

## 5. Method

The research questions considered in this study relate to different issues associated with family background measures and indices. We addressed them by analyzing the data from three large-scale assessment studies, using the methods detailed in this chapter of our paper. We describe the data from the different studies that we analyzed as well as the statistical methods we used to analyze the various issues related to measures of family background.

### 5.1 Data

All datasets used in the analyses were taken from international large-scale assessments conducted in countries from all over the world. The studies, all well known, are the following:

- The IEA Trends in International Mathematics and Science Study (TIMSS);
- The IEA Progress in International Reading Literacy Study (PIRLS); and
- The OECD Programme for International Student Assessment (PISA).

All three studies are repeatedly conducted in cycles of three (PISA), four (TIMSS), or five years (PIRLS). We used data from the most recent cycles—that is, TIMSS 2007, PIRLS 2006, and PISA 2006—because they reflect the latest methodological developments. Most of the data considered is drawn from student responses. Where available, we also analyzed data from the students' parents.

The following sections provide short descriptions of these studies as well as of the variables within the instruments (the student questionnaire and parent/home questionnaire) used in the studies that relate to family background. Also considered are derived variables or scales of family background composed from single measures reported in the studies' findings. We end this section with a description of the set of countries we included in our analyses.

#### 5.1.1 Studies

As already stated, the current research employed data from TIMSS 2007, PIRLS 2006, and PISA 2006. The description of each study that follows includes introductions to the variables and derived indices of family background used in them.

### ***TIMSS 2007***

The Trends in International Mathematics and Science Study (TIMSS) is a large-scale assessment survey designed to compare students' achievement in mathematics and science (as the name itself shows) in many countries around the world. TIMSS is a trend study conducted by the International Association for the Evaluation of Educational Achievement (IEA) and is directed by the TIMSS and PIRLS Study Center located in the U.S. at Boston College. The study is conducted in a four-year cycle, with the initial study taking place in 1995 and subsequent cycles in 1999, 2003, and 2007. The study targets two student populations—students in Grade 4 and students in Grade 8.

The total number of countries participating in TIMSS 2007 was 59, with an additional eight benchmarking participants.<sup>2</sup> The number of participating countries at fourth grade was 37 countries plus seven benchmarking participants, with over 183,000 participating students in total. Fifty countries and seven benchmarking participants took part in the survey of eighth-grade students, who totaled more than 241,000 in number (Martin et al., 2008).

In addition to collecting achievement data in the two content domains (mathematics and science), TIMSS 2007 also collected data on the social and educational contexts of students related to curriculum, schools, teachers and their preparation, and classroom activities and characteristics. These contextual data were collected by means of four different questionnaires:

1. *The curriculum questionnaire*, completed by the TIMSS national research coordinators (NRCs) of the participating countries;
2. *The student questionnaire*, completed by the students;
3. *The teacher questionnaire*, completed by the students' teachers and administered in three forms—one for the fourth-grade class teacher and two different ones for the science and mathematics teachers of the eighth-grade students; and
4. *The school questionnaire*, completed by the principals of the schools of the students surveyed (Mullis et al., 2005).

Because our focus in this paper is on the family backgrounds of students, we used only the student questionnaire data from both target populations (Grades 4 and 8). Each student participating in the mathematics and science assessment completed the student questionnaire. It contained questions concerning students' circumstances at home and school, classroom experiences, self-perceptions of aptitude for and attitudes toward both subjects of the assessment, homework, out of school activities, computer use, and basic demographic information (Mullis et al., 2005). TIMSS does not collect data from parents.

The TIMSS 2007 student questionnaire data on family background included the following aspects: the frequency with which the language of the TIMSS assessment

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2 Benchmarking participants are "regional entities that follow the same assessment procedures as the countries;" see Olson, Martin, and Mullis (2008, p. 2).

was spoken at home, the number of books at home, the availability of specific educational resources at home, the availability of specific home possessions, the immigration status of the student and each one of his or her parents, and the highest level of education of each of the parents. Note, however, that the information on parental education was collected from the Grade 8 students only. For more details on the items and variables pertaining to family background in TIMSS 2007, see Table 5.1.

**Table 5.1: Items and variables in the TIMSS 2007 student questionnaire associated with family background**

Item content	Description	Variable Grade 4	Variable Grade 8
Language	Student's frequency of use of the language of the test at home	AS4GOLAN	BS4GOLAN
Books in the home	Number of books in the student's home	AS4GBOOK	BS4GBOOK
Home possessions	Several items about educational resources and general possessions in the student's home* Calculator Computer Study desk Dictionary Internet connection	AS4GTH01 AS4GTH02 AS4GTH03 AS4GTH04 AS4GTH05	BS4GTH01 BS4GTH02 BS4GTH03 BS4GTH04 BS4GTH05
Parents born in country	Whether or not mother was born in country Whether or not father was born in country Whether or not parents were born in country	AS4GMBRN AS4GFBRN ASDGBORN	BS4GMBRN BS4GFBRN BSDGBORN
Student born in country	Whether or not student was born in country and, if not, age at which student emigrated	AS4GBORN (AS4GBRNC)	BS4GBORN (BS4GBRNC)
Parents' education (Grade 8 only)	Highest level of education completed by father Highest level of education completed by mother Highest level of education completed by parents		BS4GMFED BS4GFMED BSDGEDUP

**Note:** \* In addition to the five home-possession items included in the international questionnaire, TIMSS offered participating countries the opportunity to survey country-specific items. Because these differed from country to country, they are not included in our analyses.

In addition to containing information on single-indicator variables, the TIMSS 2007 international database also contains derived variables using single measures from the student questionnaire. Because TIMSS surveys two different populations (Grade 4 and Grade 8 students), there are separate derived family background variables for each. Only one family background variable is derived from the Grade 4 student questionnaire—"parents born in country." It is based on the students' responses to two separate questions that ask students whether their mothers and fathers were born in the country where they (the students) were taking the assessment. The source variables are dichotomous (yes/no), and the values in the derived variable depend on combinations of students' answers about the country of birth of each parent. The derived variable has three categories: both parents born in country, only one parent born in country (students respond with "yes" for one of the parents and "no" or missing answer for the other), and neither parent born in country ("no" for both parents or missing answers for both parents) (Foy & Olson, 2009a, p. 6).

There were two derived variables for the second TIMSS 2007 population (Grade 8 students). One of them was again “parents born in country,” which was computed in the same way as described above for the first population (Grade 4 students). The other variable derived from the Grade 8 student questionnaire was “parents’ highest education level,” taken from students’ responses to the question about the highest level of education attained by each parent. If data for the mother’s highest level of education were missing, the value from the father’s education was used, and vice versa. If data about both parents were missing, the derived variable was set to missing. If both variables had valid data, the value for the parent with the higher educational level was taken (Foy & Olson, 2009a, p. 56).

### ***PIRLS 2006***

The Progress in International Reading Literacy Study (PIRLS) is also an international large-scale trend assessment conducted by IEA and directed by the International Study Center at Boston College. PIRLS assesses reading literacy in cycles of five years. The first PIRLS cycle took place in 2001, and the second one was conducted in 2006. PIRLS assesses the reading literacy of students in Grade 4.

PIRLS 2006 was conducted in 40 countries around the world. Belgium participated with two education systems, and five Canadian provinces took part independently, making for a total of 45 participating education systems (Mullis et al., 2007, p. 1). The total number of tested students was over 200,000 (Foy & Kennedy, 2008a, p. 1).

PIRLS 2006 also used contextual questionnaires, with the aim of gathering information on four different contexts to aid understanding of the achievement data. These contexts were national and community, home, school, and classroom. The vehicles used to collect this information were the following:

1. The student questionnaire, completed by the participating students;
2. The so-called Learning to Read Survey (also known as the home questionnaire), completed by the parents of each participating student;
3. The teacher questionnaire, completed by the students’ respective teachers;
4. The school questionnaire, completed by the school principals; and
5. The curriculum questionnaire, completed by each participating country’s NRC (Mullis et al., 2006).

Each student taking part in the 2006 study completed the student questionnaire. It collected information on various student characteristics: the student’s home and school life (classroom experiences, reading as homework), the student’s perception of his or her ability as a reader and his or her attitudes toward reading, the frequency with which the student read out of school and used computers, and the type of literacy resources at home. The student questionnaire also included items designed to collect basic demographic information (Mullis et al., 2006).

In contrast to TIMSS 2007, PIRLS 2006 also used a parent questionnaire (the aforementioned Learning to Read Survey). The parents of each student taking part in the reading achievement test were asked to complete it. The questionnaire included

items for gathering information from parents (or primary caregivers) about literacy interactions between parents and child, literacy resources in the home, parents' reading habits and attitudes toward reading, and the connections between the parents and their child's school. The questionnaire also collected basic demographic and socioeconomic information (Mullis et al., 2006).

The PIRLS 2006 student questionnaire and Learning to Read Survey collected data on different aspects of family background. The items in the student questionnaire that sought out this information were those on the frequency with which the language of the test was used in students' homes, the number of books at home, the availability of particular educational resources and home possessions, and the immigration status of each student and of each of his or her parents.

The Learning to Read Survey (or "home" questionnaire) contained items on the language of children's books in the home, the language most often used at home, the number of books at home, the level of education of each parent, and the employment situation and main job of each parent. The questionnaire also contained a measure of the parents' financial wellbeing (as perceived by the parents). For more detailed information on the questions included in the student and home questionnaires and their associated variables, refer to Tables 5.2 and 5.3.

**Table 5.2: Items and variables in the PIRLS 2006 student questionnaire associated with family background**

Item content	Description	Variable
Language	Student's frequency of use of the language of the test at home	ASBGLNGH
Books in the home	Number of books in the student's home	ASBGBOOK
Home possessions	Several items about educational resources and general possessions in the student's home* Computer Study desk Own books Daily newspaper Own room Own cellphone	ASBGTA1 ASBGTA2 ASBGTA3 ASBGTA4 ASBGTA5 ASBGTA6
Parents born in country	Whether or not mother was born in country Whether or not father was born in country Whether or not parents were born in country	ASGBRNM ASGBRNF ASDGBRN
Student born in country	Whether or not student was born in country	ASGBRN1

**Note:** \* In addition to the six home-possession items included in the international questionnaire, PIRLS offered participating countries the opportunity to survey country-specific indicators of wealth. Because these differed from country to country, they are not included in our analyses

**Table 5.3: Items and variables in the PIRLS 2006 Learning to Read Survey associated with family background**

<b>Item content</b>	<b>Description</b>	<b>Variable</b>
Language of books	Language of children's books in the home	ASBHCHBL
Language spoken	Language used most often when parents speak with their child (F=father, M=mother)	ASBHLAHF ASBHLAHM
Books in the home	Number of books in the home	ASBHBOOK
Children's books in the home	Number of children's books in the home	ASBHCHBK
Parents' education	Highest level of education completed by father Highest level of education completed by mother Highest level of education completed by parents	ASBHLEDF ASBHLEDM ASDHEDUP
Parents' employment situation	Employment situation of father Employment situation of mother Employment situation of parents	ASBHEMPF ASBHEMPM ASDHPEMP
Parents' main job	Father's main job Mother's main job Parents' occupational level	ASBHMJF ASBHMJM ASDHOCCP
Family financially well off	Self-report of family's financial situation relative to other families	ASBHWELL
Early home-literacy activities	Reading books Telling stories Singing songs Playing with ABC-tools Playing word games Reading aloud signs and labels	ASBHHA01 ASBHHA02 ASBHHA03 ASBHHA04 ASBHHA07 ASBHHA09

In addition to the particular variables measuring different family characteristics, PIRLS derived variables that were computed by combining data from single items. Derived variables "provided a more comprehensive picture of the construct of interest than the individual variables could on their own" (Martin et al., 2007, p. 197). Not all students were included in the computation of the derived variables: those who had missing values for a certain number of the single items included in the calculation were assigned a missing value for the derived variables. The indices (derived variables) in the PIRLS 2006 international database consisted of three categories—high, medium, and low. When constructing an index of the components (single items), researchers need to intercorrelate these in order to produce a reliable scale (Martin et al., 2007).

PIRLS 2006 has two family background indices of interest within the context of our study—the Index of Home Educational Resources and the Index of Early Home Literacy Activities—as well as four other derived variables: "student's parents born in country," "parents' highest education level," "parents' employment situation," and "parents' highest occupational level."

The Index of Home Educational Resources (HER) is based on the responses to the questions in both the student and the parent questionnaire about the educational resources at home. The index "is intended to summarize the students' and parents' reports about aspects of the home environment and the extent to which it supports

literacy" (Martin et al., 2007, p. 201). When deriving this variable, the research term used the following variables from both instruments (Foy & Kennedy, 2008c; Martin et al., 2007):

- Number of books in the home;
- Number of children's books in the home;
- Availability of home-possession items (four variables for different items at home—computer, study desk, own books, daily newspaper); and
- Highest level of educational attainment of either parent.

Interested readers might like to look at the original questions from the questionnaires published in Supplement 1 of the PIRLS 2006 user guide (Foy & Kennedy, 2008c). The user guide also includes the response categories of each one of the variables as well as the categories of the Index of Home Educational Resources itself, which is Supplement 3 of the guide.

The second index of family background that was of interest to us was the Index of Early Home Literacy Activities (EHLA). This index was obtained from parents' responses about the frequency of engaging in different reading-related activities with their children before their children started primary school. The index places students into three categories—high (2.33 through 3), medium (1.67 through 2.33) and low (1 to less than 1.67), with the numbers referring to the average that was computed across the six items based on a three-point scale: "never or almost never" = 1, "sometimes" = 2, and "often" = 3 (Martin et al., 2007).

The separate variables used to construct this index were the six items of the question, "Before your child began primary school, how often did you or someone else in your home do the following activities with him or her?" Each item had three response categories—"often", "sometimes," and "never or almost never." The six items included reading books, telling stories, singing songs, playing with alphabet toys, playing word games, and reading aloud signs and labels (Foy & Kennedy, 2008c). For more details on the Index of Early Home Literacy Activities, see the home questionnaire in Supplement 1 and the full description of the index in Supplement 3 of the PIRLS 2006 user guide for the PIRLS 2006 international database (Foy & Kennedy, 2008c).

Another derived variable is "student's parents born in country," obtained from questions in the student questionnaire that asked whether the mother and the father were born in the country of the literacy achievement test. The derived variable has three response categories: "both" (if the student responded that both his or her mother and father were born in the country of the test), "either" (one parent born in the country of the test and the other in a different country), and "neither" (both parents born in a country other than the one of the test) (Foy & Kennedy, 2008c, p. 4).

The variable "parents' highest education level" was derived from questions in the home questionnaire concerning the highest level of education completed by both parents. The variables used for the computation were first collapsed by merging the categories concerning postsecondary nontertiary education into one category and

merging the categories for higher education into another. The value for the parent with the highest education level was taken and all “not applicable responses” were recoded as missing (Foy & Kennedy, 2008c, p. 22).

“Parents’ employment situation” was derived using the home questionnaire item that asked about the employment status of both parents. The derived variable was based on the answers of the parents and had the following categories: both fulltime; either fulltime; both less than fulltime (for parents answering that they worked part-time for money or that they did not work in any type of paid job, but were looking for such a job); and other (for those who responded that they had some other kind of working arrangement or answered that none of the response categories was applicable to them) (Foy & Kennedy, 2008c, p. 23).

“Parents’ highest occupational level” was derived from the answers of the parents to questions about the kind of work each one of them was doing. The response categories of the source variables about the professions were collapsed from 12 to 7 in the derived variable (from “professional” to “never worked outside of home for pay” plus “not applicable”) (Foy & Kennedy, 2008c, p. 24).

### ***PISA 2006***

The Programme for International Student Assessment (PISA) “is a collaborative effort among OECD member countries to measure how well 15-year-old students approaching the end of compulsory schooling are prepared to meet the challenges of today’s knowledge societies” (OECD, 2009, p. 3). PISA was launched in 1997 by the Organisation for Economic Co-operation and Development (OECD). This was done, as the founders of PISA stated, “In response to the need for cross-nationally comparable evidence on student performance” (OECD, 2007, p. 3).

PISA surveys the key competencies of 15-year-old students in order to answer the question of whether these students are prepared to participate in the global economy and real-life challenges after finishing their schooling. PISA does not focus on a specific grade level in school. Rather, it defines its target population as students between 15 years and 3 months of age and 16 years and 2 months of age at the time of the assessment. In addition, students who take the test should have completed at least six years of formal schooling. This age bracket was selected to capture students (in the participating countries) just as they are about to finish compulsory education (OECD, 2007, pp. 22–23).

PISA is conducted in cycles of three years, the first of which took place in 2000, and the following in 2003 and 2006. Each cycle has a major emphasis on one of the subject domains PISA assesses (mathematics, science, and reading). The PISA assessment of 2006 focused on science (OECD, 2009, p. 28). The total number of countries that participated in this assessment was 57, 30 of which were OECD countries and 27 of which were OECD partner countries (OECD, 2007, p. 17). Nearly 400,000 students took part in the survey (OECD, 2009, p. 22).



In addition to administering the achievement tests, PISA 2006 used contextual questionnaires—a student questionnaire, a school questionnaire, an information and communication technologies (ICT) familiarity questionnaire (completed by students), and a parent questionnaire. The last two questionnaires were optional, that is, countries were free to decide whether to use them or not (OECD, 2009, p. 59). The parent questionnaire was administered in 10 OECD and six partner countries only (OECD, 2009, p. 24).

Besides collecting information on basic student characteristics, the PISA 2006 student questionnaire asked about different family background aspects: parental occupation and education, home possessions and number of books at home, immigration status of both parents and the student, and the language most commonly used at home (OECD, 2009, p. 58). The parent questionnaire included items on parental background: age, occupation, and education of each parent, and total income of the household (OECD, 2009, p. 60). For more details on the student and parent questionnaire items, refer to Tables 5.4 and 5.5.

Along with the single items in these two background instruments, PISA 2006 employed derived variables or scales, obtained by combining the information from the questions in the student and parent questionnaires. The family background indices computed from individual items taken from the student questionnaire included the following:

- Home possessions;
- Cultural possessions;
- Home educational resources;
- Family-wealth possessions;
- Occupational status of parents;
- Indices of blue-collar/white-collar parental occupation;
- Indicators of a science-related career of both parents and science-related career expectations of students;
- Indices of parental education;
- Immigration status of the mother, father, and student; and
- Language most commonly spoken at home.

One additional index was calculated on the basis of three other derived variables. This was the Index of Economic, Social, and Cultural Status (ESCS), which was computed from three derived variables—home possessions, parents' estimated years of schooling, and highest occupational status of parents. The home possessions, cultural possessions, home educational resources, and family-wealth possessions scales are all indices derived from home possessions (OECD, 2009, pp. 304ff.).

Table 5.4: Items and variables in PISA 2006 student questionnaire associated with family background

Item content	Description	Variable	Scale
Language	Language spoken at home	ST12Q01	
Books in the home	Number of books in the student's home	ST15Q01	
Home possessions	Several items about educational resources and general possessions in the student's home* Study desk Own room Quiet place to study Computer for school work Educational software Link to internet Own calculator Classic literature Books of poetry Works of art Books to help with school work Dictionary Dishwasher DVD/VCR player Cellphone (number of) Television (number of) Cars (number of) Rooms with bath or shower (number of)	ST13Q01 ST13Q02 ST13Q03 ST13Q04 ST13Q05 ST13Q06 ST13Q07 ST13Q08 ST13Q09 ST13Q10 ST13Q11 ST13Q12 ST13Q13 ST13Q14 ST14Q01 ST14Q02 ST14Q03 ST14Q04	WEALTH, CULTPOS, HEDRES, HOMEPOS (using different combinations of the home- possession variables)
Parents born in country	Whether or not mother was born in country Whether or not father was born in country Mother's country of birth Father's country of birth	ST11Q02 ST11Q03 COBN_M COBN_F	IMMIG
Student born in country	Whether or not student was born in country (Student's age at time of immigration) Student's country of birth	ST11Q01 (ST11Q04) COBN_S	
Occupation of parents	Occupation of mother ISEI coded Occupation of father ISEI coded Highest occupation of parents ISEI coded Mother white-collar/blue-collar classification Father white-collar/blue-collar classification Highest parent white-collar/blue-collar classification	BMMJ BFMJ HISEI MSECATEG FSECATEG HSECATEG	
Education of parents	Highest education of mother Highest education of father Highest education of parents	MISCED FISCED HISCED	PARED (years of schooling)

**Note:** \*In addition to the home possession items included in the international questionnaire, PISA offered participating countries the opportunity to survey country-specific items. Because these differed from country to country, we did not include them in our analyses.

**Table 5.5: Items and variables in PISA 2006 parent questionnaire associated with family background**

<b>Item content</b>	<b>Description</b>	<b>Variable</b>
Household income	Relative to median	PA15Q01
Occupation of parents	Occupation of mother ISEI coded Occupation of father ISEI coded Highest occupation of parents ISEI coded	PQBMMJ PQBFMJ PQHISEI
Education of parents	Highest education of mother Highest education of father Highest education of parents	PQMISCED PQFISCED PQHISCED

Two more groups of indices were computed from variables taken from the parent questionnaire: the Educational Level of Parents, and the Index of Occupational Status of Parents (OECD, 2009, pp. 309–310). Both indices include three separately derived variables—one for the mother, one for the father, and one for the highest educational level/occupational status of both parents.

The different scales on home possessions in PISA 2006 use different sets of items about possessions available at home. The Home Possessions Scale is a summary index derived from items on home possessions in the student questionnaire. These related to the availability of one’s own room, a study desk, internet connection, and so on. Another set of questions asked about the number of different items available at home (cellphones, televisions, computers, cars, and rooms with bath or shower). One more variable—number of books at home—was added to the calculation of the Home Possessions Scale (OECD, 2009, p. 316).

The scale was constructed in two steps. First, item parameters for the aforementioned items were estimated for each country based on the item set. The sum of parameters was then constrained to zero for each country. Second, the item parameters were anchored, and the country-specific items were then appended. Each country was scaled separately (OECD, 2009, p. 317).

The cultural possessions and home educational resources scales were derived in a similar way, but only in one step, thereby allowing the item parameters to vary by country. The cultural possessions scale was calculated using three items from the student questionnaire—availability of classic literature, books at home, and works of art at home. The home educational resources scale uses seven items from the home-possessions questions included in the student questionnaire—study desk, place to study, computer to use for school work, educational software, own calculator, books helpful for school work, and dictionary (OECD, 2009, pp. 316–317).

The family wealth possessions scale uses items on home possessions included in two questions from the student questionnaire. The first question is about whether or not the student had a room of his or her own at home and whether the following items were also available in the home: an internet connection, a dishwasher, a DVD player, and three country-specific items. The second question asked about the number

of cellphones, televisions, computers, and cars in the home. The family wealth possessions scale was constructed in the same way as the Home Possessions Scale (OECD, 2009, pp. 316–317).

The occupational data for both parents was obtained through open-ended questions in the student questionnaire that were then coded into ISCO-88 codes. These codes, in turn, were mapped to the International Socio-Economic Index of Occupational Status (ISEI). Three such variables with ISEI scores were produced: one for the mother, one for the father, and one indicating the highest ISEI score of either parent (OECD, 2009, p. 305).

The Index of Blue-Collar/White-Collar Parental Occupation was based on students' reports on their parents' jobs. The ISCO-88 codes were recoded into four categories (blue collar, white collar, high skilled, low skilled) and set up as two separate variables for the mother and father employment categories. An additional variable was then created from these two variables, namely the highest employment category of either parent (OECD, 2009, p. 306).

Another set of variables derived from the information on occupation concerned the science-related occupations of parents and the type of occupation students hoped to pursue in the future. These variables were computed by aggregating ISCO-88 codes into two categories, one called science-related occupations, and the other called no science-related occupations/undetermined (OECD, 2009, p. 306).

Information on parental education from the student questionnaire was recoded (from 0 = none through to 6 = ISCED 5A & 6) into variables indicating the educational level of the mother and the father. In addition, the Index of Highest Educational Level was obtained by taking the highest ISCED level of either parent. The completed education level was converted into the estimated number of years of schooling for both parents (OECD, 2009, p. 305).

The original questions asking whether the mother's, father's, and student's country of birth was the same as the country in which the student completed the PISA assessment were copied into new variables and then recoded into dichotomous variables (i.e., country of birth is the same as the country of assessment or the opposite). The Index of Immigrant Background, calculated on the basis of the original values of the copied variables indicating country of birth, had three categories: native students (students with at least one parent born in the country), first-generation immigrant student (born outside the country with parents also born outside), and second-generation student (born in country, but parents born outside). Students who did not respond to these questions, either about themselves or both parents, were assigned missing values for this variable (OECD, 2009, pp. 30–306).

The language spoken at home variable was derived from a question in the student questionnaire about languages spoken at home and was then recoded into three categories: same as the language of assessment; language of the country, but different from the one of the assessment; and foreign language (OECD, 2009, p. 306).

The Index of Economic, Social, and Cultural Status (ESCS) was derived from three other indices—highest occupational status of parents, estimated years of parental schooling, and home possessions. “The ESCS scores were obtained as component scores for the first principal component with zero being the score of an average OECD student and one the standard deviation across equally weighted OECD countries” (OECD, 2009, p. 346). The ESCS for the OECD partner-countries was derived by summing the products of the OECD factor loadings and the OECD-standardized highest occupational status of parents, estimated years of schooling of parents, and home possessions, and then dividing the result by the eigenvalue of the first principal component (OECD, 2009, p. 346).

The Educational Level of Parents Index was the first of the group of indices derived from the parent questionnaire in PISA 2006. The questions for the educational level of the mother and of the father in the parent questionnaire contained four options; parents were asked to check (tick) the ones that applied to them. The educational level for each parent was obtained by taking only the answer from the parent who had the highest completed level of education. The Highest Educational Level of Parents Index therefore represents the highest completed level of one parent, not both (OECD, 2009, p. 309).

The Occupational Status of Parents Index was derived from the occupation information in the parent questionnaire, and it was obtained from the information included in the open-ended questions. The parents’ responses were coded into ISCO-88 codes, recoded into ISEI values, and the scores for mother’s occupation and father’s occupation were then produced (two variables—one for each parent). The Highest Occupational Level of Parents, therefore, also represents the answer from the parent with the highest occupational level (OECD, 2009, pp. 309–310).

### **5.1.2 Countries**

Part of our research project has been concerned with evaluating measures of family background with regard to different purposes, a circumstance that has implications for administering the studies of interest in different sets of countries. Different studies collect background information on different aspects and in a different way. It is therefore necessary to verify whether and to what extent certain variables or scales derived from those variables are associated with achievement. We could expect that two different studies measuring the same background characteristics would compute nearly the same association between the background measures and achievement. If not, then the reasons for the differences should be sought. However, such comparisons have two problems. First, the large-scale studies described so far are conducted in different countries. Second, the PIRLS 2006 assessment had a target population of Grade 4 students, PISA 2006 surveyed students between 15 and 16 years of age, and TIMSS 2007 collected data on students from Grades 4 and 8. It is fair to assume that students in such different age groups will have different knowledge about their families’ background characteristics, not to mention ability to produce accurate information. For example, and as we discussed earlier in this paper, studies show that students’ knowledge about their parents can differ considerably

across different age groups. In general, the older the students are, the more accurate their answers about background characteristics are likely to be (Baratz-Snowden et al., 1988; Ensminger et al., 2000; Hauser, 1994).

To address the problem of accuracy in responses from students in different age groups, we conducted two comparisons—one between the PIRLS 2006 and TIMSS 2007 (Grade 4) results, and the other between the PISA 2006 and TIMSS 2007 (Grade 8) results. This separation allowed us to control for student age (with regard to accuracy of their knowledge) when endeavoring to determine the association between home background measures and achievement.

To address the problems associated with different countries participating in the studies, we compared the results for those countries that participated in the pairs of studies that targeted students in the same or near-same age groups, thus PIRLS 2006 and TIMSS 2007 Grade 4, and PISA 2006 and TIMSS 2007 Grade 8. Some of the countries that participated in TIMSS 2007 conducted the assessment with both student populations; others in only one. In order to match the countries with data from both studies in each pair, we used the information contained in Table 5.6. The countries that participated in the two pairings can be easily identified from the table.

Table 5.6 shows the countries participating in the studies in scope. Some of the countries that participated in TIMSS 2007 conducted the assessment with both student populations; others in only one.

## **5.2 Analysis**

To assess the quality of the indicators of family background, we analyzed the data with regard to the following criteria: nonresponse, association with achievement, and, in the case of scales, reliability. Using as our basis the empirical findings from the analysis, we categorized the criteria to aid ease of comparison. We used SPSS to compute response rates and reliability statistics, and the IEA IDB Analyzer software to calculate the association of family background indicators with achievement. The latter included the calculation of standard errors (SEs). In order to retain readability of the result tables, SEs were not included in the tables.

### **5.2.1 Nonresponse**

Every study usually has cases in which some respondents do not provide answers to certain questions. Missing data originating from nonresponse can be a serious problem in research. One of the issues with nonresponse is that it decreases the size of the effective sample drawn from the population of interest.

Reasons for nonresponse vary: refusal to answer, accidental skipping of items, lack of interest in the issue or topic, and lack of knowledge needed to answer the question. In research, nonresponse causes problems because it is expected that each record in the dataset has values on all variables. The usual and easiest solution to this problem is to exclude cases that have missing values for any of the variables included in an analysis (Alison, 2002).

Table 5.6: Countries participating in PIRLS 2006, PISA 2006, and TIMSS 2007

Country/ education system					Country/ education system				
	PIRLS 2006	TIMSS 2007 (Grade 4)	PISA 2006	TIMSS 2007 (Grade 8)		PIRLS 2006	TIMSS 2007 (Grade 4)	PISA 2006	TIMSS 2007 (Grade 8)
Algeria		•		•	Liechtenstein			•	
Argentina			•		Lithuania	•	•	•	•
Armenia		•		•	Luxembourg	•		•	
Australia		•	•		Macao-China			•	
Austria	•	•	•		Macedonia, Republic of	•			
Azerbaijan			•		Malaysia				•
Bahrain				•	Malta				•
Belgium			•		Mexico			•	
Belgium (Flemish)	•				Moldova, Republic of	•			
Belgium (French)	•				Mongolia		•		•
Bosnia and Herzegovina				•	Montenegro			•	
Botswana				•	Morocco	•	•	•	•
Brazil			•		Netherlands	•	•	•	
Bulgaria	•		•	•	New Zealand	•	•	•	
Canada			•		Norway	•	•	•	•
Canada, Alberta	•				Oman				•
Canada, British Columbia	•				Palestinian National Authority				•
Canada, Ontario	•				Poland	•		•	
Canada, Québec	•				Portugal			•	
Chile			•		Qatar	•	•	•	•
Chinese Taipei	•	•	•	•	Romania	•		•	•
Colombia			•	•	Russian Federation	•	•	•	•
Croatia			•		Saudi Arabia				•
Cyprus				•	Scotland	•	•		•
Czech Republic		•	•	•	Serbia			•	•
Denmark	•	•	•		Singapore	•	•		•
Egypt				•	Slovak Republic	•	•	•	
El Salvador		•		•	Slovenia	•	•	•	•
England	•	•		•	South Africa	•			
Estonia			•		Spain	•		•	
Finland			•		Sweden	•	•	•	•
France	•		•		Switzerland			•	
Georgia	•	•		•	Syrian Arab Republic				•
Germany	•	•	•		Thailand			•	•
Ghana				•	Trinidad and Tobago	•			
Greece			•		Tunisia		•	•	•
Hong Kong SAR	•	•	•	•	Turkey			•	•
Hungary	•	•	•	•	Ukraine		•		•
Iceland	•		•		United Kingdom			•	
Indonesia	•		•	•	United States	•	•	•	•
Iran, Islamic Republic of	•	•		•	Uruguay			•	
Ireland				•	Yemen		•		
Israel	•		•	•	<i>Benchmarking participants</i>				
Italy	•	•	•	•	Alberta, Canada		•		
Japan			•	•	Basque Country, Spain				•
Jordan				•	British Columbia, Canada		•		•
Kazakhstan			•		Dubai, UAE		•		•
Korea, Republic of			•	•	Massachusetts, USA		•		•
Kuwait	•	•		•	Minnesota, USA		•		•
Latvia	•	•	•		Ontario, Canada		•		•
Lebanon				•	Québec, Canada		•		•

This practice, however, introduces the problem of sample size mentioned above. As McKnight and his colleagues (McKnight, McKnight, Sidani, & Figueredo, 2007) argued, the biggest problem associated with nonresponse is its influence on the results of a study. If there is a discernible pattern of missing responses (e.g., one group of respondents with certain characteristics in the sample has mostly missing data on the variables of interest), this will lead to overestimating the information provided from the respondents who do not share these characteristics. In general, the greater the amount of missing data, the larger the impact will be on ability (reduced) to generalize the study findings and to draw statistical inferences.

In addition, decreasing the sample size can result in loss of representativeness, and nonresponse can lead to biased estimates and wrong statistical conclusions (McKnight et al., 2007, pp. 6–7). Moreover, each study tries to achieve high-quality results in terms of reliability and validity. Missing data influence the reliability and validity of the indicators and constructs as well as ability to generalize findings (McKnight et al., 2007, pp. 11–13).

These are all reasons why we wanted to analyze the amount of nonresponse to family background variables in the three studies of interest. Missing data become an especially important issue when indicators of family background are used to derive variables, scales, and indices representing some latent characteristic.

The analyses that follow compare the amount of nonresponse per family background variable, scale, or index composed from separate family background indicators across the three studies of interest. We conducted a separate analysis for each study, and then conducted comparative analyses for each pair of studies (PIRLS 2006 and TIMSS 2007 Grade 4, and PISA 2006 and TIMSS 2007 Grade 8) as stated in the previous section.

Because we are concerned in this paper with comparing measures of family background across the three large-scale assessment studies, we set the criteria that we used to classify the quality of data with regard to nonresponse not solely according to theoretical considerations, but also according to empirical findings. Although a certain amount of nonresponse (e.g., 7% as just an arbitrary example) could be seen as still providing sufficient information for analysis purposes, it might also be seen as a moderate amount when compared to nonresponse rates with other indicators from the studies in our scope. Therefore, for the purpose of our analyses, we categorized a nonresponse rate below 5% as “low,” a nonresponse rate between 5 to 15% as “moderate,” and a rate above 15% as “high.”

In addition to providing the median nonresponse across all of the participating countries except the benchmarking participants, we included the inter-quartile range (IQR) as a measure of dispersion. This measure indicates the variation of the nonresponse rate for the middle 50% of the countries, that is, the difference between the nonresponse rate of the upper end of the lowest 25% of countries and the nonresponse rate of the lower end of the upper 25% of countries. The IQR thus indicates variation across countries. A low IQR represents similar nonresponse across



countries, whereas a high IQR points to considerable differences in nonresponse rates across countries. With regard to defining thresholds for categorizing the IQR for nonresponse as “low,” “moderate,” or “high,” there is no universally valid or agreed upon default value. Rather, the distribution of nonresponse rates needs to be checked if the IQR indicates substantial differences across countries.

According to the design of the three studies of interest, data are collected from parents only if their children participated in the assessment. Thus, unit nonresponse might occur with regard to data from the home/parent questionnaire. Consequently, nonresponse for student questionnaire data is a matter of item nonresponse only (i.e., a student did not answer a particular item or question), whereas nonresponse for home/parent questionnaire data is the combination of item and unit nonresponse (i.e., parents who did not return the home/parent questionnaire at all).

### **5.2.2 Association with Achievement**

One major purpose of TIMSS, PIRLS, and PISA is to measure achievement in specific subject content domains—mathematics, science, and reading. As we have explained, all three studies collect background information about students and their parents, teachers, and school. This background information is important for the analysis of contextual factors (resources and activities) that can foster achievement (Mullis et al., 2006). As Sirin (2005), for example, points out, SES is both directly and indirectly linked to academic achievement. The indirect link is through multiple interacting systems.

Because the influence of different family background components on achievement has been well documented in the research literature, we wanted to determine the strength of the association of background variables (including single components as well as derived variables) with students’ overall achievement per content domain by computing correlation coefficients and then analyzing the explained variance using simple linear regression. For PIRLS 2006, we investigated the association of the background variables with achievement, that is, the overall reading achievement score. With TIMSS 2006, our investigation encompassed both the mathematics and science domains. With PISA 2006, it encompassed all three domains—reading, mathematics, and science.

In order to categorize the quality of the family background items and scales, we used the following three levels: a “weak” association existed if the variance in student achievement explained by an indicator was below 5%. A “moderate” association resulted in 5% to less than 10% of the explained variance, whereas a “strong” association was evident if 10% or more of the variance could be explained by a single indicator or a scale. This classification was again driven by our empirical findings. Our goals were, first, to compare the three studies in relation to one another, and then to identify the most appropriate or best-to-use indicator of family background within each of the three large-scale studies. This approach enabled us to set the category limits according to the empirical findings of our study.

We also computed, for the scales and indices derived in PIRLS and PISA, Pearson correlation coefficients, using the median achievement scores across countries and the respective IQRs. We determined “weak” correlations as those with coefficients of less than 0.2, “moderate” correlations as ones with coefficients ranging from 0.2 to less than 0.3, and “strong” correlations as those with coefficients equal to or greater than 0.3.

### 5.2.3 Reliability of Scales

Reliability is one of the most important issues in measurement. According to Cronbach (1960, p. 126), reliability provides information “about the consistency of a person’s scores on a series of measurements.” As DeVellis (2003, p. 27) puts it, scale reliability is “the proportion of variance attributable to the true score of the latent variable.” The reliability of scales is related to the items they consist of, and also to the latent variable that these items have in common. Cronbach’s alpha, widely used as a coefficient of reliability, is close to the classical definition of reliability, that is, “the proportion of variance in a scale that is attributable to the true score of the latent variable” (DeVellis, 2003, p. 47).

We used Cronbach’s alpha, which indicates the internal consistency of a scale, to determine the reliability of the derived variables (scales and indices) of family background for our three studies of interest (TIMSS 2007, PIRLS 2006, PISA 2006). We consider this analysis a particularly important part of our investigation because the more reliable a scale is (in terms of the internal consistency of the variables included), the more precise is the derived measure itself. The reliability coefficient tells us how confident we can be about a measure. And because reliability is related to measurement error, the more reliable a measure is, the more precisely we can judge the influence of a certain behavior or attribute (Cronbach, 1960, p. 126).

Again, the manner in which we set criteria for describing the quality of the data was mainly driven by our empirical findings, given that our focus was on comparing results deploying data from across the three studies. Nevertheless, we discuss the outcomes of the reliability analysis with regard to commonly used quality standards (for a discussion on the latter, see Cortina, 1993). In this paper, we took a “low” reliability of a scale to mean a Cronbach’s alpha of below 0.65. A “moderate” reliability meant scales or indices with a Cronbach’s alpha of between 0.65 and 0.74, and a “high” reliability was achieved with a Cronbach’s alpha of 0.75 and above.

To evaluate the importance of the scale items, we also investigated the item-total correlations. These statistics are used to check if the items comprising a scale measure the same construct. Correlations above 0.3 are seen as sufficient (see, for example, Everitt, 2002). Correlations below 0.3 suggest that an item should be dropped from the scale. In this paper, item-total correlations below 0.3 should be seen as “low,” correlations from 0.3 to 0.5 as “moderate,” and correlations above 0.5 as “high.”

Another way of evaluating the importance of scale items is to investigate how the association with achievement is affected by removing or adding items. Normally, we could expect that the items that affect the scale reliability (and, hence, its validity) will

also affect the association with an outcome variable, such as academic achievement. Thus, if an item reduces or increases the reliability of a scale, it will also cause the association with the outcome variable to reduce or increase. And even if this is not the case (i. e., where there is an item that increases the scale reliability but reduces the association with achievement), the item will still be validated by the reliability analysis regardless of the association with achievement. In other words, the criterion used to validate the item is not its correlation with achievement but rather whether it is a reliable indicator of the concept at the heart of the scale. The criterion of the association with achievement is thus subordinate to the scale reliability criterion. Associations of items with an outcome variable are not theoretically meaningful on their own; what is meaningful is the association with the scale (construct), not with the individual items.