 | 65.86 | 3.17 | 0.12 | 0.10 | 12.71 | 1.92 |
| *Belgium* | Western Europe | 42.35 | 1.20 | 21.90 | 76.90 | 97.73 | 2.32 | 0.33 | 0.09 | 12.57 | 2.95 |
| *Bulgaria* | Eastern Europe | 16.21 | 6.40 | 31.30 | 62.30 | 72.97 | -0.33 | -0.31 | 0.21 | 15.21 | 9.20 |
| *Brazil* | South America | 15.40 | 14.60 | 22.70 | 62.80 | 84.90 | 0.01 | -1.16 | 0.45 | 27.11 | 12.88 |
| *Canada* | Northern America | 42.15 | 2.20 | 20.30 | 77.50 | 81.29 | 3.30 | 0.35 | 0.11 | 11.36 | 3.37 |
| *Switzerland* | Western Europe | 57.85 | 3.60 | 21.10 | 75.30 | 73.74 | 4.97 | 0.23 | 0.06 | 12.84 | 1.95 |
| *Chile* | South America | 21.62 | 10.40 | 23.90 | 65.70 | 88.99 | 0.47 | -0.71 | 0.35 | 24.98 | 8.67 |
| *Colombia* | South America | 12.06 | 15.20 | 17.70 | 67.10 | 75.60 | -0.31 | -1.48 | 0.42 | 35.38 | 19.92 |
| *Costa Rica* | Central America | 14.13 | 13.20 | 20.70 | 66.10 | 73.94 | 0.42 | -1.03 | 0.31 | 24.08 | 6.23 |
| *Czech Republic* | Eastern Europe | 29.05 | 3.10 | 38.20 | 58.70 | 73.12 | 0.57 | 0.02 | 0.13 | 16.45 | 3.30 |
| *Germany* | Western Europe | 43.56 | 1.50 | 28.30 | 70.20 | 74.69 | 2.21 | 0.28 | 0.09 | 12.24 | 2.72 |
| *Denmark* | Northern Europe | 44.80 | 2.60 | 19.60 | 77.80 | 87.14 | 1.91 | 0.84 | 0.05 | 13.78 | 3.82 |
| *Spain* | Southern Europe | 31.99 | 4.40 | 20.60 | 75.00 | 78.90 | -1.22 | -0.01 | 0.10 | 9.68 | 2.13 |
| *Estonia* | Northern Europe | 26.02 | 4.70 | 31.10 | 64.20 | 67.84 | -0.80 | 0.21 | 0.16 | 19.26 | 4.14 |
| *Finland* | Northern Europe | 40.62 | 4.10 | 22.90 | 73.00 | 83.82 | 1.50 | 0.18 | 0.07 | 13.91 | 3.10 |
| *France* | Western Europe | 37.65 | 2.90 | 21.70 | 75.40 | 78.82 | 0.55 | 0.03 | 0.11 | 14.35 | 2.79 |
| *United Kingdom* | Northern Europe | 37.71 | 1.20 | 19.10 | 79.70 | 81.83 | 1.55 | 0.39 | 0.17 | 15.73 | 2.29 |
| *Greece* | Southern Europe | 25.28 | 13.00 | 16.70 | 70.30 | 77.00 | -1.46 | -0.45 | 0.13 | 9.31 | 3.15 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Hong Kong SAR, China* | Eastern Asia | 51.31 | 0.20 | 15.20 | 84.60 | 100.00 | 1.05 | -0.10 | NA | 12.75 | 4.63 |
| *Croatia* | Southern Europe | 21.13 | 12.30 | 28.10 | 59.60 | 58.07 | -0.77 | -0.29 | 0.14 | 7.72 | 2.10 |
| *Hungary* | Eastern Europe | 23.09 | 5.20 | 29.80 | 65.00 | 69.83 | 0.30 | -0.29 | 0.26 | 19.75 | 4.60 |
| *Indonesia* | South-Eastern Asia | 9.42 | 35.20 | 21.40 | 43.40 | 51.49 | -0.34 | -2.40 | 0.48 | 31.50 | 28.45 |
| *Ireland* | Northern Europe | 46.50 | 4.70 | 18.30 | 77.00 | 62.39 | -3.04 | 0.06 | 0.15 | 10.41 | 1.50 |
| *Iceland* | Northern Europe | 40.49 | 5.50 | 18.40 | 76.10 | 93.84 | -0.67 | 0.67 | 0.09 | 9.86 | 1.97 |
| *Italy* | Southern Europe | 36.24 | 3.70 | 27.90 | 68.40 | 68.56 | 0.44 | -0.08 | 0.12 | 9.22 | 1.79 |
| *Jordan* | Western Asia | 9.13 | 2.00 | 17.50 | 80.50 | 82.97 | 12.20 | -0.76 | 0.49 | 19.34 | 13.85 |
| *Japan* | Eastern Asia | 37.19 | 3.90 | 26.20 | 69.90 | 91.90 | 0.28 | -0.75 | 0.13 | 11.48 | 2.93 |
| *Kazakhstan* | Central Asia | 22.39 | 25.60 | 19.40 | 55.00 | 53.46 | 0.95 | -1.34 | 0.23 | 16.81 | 5.05 |
| *Korea, Rep.* | Eastern Asia | 32.10 | 6.20 | 24.50 | 69.30 | 82.14 | 0.34 | -0.39 | 0.08 | 8.28 | 3.85 |
| *Lithuania* | Northern Europe | 24.66 | 8.90 | 25.10 | 66.00 | 66.60 | -4.89 | -0.29 | 0.14 | 15.52 | 2.99 |
| *Luxembourg* | Western Europe | 91.62 | 1.30 | 12.70 | 86.00 | 89.25 | 9.17 | 0.26 | 0.11 | 11.52 | 2.59 |
| *Latvia* | Northern Europe | 21.25 | 8.40 | 23.50 | 68.10 | 67.55 | -4.10 | -0.20 | 0.19 | 21.09 | 5.32 |
| *Macao SAR, China* | Eastern Asia | 126.86 | 0.20 | 14.80 | 85.00 | 100.00 | 7.53 | -0.09 | NA | 14.54 | 6.01 |
| *Mexico* | Central America | 16.46 | 13.50 | 23.80 | 62.70 | 78.41 | -0.25 | -1.57 | 0.37 | 19.34 | 7.84 |
| *Montenegro* | Southern Europe | 13.86 | 5.70 | 17.40 | 77.00 | 63.46 | -0.50 | -0.51 | 0.18 | 7.34 | 3.98 |
| *Malaysia* | South-Eastern Asia | 23.01 | 12.60 | 28.40 | 59.00 | 72.53 | 2.68 | -1.06 | 0.30 | 17.54 | 9.37 |
| *Netherlands* | Western Europe | 46.71 | 2.70 | 17.10 | 80.10 | 88.58 | 0.37 | 0.53 | 0.05 | 10.30 | 2.09 |
| *Norway* | Northern Europe | 65.45 | 2.20 | 20.10 | 77.70 | 79.67 | 4.42 | 0.71 | 0.07 | 9.73 | 2.47 |
| *New Zealand* | Australia and New Zealand | 32.99 | 6.80 | 20.30 | 72.90 | 86.20 | 2.06 | 0.08 | 0.18 | 19.33 | 6.96 |
| *Peru* | South America | 11.15 | 23.90 | 17.50 | 58.60 | 77.62 | -0.80 | -1.72 | 0.40 | 18.64 | 6.96 |
| *Poland* | Eastern Europe | 23.83 | 12.60 | 30.40 | 57.00 | 60.69 | -0.19 | -0.08 | 0.15 | 18.61 | 6.65 |
| *Portugal* | Southern Europe | 26.45 | 10.50 | 25.60 | 63.90 | 61.76 | -1.33 | -0.02 | 0.13 | 12.96 | 3.17 |
| *Qatar* | Western Asia | 127.61 | 1.40 | 51.80 | 46.80 | 98.95 | 28.54 | 0.29 | 0.56 | 23.80 | 18.61 |
| *Romania* | Eastern Europe | 18.98 | 29.00 | 28.70 | 42.40 | 54.09 | -1.50 | -0.71 | 0.34 | 17.46 | 10.88 |
| *Russian Federation* | Eastern Europe | 25.78 | 7.30 | 27.80 | 64.90 | 73.79 | 0.71 | -0.42 | 0.30 | 23.21 | 3.98 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Singapore* | South-Eastern Asia | 77.43 | 0.40 | 20.20 | 79.50 | 100.00 | 6.36 | 0.24 | 0.09 | 10.38 | 4.05 |
| *Serbia* | Southern Europe | 13.11 | 21.00 | 26.50 | 52.50 | 55.31 | -1.39 | -0.47 | 0.19 | 8.46 | 4.67 |
| *Slovak Republic* | Eastern Europe | 26.65 | 3.20 | 37.50 | 59.20 | 54.16 | 0.21 | -0.20 | 0.18 | 14.97 | 3.85 |
| *Slovenia* | Southern Europe | 28.90 | 8.30 | 31.00 | 60.70 | 49.86 | 0.81 | 0.27 | 0.07 | 11.51 | 2.97 |
| *Sweden* | Northern Europe | 44.72 | 2.00 | 19.60 | 78.40 | 85.36 | 2.67 | 0.57 | 0.05 | 8.61 | 3.13 |
| *Thailand* | South-Eastern Asia | 14.71 | 39.70 | 21.00 | 39.40 | 46.68 | 0.25 | -1.47 | 0.31 | 30.78 | 24.20 |
| *Tunisia* | Northern Africa | 10.60 | 12.50 | 29.90 | 57.60 | 66.27 | -0.61 | -1.51 | 0.30 | 19.46 | 15.26 |
| *Turkey* | Western Asia | 20.64 | 23.60 | 26.10 | 50.40 | 71.83 | 2.18 | -1.39 | 0.37 | 13.62 | 11.04 |
| *Uruguay* | South America | 18.82 | 10.20 | 18.90 | 70.90 | 94.80 | -0.88 | -0.55 | 0.32 | 19.83 | 6.34 |
| *United States* | Northern America | 51.45 | 1.60 | 17.80 | 80.70 | 81.11 | 1.43 | 0.01 | 0.24 | 18.69 | 5.06 |
| *Vietnam* | South-Eastern Asia | 4.91 | 47.40 | 21.10 | 31.50 | 31.67 | -0.22 | -2.25 | 0.33 | 15.59 | 10.17 |
| ***Mean*** | | ***34.27*** | ***9.78*** | ***23.48*** | ***66.74*** | ***75.14*** | ***1.48*** | ***-0.33*** | ***0.24*** | ***15.94*** | ***6.36*** |
| ***Standard Deviation*** | | ***24.57*** | ***11.05*** | ***6.50*** | ***12.37*** | ***15.08*** | ***4.60*** | ***0.74*** | ***0.13*** | ***6.14*** | ***5.59*** |

Note: Gender Inequality Index is missing in Hong Kong and Macau.

## APPENDIX C: Correlation Matrix Plot between National-level Variables



## APPENDIX D: Parental Absence Effects on Test Scores by Country

| *Country* | *Effect of Father Absence* | | | | | | *Effect of Mother Absence* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Math | | Reading | | Science | | Math | | Reading | | Science | |
| | beta | se | beta | se | beta | se | beta | se | beta | se | beta | se |
| *United Arab Emirates* | -56.95 | 3.20 | -57.54 | 3.62 | -58.21 | 3.13 | -69.82 | 4.01 | -69.80 | 4.58 | -68.35 | 4.17 |
| *Argentina* | -13.13 | 3.32 | -17.52 | 3.75 | -23.70 | 4.06 | -27.28 | 5.96 | -33.76 | 6.34 | -30.69 | 7.35 |
| *Australia* | -23.29 | 2.52 | -23.01 | 2.62 | -22.23 | 2.76 | -34.63 | 7.20 | -33.15 | 7.73 | -35.37 | 8.24 |
| *Austria* | -7.26 | 5.18 | -3.97 | 4.69 | -7.53 | 5.52 | -31.03 | 12.32 | -39.36 | 11.38 | -32.66 | 11.59 |
| *Belgium* | -35.02 | 4.80 | -27.56 | 4.79 | -35.08 | 4.92 | -58.41 | 5.92 | -60.00 | 6.87 | -44.63 | 6.34 |
| *Bulgaria* | -22.89 | 4.01 | -34.07 | 5.52 | -23.78 | 4.63 | -49.07 | 5.14 | -72.33 | 7.05 | -53.94 | 6.05 |
| *Brazil* | -20.21 | 2.34 | -19.88 | 2.58 | -20.33 | 2.50 | -44.97 | 2.97 | -46.42 | 3.26 | -44.36 | 3.00 |
| *Canada* | -18.21 | 3.13 | -16.49 | 3.08 | -16.29 | 2.91 | -30.04 | 4.82 | -36.66 | 5.10 | -25.43 | 5.08 |
| *Switzerland* | -11.39 | 3.65 | -2.78 | 3.72 | -13.28 | 3.89 | -40.11 | 9.50 | -29.72 | 8.16 | -28.71 | 9.00 |
| *Chile* | -18.32 | 2.87 | -17.46 | 2.72 | -14.45 | 2.69 | -51.04 | 4.02 | -58.91 | 4.05 | -47.95 | 4.48 |
| *Colombia* | -25.10 | 3.21 | -22.66 | 3.52 | -26.70 | 3.32 | -45.41 | 3.96 | -52.89 | 4.49 | -46.55 | 3.79 |
| *Costa Rica* | -11.93 | 3.05 | -11.06 | 3.77 | -10.15 | 3.18 | -37.60 | 5.60 | -41.81 | 7.22 | -43.67 | 5.44 |
| *Czechia* | -22.31 | 4.66 | -16.76 | 4.03 | -11.18 | 4.30 | -51.56 | 10.09 | -45.65 | 8.85 | -56.95 | 9.15 |
| *Germany* | -11.84 | 5.34 | -4.92 | 5.46 | -8.36 | 5.39 | -52.84 | 11.79 | -47.88 | 10.07 | -62.57 | 11.91 |
| *Denmark* | -26.98 | 4.37 | -20.28 | 5.02 | -27.40 | 5.12 | -40.84 | 6.80 | -52.82 | 7.76 | -44.68 | 7.21 |
| *Spain* | -13.16 | 2.66 | -9.43 | 2.96 | -8.18 | 3.17 | -50.30 | 6.90 | -46.09 | 8.05 | -50.89 | 7.66 |
| *Estonia* | -0.54 | 3.84 | 2.24 | 3.94 | 3.57 | 4.12 | -22.12 | 6.13 | -20.80 | 6.74 | -11.45 | 5.77 |
| *Finland* | -20.92 | 3.66 | -14.61 | 4.15 | -20.92 | 4.04 | -39.24 | 7.26 | -20.01 | 7.36 | -40.94 | 7.20 |
| *France* | -24.75 | 4.41 | -16.40 | 4.82 | -17.73 | 4.58 | -46.26 | 9.25 | -54.23 | 11.47 | -37.55 | 10.31 |
| *United Kingdom* | -26.22 | 4.05 | -21.68 | 4.07 | -25.02 | 4.30 | -50.72 | 8.98 | -43.77 | 9.40 | -45.37 | 9.53 |
| *Greece* | -22.97 | 5.56 | -32.06 | 5.59 | -23.09 | 5.43 | -77.17 | 8.26 | -89.30 | 10.84 | -78.67 | 7.44 |
| *Hong Kong SAR China* | -7.72 | 4.64 | -9.67 | 4.54 | -5.71 | 4.48 | -37.21 | 7.06 | -36.04 | 7.36 | -29.02 | 6.80 |
| *Croatia* | 1.59 | 5.56 | 6.14 | 4.97 | 0.29 | 5.56 | -43.37 | 10.40 | -41.65 | 9.84 | -46.20 | 11.06 |
| *Hungary* | -17.61 | 4.25 | -17.70 | 4.23 | -16.66 | 3.81 | -47.72 | 6.80 | -55.61 | 7.61 | -35.44 | 7.08 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Indonesia* | -35.11 | 5.06 | -36.11 | 4.76 | -31.24 | 4.40 | -38.16 | 4.93 | -38.93 | 4.50 | -34.77 | 4.34 |
| *Ireland* | -28.35 | 3.67 | -25.79 | 3.86 | -31.02 | 4.26 | -42.76 | 14.32 | -31.77 | 14.53 | -33.28 | 13.48 |
| *Iceland* | -20.07 | 5.98 | -15.26 | 6.08 | -25.13 | 6.17 | -64.62 | 14.16 | -65.96 | 15.53 | -63.09 | 15.95 |
| *Italy* | -11.06 | 2.74 | -3.11 | 3.41 | -7.78 | 2.96 | -30.62 | 6.95 | -35.10 | 7.33 | -40.41 | 7.42 |
| *Jordan* | -37.88 | 3.30 | -41.99 | 4.04 | -41.11 | 3.91 | -46.20 | 3.64 | -55.67 | 4.30 | -48.34 | 4.42 |
| *Japan* | -26.30 | 4.90 | -30.98 | 5.39 | -28.43 | 4.96 | -37.60 | 9.51 | -37.17 | 9.49 | -20.27 | 10.05 |
| *Kazakhstan* | -2.31 | 3.32 | -1.41 | 3.23 | 2.64 | 3.80 | -22.25 | 6.21 | -33.68 | 6.22 | -18.96 | 6.18 |
| *South Korea* | -18.72 | 5.70 | -27.41 | 4.98 | -21.10 | 4.76 | -63.63 | 7.26 | -60.86 | 7.00 | -39.23 | 6.21 |
| *Lithuania* | -14.33 | 4.63 | -9.25 | 4.24 | -14.85 | 4.39 | -38.63 | 9.74 | -39.80 | 10.46 | -44.03 | 10.82 |
| *Luxembourg* | -13.79 | 4.45 | -11.26 | 4.91 | -12.87 | 5.07 | -30.10 | 10.43 | -53.79 | 12.76 | -32.87 | 11.98 |
| *Latvia* | -4.14 | 4.28 | 2.21 | 4.56 | 1.09 | 4.01 | -19.09 | 7.63 | -7.44 | 7.52 | -11.63 | 7.24 |
| *Macau SAR China* | -11.02 | 4.01 | -5.02 | 3.50 | -7.04 | 3.35 | -23.49 | 5.27 | -23.43 | 4.93 | -19.71 | 4.60 |
| *Mexico* | -9.85 | 2.00 | -6.51 | 2.27 | -7.02 | 1.95 | -32.54 | 2.59 | -36.35 | 2.86 | -26.03 | 2.46 |
| *Montenegro* | -14.50 | 5.76 | -20.69 | 5.81 | -10.46 | 5.93 | -62.64 | 6.02 | -57.13 | 7.56 | -52.60 | 6.56 |
| *Malaysia* | -35.18 | 3.53 | -29.37 | 4.12 | -26.04 | 3.57 | -52.55 | 4.62 | -44.20 | 5.92 | -41.94 | 4.74 |
| *Netherlands* | -31.84 | 5.19 | -20.61 | 5.96 | -28.20 | 6.04 | -63.07 | 12.02 | -50.57 | 13.40 | -58.57 | 13.21 |
| *Norway* | -19.67 | 4.88 | -16.22 | 5.43 | -14.39 | 5.69 | -34.85 | 9.41 | -58.43 | 10.49 | -52.78 | 10.68 |
| *New Zealand* | -28.64 | 4.24 | -27.84 | 4.65 | -26.49 | 4.82 | -56.11 | 5.86 | -63.65 | 6.58 | -56.25 | 6.51 |
| *Peru* | 0.76 | 3.46 | 8.32 | 4.03 | -0.54 | 3.21 | -14.99 | 5.29 | -11.04 | 5.94 | -14.87 | 5.19 |
| *Poland* | -38.74 | 4.43 | -36.69 | 5.31 | -33.95 | 4.52 | -70.21 | 5.95 | -74.15 | 6.62 | -64.78 | 6.17 |
| *Portugal* | -6.94 | 4.78 | -1.31 | 4.06 | -11.43 | 3.87 | -46.25 | 7.55 | -45.18 | 7.74 | -43.05 | 7.34 |
| *Qatar* | -66.85 | 1.79 | -62.70 | 2.55 | -64.38 | 2.07 | -67.05 | 2.25 | -63.61 | 3.09 | -63.39 | 2.33 |
| *Romania* | -21.34 | 3.41 | -20.76 | 3.66 | -18.48 | 3.24 | -33.99 | 4.67 | -35.80 | 5.27 | -30.64 | 4.17 |
| *Russia* | -6.46 | 4.34 | -6.13 | 4.07 | -7.53 | 4.26 | -43.98 | 12.67 | -42.50 | 9.56 | -38.87 | 10.37 |
| *Singapore* | -18.14 | 6.06 | -19.17 | 5.59 | -22.83 | 5.85 | -38.84 | 7.75 | -43.34 | 8.15 | -42.50 | 7.50 |
| *Serbia* | -21.46 | 5.10 | -19.15 | 5.76 | -11.29 | 5.47 | -46.31 | 8.65 | -52.51 | 9.28 | -33.53 | 8.79 |
| *Slovakia* | -24.68 | 5.95 | -17.36 | 6.37 | -23.18 | 5.74 | -54.02 | 9.94 | -55.62 | 8.98 | -51.25 | 9.12 |
| *Slovenia* | -20.65 | 5.07 | -20.95 | 4.59 | -23.82 | 4.68 | -53.28 | 8.91 | -71.55 | 8.69 | -57.34 | 9.10 |
| *Sweden* | -29.41 | 5.04 | -26.57 | 6.31 | -32.51 | 5.05 | -39.96 | 9.54 | -49.47 | 10.66 | -46.05 | 10.98 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Thailand* | -30.26 | 3.57 | -33.76 | 3.63 | -27.58 | 3.45 | -42.19 | 3.84 | -48.44 | 3.52 | -41.20 | 3.56 |
| *Tunisia* | -39.45 | 4.77 | -43.91 | 5.20 | -31.74 | 4.66 | -48.81 | 5.70 | -54.55 | 6.20 | -41.45 | 5.40 |
| *Turkey* | -50.51 | 4.78 | -53.28 | 4.76 | -40.49 | 4.15 | -62.58 | 4.71 | -64.67 | 4.73 | -51.61 | 3.96 |
| *Uruguay* | -13.05 | 3.77 | -9.33 | 4.32 | -8.97 | 4.30 | -57.90 | 5.77 | -53.52 | 6.79 | -51.45 | 6.38 |
| *United States* | -27.43 | 4.44 | -26.95 | 4.49 | -26.26 | 4.74 | -32.35 | 6.71 | -27.71 | 6.69 | -24.62 | 6.79 |
| *Vietnam* | -24.86 | 5.01 | -21.22 | 4.33 | -22.74 | 4.78 | -48.87 | 6.44 | -39.93 | 5.92 | -44.00 | 5.96 |

Note: Estimates are from bivariate regression models predicting test scores by father/mother absence.