`(Agasisti, Tommaso and Gil-Izquierdo, María and Han, Seong

Won)

This study used data from OECD PISA, a triennial large-scale international survey to measure the knowledge and skills of representative samples of 15-year-old students from more than 60 education systems worldwide. Since 2000, PISA has been assessing student performance in reading, mathematics, and science, with each survey assessing one subject in greater depth.

The research presented in this study focused on PISA 2012. The survey involved 65 countries, 34 being OECD countries, and this time it focused on mathematics. For the reasons illustrated in the subsequent sections, this research includes data and results from 12 countries in the EU-15 group.

Chi Chiao

Chiung-Hui Chiu

The samples in this study were drawn from the PISA 2012 dataset (http://pisa2012.acer.edu.au/downloads.php), in which around 510,000 students completed the assessment. Among the 65 countries and economies included in this dataset, Chinese Taipei, Hong Kong-China, Japan, Korea,Macao-China and Shanghai-China are all among the top ten performers in mathematics, reading and science. In addition to the high level of student performance, these six regions also have many other similarities, such as a common

cultural background based on Confucianism, and high ICT Development Index (7.59 \* 8.81, with Taipei and Shanghai not included in this data). A total of 32,612 students were chosen as the target samples from these six regions in East Asia. After removing missing data, 31,161 students were included in the study, with 50.9% being male and 49.1% female.

Birgit Eickelmann1 & Julia Gerick2 & Christian Koop1

The present contribution makes use of the representative student and school data provided by the study of PISA 2012, which, as an international comparative educational achievement study, is carried out every three years as an educational monitoring for the purpose of addressing the achievement of the respective educational system in a context of international comparison (OECD 2013a). In the 2012 cycle, 65 educational systems participated in the assessment (OECD 2013a). Please already note at this point that due to its cross-sectional design, PISA does not yield information on causalities. Apart from student assessments, which in 2012 focused on mathematics achievement of 15 year-old students, both PISA 2012 and the preceding cycles made use of extensive background questionnaires for students, which provided an important data basis for this contribution. What is more, the school questionnaire also plays a significant role for the research interest of this contribution. In this questionnaire, the school administrations provided important information on their schools’ basic data, but also on school strategies and school leadership (see ibid.).

Funda Erdogdu, Erkan Erdogdu+++

The Programme for International Student Assessment (PISA) is a triennial international survey which aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students. Since the year 2000, every three years, 15-year-old students from randomly selected schools worldwide have taken the tests; and the results from PISA surveys have provided the basic data for many professional and academic studies, such as Gil-Flores, Torres-Gordillo, and Perera-Rodriguez (2012), Lee and Wu (2013), Luu and Freeman (2011),Tomte and Hatlevik (2011), Wittwer and Senkbeil (2008) and Zhong (2011).

PISA 2012 is the program's 5th survey. It assessed the competencies of 15-year-olds in reading, mathematics and science in 65 countries and economies. Around 510,000 students between the ages of 15 years 3 months and 16 years 2 months participated in the assessment, representing about 28 million 15-year-olds globally. The students took a paper-based test that lasted 2 h. The tests were a mixture of open-ended and multiple-choice questions that were organized in groups based on a passage setting out a real-life situation. A total of about 390 min of test items were covered. Students took different combinations of different tests. Students and school principals also answered questionnaires to provide information about the students' backgrounds, schools and learning experiences and about the broader school system and learning environment. The data used in this paper come from PISA 2012 dataset, the further details of which is available from OECD (2013). Table 1 shows descriptive statistics of the variables.

Xiang Hu, Yang Gong, Chun Lai, Frederick K.S. Leung++++

The main data source for this study was PISA 2015, an international large-scale assessment that measured 15-year-old students’ mathematics, reading, and scientific literacy. A total of 72 countries and regions participated in PISA 2015. The ICT familiarity questionnaire and student background questionnaire completed by students as well as school questionnaire completed by principals were used together to obtain student and school contextual information. Since the ICT familiarity questionnaire was optional for participating countries, only countries that had completed this questionnaire were included. In addition, Puerto Rico (USA) was also excluded from our study because no school information was provided. Data were also retrieved from the International Communication Union (ITU) and World Bank datasets to generate the national level indicators. As a member of the United Nations Development Group, the ITU developed the ICT Development Index (IDI), which encompass three indicators (national ICT access, ICT use, and ICT skills) to measure the national ICT development level. In addition, data on national gross domestic product (GDP) per capita was obtained from World Bank datasets. PISA 2015 participating countries and economies that were not involved in the 2015 IDI or GDP per capita survey were excluded in the present study. As a result, a total of 305,414 students from 11,075 schools of 44 countries were retained in the sample (see Appendix A).

Joyce Gubbels , Nicole M. Swart and Margriet . Groen

. In the first stage of sampling, a sample of 203 Dutch schools with 15-year-olds was drawn by Westat. These schools were sampled systematically from a comprehensive national list of all PISA eligible schools, with probabilities that were proportional to the estimated number of 15-year-old students enrolled in the school. For a comprehensive elucidation on PISA sampling and survey methods, see the The PISA study applies a two-stage stratified sampling strategy international report (OECD 2015b). Sampled schools were invited to participate via a letter. When a school from the original sample declined participation, a replacement school was invited to participate. This resulted in an overall sample of 187 Dutch schools. As a second stage of sampling, students within these schools were sampled. The Target Cluster Size (TCS) for the Netherlands was set to 35, which means that a sample of 35 students was selected with equal probability within each school. For schools with fewer than 35 PISA eligible students, all students were selected. The sample consisted of 5385 students, yet due to some missing values in the ICT questionnaire (n = 202), the eventual sample for the present study consists of 5183 students (49.2% male) with a mean age of 15 years and 9 months (SD = 3.5 months).

THOMAS FUCHS

LUDGER WOESSMANN (BIVARIATE AND MULTIVARIATE EVIDENCE)

To estimate the relationship between computers and student learning empirically, we use the student-level dataset of the Programme for International Student Assessment (PISA), an

international student achievement test of 15-year-old students conducted in 2000 by the

Organisation for Economic Co-Operation and Development (OECD). The study tested student performance in reading, math and science in 32 developed and emerging countries, 28

of which are OECD countries. The OECD ensured a consistent and coherent study design and

as much comparability as possible among the participating countries. The countries

participating in the PISA 2000 study are: Australia, Austria, Belgium, Brazil, Canada, the

Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland,

Italy, Japan, Korea, Latvia, Liechtenstein,1 Luxembourg, Mexico, the Netherlands, New

Zealand, Norway, Poland, Portugal, the Russian Federation, Spain, Sweden, Switzerland, the

United Kingdom and the United States.

PISA sampled a representative random sample of the population of 15-year-old students in each country.3 The PISA study tested the students with paper and pencil tests, which lasted two hours for each student. Using item response theory, the test results were transformed into test scores with an OECD mean of 500 points and an OECD standard deviation of 100 points.

In this paper, we use the student-level database constructed by Fuchs and Wößmann

(2004), who provide more detailed information and notes on the specific database. They combine the test results with background information on students and schools from PISA background questionnaires answered by the specific students and schools tested in PISA. In addition to the rich PISA data at the student and school level, we also use some country-level data on the countries’ GDP per capita, on their average educational expenditure per student in secondary education and on the existence of curriculum-based external exit exams.

THOMAS FUCHS

LUDGER WOESSMANN

The international dataset used in this analysis is the OECD Programme for International Student Assessment (PISA). In addition to testing the robustness of findings derived from previous international student achievement tests, the analysis based on PISA contributes several additional new aspects to the literature. First, PISA tested a new subject, namely reading literacy, in addition to math and science already tested in IAEP and TIMSS. This alternative measure of performance broadens the outcome of the education process considered in the analyses. Second, particularly in reading, but also in the more traditional domains of math and science, “PISA aims to define each domain not merely in terms of mastery of the school curriculum, but in terms of important knowledge and skills needed in adult life” (OECD 2000, p. 8). That is, rather than being curriculum-based as the previous studies, “PISA looked at young people’s ability to use their knowledge and skills in order to meet real-life challenges” (OECD 2001, p. 16). For example, reading literacy is defined in terms of “the capacity to understand, use and reflect on written texts, in order to achieve one’s goals, to develop one’s knowledge and potential, and to participate in society” (OECD 2000, p. 10).3 There is a similar real-life related focus in the other two subjects. While on the one hand, this real-life focus should constitute the most important outcome of the education process, on the other hand it bears the caveat that schools are assessed not on the basis of what their school system asks them to teach in their curriculum, but rather on what students might need particularly well for coping with everyday life. Third, rather than targeting students in specific grades as in previous studies, PISA’s target population are the 15-year-old students in each country, regardless of the specific grade they may currently be attending. This target population is not only interesting because it means that PISA assesses young people near the end of compulsory schooling, but also because it captures students of the very same age in each country independent of the structure of national school systems. By contrast, the somewhat artificial grade-related focus of other studies may be distorted by differing entry ages and grade-repetition rules in different countries. Fourth, the PISA data provide more detailed information than previous international studies on some institutional characteristics of the school systems. For example, PISA provides data on whether schools are publicly or privately operated, on which share of their funding stems from public or private sources and on whether schools can fire their teachers. These features of the background data help to identify improved internationally comparable measures of schooling institutions. Fifth, the PISA data also provide more detailed information than previous international studies on students’ family background. For instance, there is information about the occupation of parents and the availability of computers at home. This should contribute to a more robust assessment of the different potential determinants of student performance. Finally, reading literacy is likely to depend more heavily on family-background variables than performance in math and science. Hence controlling for a rich set of family-background variables should establish a more robust test of the institutions-performance link if the ability to read is the dependent variable. Taken together, the PISA international dataset allows for a re-examination of results based on previous international tests using an additional subject, real-life rather than curriculum-based capabilities, an age-based target population and richer data particularly on family background and institutional features of the school system.

**2.2 The PISA Database**

The PISA study was conducted in 2000 in 32 developed and emerging countries, 28 of which are OECD countries, in order to obtain an internationally comparable database on the educational achievement of 15-year-old students in reading, math and science. The study was organized and conducted by the OECD, ensuring as much comparability among participants as possible and a consistent and coherent study design.4 The countries participating in the PISA 2000 study are: Australia, Austria, Belgium, Brazil, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Latvia, Liechtenstein,5 Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Russian Federation, Spain, Sweden, Switzerland, the United Kingdom and the United States. As described above, PISA’s target population were the 15-year-old students in each country. More specifically, PISA sampled students aged between 15 years and 3 months as the lower bound and 16 years and 2 months as the upper bound at the beginning of the assessment period. The students had to be enrolled in an educational institution, regardless of the grade level or type of institution in which they were enrolled. The average age of OECD country students participating in PISA was 15 years and 8 months, varying by a maximum of only 2 months among the participating countries. The PISA sampling procedure ensured that a representative sample of the target population was tested in each country. Most PISA countries employed a two-stage stratified sampling technique. The first stage drew a (usually stratified) random sample of schools in which 15-year-old students were enrolled, yielding a minimum sample of 150 schools per country. The

second stage randomly sampled 35 of the 15-year-old students in each of these schools, with each 15-year-old student in a school having equal probability of selection. Within each

country, this sampling procedure typically led to a sample of between 4,500 and 10,000 tested students. The performance tests were paper and pencil tests. The assessment lasted a total of two hours for each student. Test items included both multiple-choice items and questions requiring the students to construct their own responses. The PISA tests were constructed to test a range of relevant skills and competencies that reflected how well young adults are prepared to meet the challenges of the future by being able to analyze, reason and communicate their ideas effectively. Each subject was tested using a broad sample of tasks with differing levels of difficulty in order to represent a coherent and comprehensive indicator of the continuum of students’ abilities. Using item response theory, PISA mapped performance in each subject on a scale with an international mean of 500 test-score points across the OECD countries and an international standard deviation of 100 test-score points across the OECD countries. The main focus of the PISA 2000 study was on reading literacy, with two-thirds of the testing time devoted to this subject. In the other two subjects, smaller samples of students were tested. The correlation of student performance between the three subjects is substantial, at 0.700 between reading and math (96,913 joint observations), 0.718 between reading and science (96,815) and 0.639 between math and science (39,079). In addition to the performance tests, students as well as school principals answered respective background questionnaires, yielding rich background information on students’ personal characteristics and family backgrounds as well as on schools’ resource endowments and institutional settings. Combining the available data, we constructed a dataset containing 174,227 students in 31 countries tested in reading literacy. In math, the sample size is 96,855 students, and 96,758 students in science. The dataset combines the student test scores in reading, math and science with students’ characteristics, family-background data and school-related variables of resource use and institutional settings.6 For estimation purposes, a variety of the qualitative variables were transformed into dummy variables.

Olga Kunina‑Habenicht and Frank Goldhammer +++

The following data analyses are based on public data from PISA 2015 main study from Switzerland and Germany. In total in Switzerland 5860 15-year-old students were

tested; 2807 were female (47.9%). In Germany 6504 students participated with 3197

being female (49.2%). The amount of missing data for the ICT Engagement scale differed between items and countries: In Swiss data it ranged from 8.8 to 12.2%, whereas for Germany it varied between 18.1 and 21.3%. Closer inspection of the data for the German

sample revealed that 4593 persons (70.6%) did not have any missing value and 1105 (approx. 17%) did not provide any valid answer on ICT Engagement scales. As described in the documentation of PISA 2015 for Germany (Reiss et al. 2016) the main reason for the relatively high percentage of missing values was that answering the optional part of the student questionnaire was not mandatory in most German federal states. In particular, in federal states with voluntary participation, parental declarations of consent were necessary. Due to these different regulations, the answer rates for the questionnaire data varied between 82 and 97% in states with mandatory participation and ranged from 62 to 91% in states with voluntary participation. On average, approx. 85% of questionnaire data is available for Germany. Thus, the reported missing rates for the ICT Engagement seem to be comparable to the reported missing rates in the PISA documentation.

Bryce Odell, Adam M. Galovan, Maria Cutumisu

This research employs data from Finland and Bulgaria, two countries that participated in the ICT Familiarity Questionnaire of the PISA 2015 database (OECD 2014b, 2017b). PISA is an assessment implemented by the OECD that collects data from 15-year-old students in countries around the world every three years to evaluate students’ competence levels in mathematics, science, and reading (OECD, 2017b). This test consists of both constructed-response items and selected-response items. PISA is designed by experts in measurement, evaluation, and various content areas to test student performance and whether students are able to apply their knowledge (OECD, 2017b). The results are also used to promote equitable learning worldwide and inform decision making for educational policy. Specifically, the science variable used in this study is defined by OECD (2016) as follows: “A scientifically literate person is willing to engage in reasoned discourse about science and technology, which requires the competencies to explain phenomena scientifically, evaluate and design scientific enquiry, and interpret data and evidence scientifically” (p. 13). The surveys are also used to measure other related variables to education, such as students’ interactions with ICT, the focus of the present study. The age of the students ranges from 15 years and 3 months to 16 years and 2 months. The test items are delivered as computer-based questionnaires and quizzes. The data used for this research included the ICT Familiarity Questionnaire (OECD, 2014b) and the Student Questionnaire (OECD, 2014c). The sample consists of a total of n = 11,810 students (Bulgarian n = 5,928 and Finnish n = 5,882) who attended school part-time or full-time in their countries (OECD, 2016, 2017b). Participants were randomly chosen within their cluster sample of schools. At least 150 schools were sampled per country. Sampling weights for students were also used to compare students from different schools to ensure that the data are correctly treated (e.g., all countries were equally represented) and that sampling error is properly calculated.

Seoyeon Park and Wenting Weng

This study employed datasets from the OECD’s PISA 2015 database and the World Bank. The PISA 2015 dataset assessed 15-year-old students’ knowledge and skills in the domains of mathematics, reading, and science across 72 countries and regions. The ICT familiarity questionnaire was optional, so students from some countries completed it. We extracted two country-level indices from World Bank datasets: (1) the national gross domestic product (GDP) per capita and (2) the GINI index representing the income distribution of residents within a nation. Several countries and regions in PISA data were excluded due to a lack of GDP per capita or GINI index information. The excluded countries and regions are Hong Kong, Chinese Taipei, Macao, Spain (regions), Singapore, China (Beijing-Shanghai-Jiangsu-Guangdong), and New Zealand. As a result, a total of 168,098 students from 39 countries were retained in the sample (see Appendix A).

Dominik Petko, Andrea Cantieni, and

Doreen Prasse

The PISA study is one of the most prominent international large-scale assessments of 15-year-old students’ academic performance in core school subjects as well as several other optional topics such as problem solving or financial literacy. Next to tests in reading, math and science, additional student and school questionnaires are administered. It has been mandated by the OECD and carried out by the International Association for the Evaluation of Educational Achievement since 2000 in a 3-year cycle. Data are publicly available (http://pisa2012.acer.edu.au/) and documented (OECD, 2014). It has to be noted, however, that test items for mathematics, reading, and science are only in part publicly available and scaling procedures are not completely transparent (Sjoberg, 2012). Thus, the transparency of these measures is somewhat limited.

Gülfem Dilek YURTTAŞ KUMLU

The sample of this research consisted of a student group at the age of 15 having participated in PISA 2009 and PISA 2012 (MEB, 2010, 2013b). The sample design was a two-stage stratified sample design according to the PISA. The first-step sampling units involved in schools having 15-year-old students. The second-step sampling units included students within sampled schools. The sample consisted of 4996 students who participated in the PISA 2009 survey (OECD, 2012) and 4848 students who participated in the PISA 2012 survey (OECD, 2014b).

Danhui Zhang & Luman Liu

The data for the current study came from all five PISA cycles, which were published on the OECD website. PISA is a cross-national, large-scale assessment that has been conducted every three years since 2000; the most recent cycle was in 2012. PISA aims to assess 15-year-old students’ performance in math, reading, and science, and it also collects contextual data about students’ demographic information, their learning attitudes and behaviours, their parents, and their schools. In addition, each country had the option of completing a questionnaire that measured students’ familiarity with ICT.

ICT is administered as an additional survey in PISA test; therefore, the countries that volunteered to participate in each cycle have differed. However, increasing numbers of countries have completed the ICT questionnaire since the first cycle: 25 in PISA 2000, 32 in PISA 2003, 40 in PISA 2006, 45 in PISA 2009, and 43 in PISA 2012. Each country that completed the ICT questionnaire in all five cycles was included in this study, for total samples of 148987 students in the 2000 data, 228154 in 2003, 267242 in 2006, 316128 in 2009, and 280520 in 2012.