WORKING PAPER 41 - 2019

ESTIMATING THE STOCK OF HIGHLY SKILLED INDONESIANS

Daniel Suryadarma
Sandra Kurniawati

JULY 2019

TNP2K
THE NATIONAL TEAM FOR
THE ACCELERATION OF POVERTY REDUCTION

Australian Government

ESTIMATING THE STOCK OF HIGHLY SKILLED INDONESIANS

Daniel Suryadarma
Sandra Kurniawati

TNP2K Working Paper 41 - 2019
July 2019

The TNP2K Working Paper Series disseminates the findings of work in progress to encourage discussion and exchange of ideas on poverty, social protection and development issues.

Support to this publication is provided by the Australian Government through the MAHKOTA Program.

Suggested citation: Suryadarma, D., Kurniawati, S. Estimating the Stock of Highly Skilled Indonesians. TNP2K Working Paper 41/2019. Jakarta, Indonesia.

To request copies of this paper or for more information, please contact: info@tnp2k.go.id.

The papers are also available at the TNP2K (www.tnp2k.go.id).

THE NATIONAL TEAM FOR THE ACCELERATION OF POVERTY REDUCTION
Office of the Vice President's Secretariat
Jl. Kebon Sirih Raya No.14, Jakarta Pusat, 10110

Abstract

The most talented individuals organise production processes, discover, and innovate. As a result, talented individuals contribute more to economic growth than ordinary labour. This paper is the first step to understanding talented individuals in Indonesia. First, we use an international benchmark to estimate the number of students who could be considered as highly skilled. We then examine their background and the schools that they attend. We use three rounds of the Programme for International Student Assessment (PISA).

We find that Indonesia has a minuscule proportion of highly skilled individuals. Out of a cohort of 3.1 million 15-year-old students, Indonesia only had around 0.46 percent or 14,300 individuals with high mathematics skills and 0.06 percent or 1,900 individuals with high literacy skills in 2015. Our analysis shows that skills are associated with having tertiary-educated mothers and a favourable socioeconomic status. These skilled individuals cluster in a handful of schools that have a higher proportion of certified teachers. Students within these schools have similar characteristics, indicating the strong influence of parental choice. Our findings point to the need for Indonesia, and perhaps other similar middle-income countries, to have an active policy to identify and nurture talent.

Section 1
Introduction

The typical worker is an input to the production process while the most talented individuals organise the production processes and discover productivity-enhancing technologies that lead to higher output growth. Benzell and Brynjolfsson (2019) state that digital technology cannot replace talent. Inelastically supplied, a scarcity in the number of talented individuals would constrain growth and firms would be unable to make full use of digital abundance. This notion is related to the interaction between talent and scale (Rosen 1981; Kaplan and Rauh 2013). Benzell and Brynjolfsson (2019), therefore, consider geniuses to be more important than ordinary labour. The skills of the brightest individuals are even more critical as economies become knowledge based (Pritchett and Viarengo 2009).

Cross-country empirical studies find that highly intelligent individuals have a greater impact on economic growth than individuals of average intelligence (Burhan et al. 2014; Rindermann et al. 2015). The occupations chosen by talented individuals are also important. Murphy et al. (1989) note that countries realise the full benefit of talented individuals when they become entrepreneurs. Social benefits would be suboptimal if talented individuals become workers or, even worse, rent seekers. According to Rosen (1981), talented individuals should work in occupations with low diminishing returns to scale.

This literature has two consequences: (i) countries must have enough talented individuals. This calls for a focus on identifying and nurturing talent; and (ii) talented individuals need to be in occupations where their talents will have the greatest social impact. To achieve this, the private returns for these individuals must be highest in occupations that would produce the highest social impact. Being an entrepreneur is one way. Another way is to ensure that contracts are set to allow talented individuals to extract almost their full quasi-rents (Murphy et al. 1989).

Achieving the two objectives above is challenging–on nurturing talent, Card and Giuliano (2016) find that gifted education has no impact on the scores of gifted students. A meta-analysis of 26 studies found, however, that summer residential programs have a positive effect on the academic outcomes of gifted students (Kim 2017).

On optimal occupations, recent studies examined the determinants of becoming an inventor which is, arguably, an ideal occupation for talented individuals. Aghion et al. (2017) analysed data from Finland that found, while IQ has a positive and significant effect on the probability of becoming an inventor, parental income remains crucial. The correlation is particularly steep at higher levels of parental income. Lack of parental support also prohibits many high IQ individuals from becoming an inventor. Inefficiencies, therefore, happen even where education is high quality and completely free.

In the United States, Bell et al. (2019) find that the chance of becoming an inventor depends on gender, race, and parental socioeconomic class. They find that environment is a more important determinant than ability to innovate. The finding implies that many talented individuals, especially women and minority groups, fail to fulfill their potential to be inventors and, as a whole, society loses.

The literature on talented individuals has almost exclusively focused on rich countries. An exception is Pritchett and Viarengo (2009), who focus on Mexico. They found that Mexico produces too few highly talented individuals–between 3,500 and 6,000 individuals from a cohort of 2 million 15-year-olds. In comparison, the Republic of Korea produces 125,000, the United States 250,000, and India 100,000. The study also found that the 95th percentile Mexican student is about as smart as the average Korean student.

In this paper, we take the first step to understanding talented individuals in Indonesia by firstly estimating their number and then examining their background and the schools that they attend. We use the latest three rounds of PISA, focusing on performance in mathematics and reading tests. Given that PISA tests the skills of 15-year-olds, for the rest of this paper we prefer to use the term 'skilled' rather than talented as the latter term is closer to something one is born with. Skills, on the other hand, are a result of both talent and nurture.[1]

We find that Indonesia has a minuscule proportion of skilled individuals. In 2015, only five out of 1,000 Indonesians (0.5 percent) achieved the PISA threshold for high skills in mathematics.[2] Across the whole PISA sample, 7.6 percent passed the threshold. The rate is even smaller for reading. In 2015, only six out of 10,000 Indonesians (0.06 percent) passed the PISA threshold for high skills. In absolute numbers, Indonesia only had 14,300 individuals with high mathematics skills and 1,900 individuals with high literacy skills in 2015. The number of 15-year-old students that year was 3.1 million. While still extremely low, PISA indicates that the trend is positive between 2009 and 2015.

The small number of highly skilled individuals in Indonesia results in a very small sample size in PISA. To further understand the background of skilled individuals, therefore, we have included the sample that passed the PISA threshold for competence in mathematics or reading.[3] Only around 1-2 percent of Indonesian students are placed at this level, compared to 14-16 percent across the whole PISA sample.

Our analysis shows that skills are strongly associated with having tertiary-educated mothers and a favourable socioeconomic status. Skilled students spent more than one year in early childhood education. They live in large cities, not small villages. Rather than being uniformly distributed across schools, these skilled individuals tend to cluster in a handful of schools that have a higher proportion of certified teachers. Students within these schools have similar characteristics, indicating the strong influence of parental choice.

Section Two describes the PISA dataset and results for all countries, Section Three examines Indonesia's overall PISA performance, while Section Four contains our analysis of Indonesia's skilled individuals. We provide the conclusions in Section Five.

[1] We could find no dataset that records the IQ of Indonesians.
[2] Specifically, Levels 5 and 6 in PISA. See Section Two for further details.
[3] Level 4 in PISA.

Section 2

The PISA Data

PISA is a triennial international survey that tests the skills and knowledge of 15-year-old students. Administered by the OECD, PISA started in 2000 and, until 2015, has been undertaken six times. In total, 88 countries and economies (for example, China and Shanghai participate separately) have participated at least once. The PISA test is representative at the national level.

The skills and knowledge tested by PISA are in numeracy, science, reading, collaborative problem solving, and financial literacy, however, only the numeracy, science, and reading tests have been undertaken since the first PISA. The focus of PISA is on the application of knowledge and skills for tasks relevant in adult life, as opposed to memorisation. This is appropriate given our purpose is to measure skills that are relevant in the labour market.

To measure reading literacy, the assessment focuses on measuring students' ability to use written information in real-life situations, while in mathematics it aims to measure how well students can use and interpret mathematical concepts and apply their knowledge in real-life contexts (OECD 2016). PISA defines seven proficiency levels in reading. These proficiency levels are based on three required skills which are ability to find and collect information ("access and retrieve"), ability to process the information to make sense of a text ("integrate and interpret"), and ability to draw on knowledge, ideas, and values beyond the text ("reflect and evaluate") (OECD 2016 p.161).

In mathematics, PISA's six proficiency levels are based on three levels of cognitive demand or depth of knowledge (OECD 2016 p.55). The low depth of knowledge can be defined as ability to carry out a simple task such as recalling a fact or concept. The medium level refers to more advanced skills such as applying conceptual knowledge to explain real-life phenomena, organising data, or interpreting simple data sets. Lastly, the high depth of knowledge can be defined as an ability to analyse complex information, evaluate evidence, and develop a plan to approach a problem.

In both reading and mathematics, Level 2 is considered as a basic level of proficiency, meaning that students who achieved at this level or above are expected to demonstrate the literacy and numeracy skills that will enable them to participate productively in a knowledge-based society. PISA defines students who performed below Level 2 as low performers and those who performed at Level 5 and 6 as top performers.

Across all participating countries and economies, around 65 percent of 15-year-old students met or exceeded the basic proficiency level in mathematics (Figure 1) and around 70 percent in reading (Figure 2) in 2015. Around one-third of students scored below Level 2. These students pose a higher risk in terms of their participation in tertiary education and labour market outcomes at age 19 (OECD 2010). In 2015, around one in five students achieved Level 4 or above in either reading or mathematics.

Figure 1: Percentage of Students by Mathematics Proficiency Level

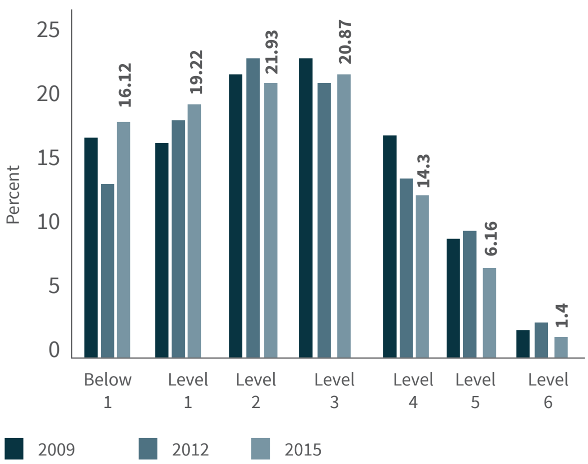
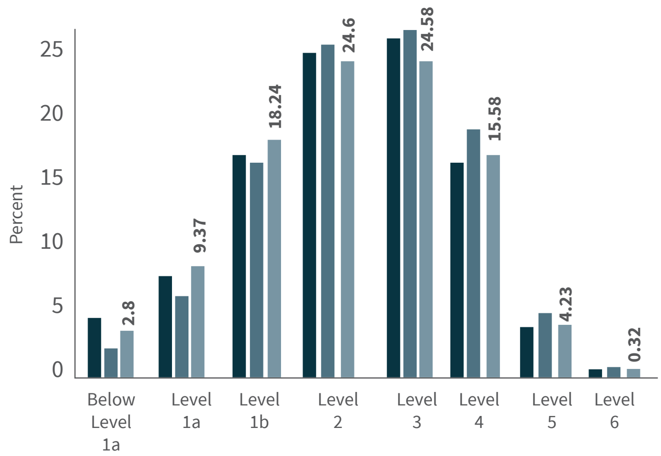


Figure 2: Percentage of Students by Reading Proficiency Level



Source: PISA 2009-2015 (authors' analysis).

Disaggregating participants into OECD and non-OECD countries, we observe a substantial difference in the distributions of student performance between the two groups (Figures 3-6). While the share of low performers (below Level 2) in mathematics in OECD countries is around 22 percent, the share in non-OECD countries is very high at 49 percent. We find the same outcomes in reading (19 percent and 42 percent respectively). When it comes to high performers, there is also a large gap between these two groups. The share of Level 4 and above in mathematics in OECD countries (28 percent) is almost double that of non-OECD countries (15 percent). In reading, the share in OECD countries (28 percent) is more than double that in non-OECD countries (12 percent). These patterns are consistent from 2009 to 2015.

Figure 3: Student Performance in Mathematics (OECD Countries)

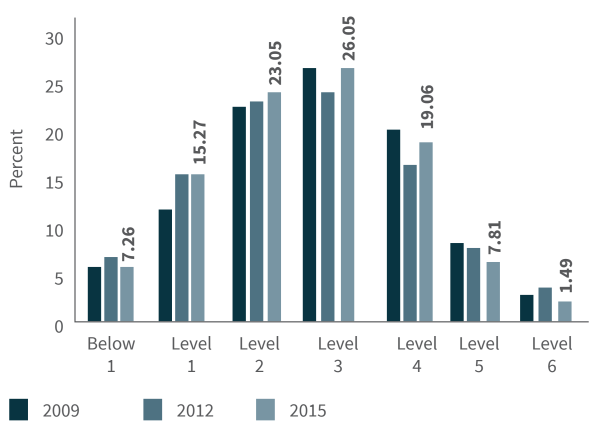
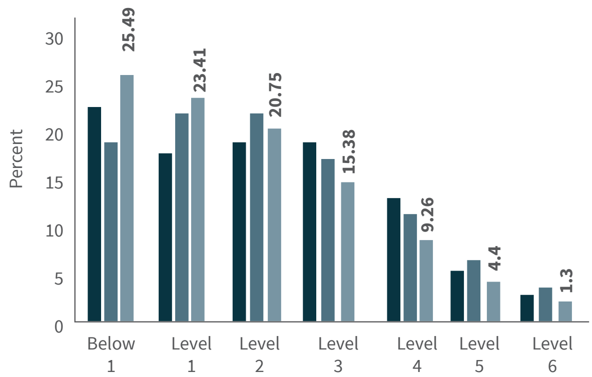


Figure 4: Student Performance in Mathematics (Non-OECD Countries)



Source: PISA 2009-2015 (authors' analysis).

Figure 5: Student Performance in Reading (OECD Countries)

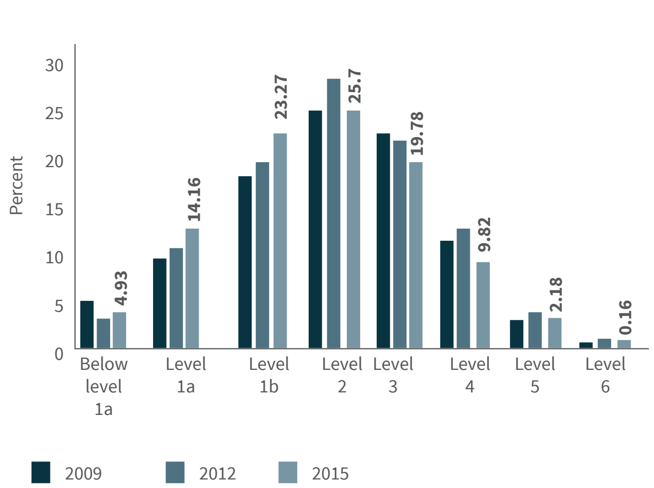
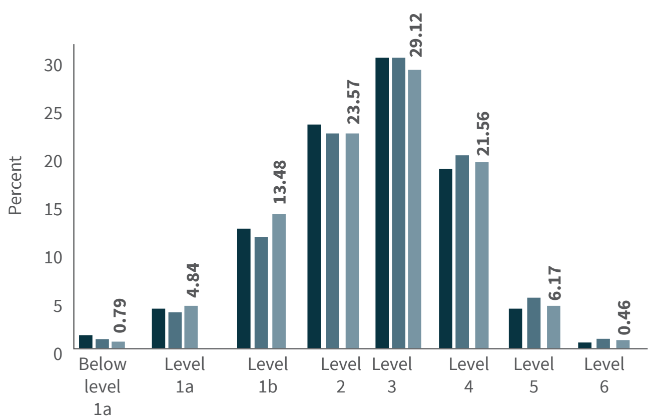


Figure 6: Student Performance in Reading (Non-OECD Countries)



Source: PISA 2009-2015 (authors' analysis).

It is also important to note that, among non-OECD countries, there is a major difference in student performance distribution between high-performing countries or economies–such as China (People's Republic of), Chinese Taipei, Hong Kong-China, Macao-China, and Singapore–and the remaining non-OECD countries (Figures 7-10). For example, in 2015 less than 10 percent of students in high-performing countries or economies did not achieve the basic level in mathematics, while 56 percent of students in all other non-OECD countries scored below this level. In high-achieving countries, around 53 percent and 35 percent of the students reached at least Level 4 in mathematics and reading respectively. By contrast, only around 8 percent of students in the other non-OECD countries achieved this threshold in either mathematics or reading.

Figure 7: Student Performance in Mathematics (Non-OECD: High-Performing Countries)

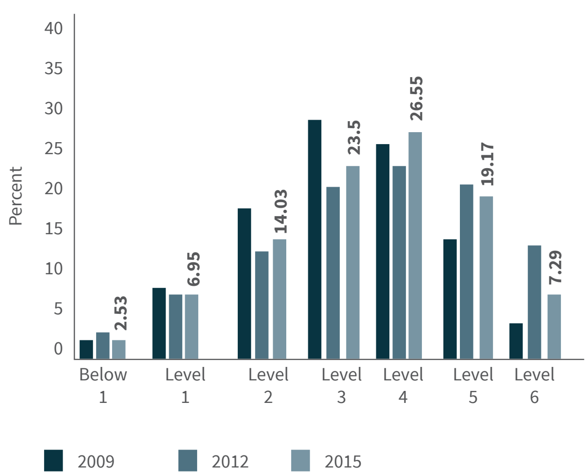
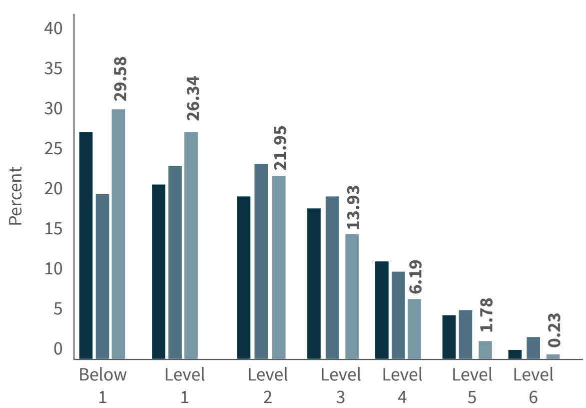


Figure 8: Student Performance in Mathematics (Non-OECD: Other Countries)



Source: PISA 2009-2015 (authors' analysis).

Figure 9: Student Performance in Reading (Non-OECD: High-Performing Countries)

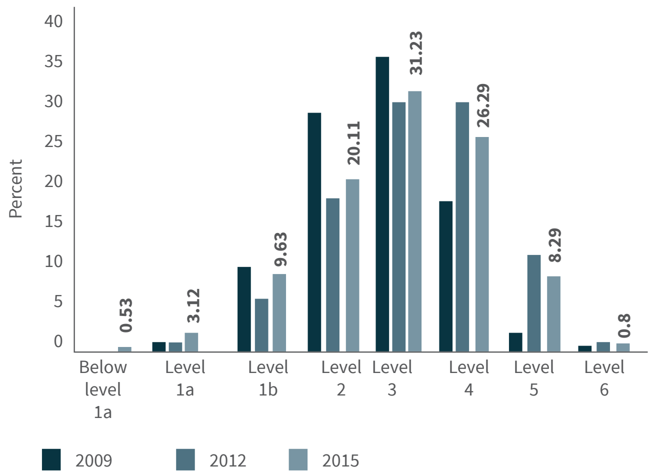
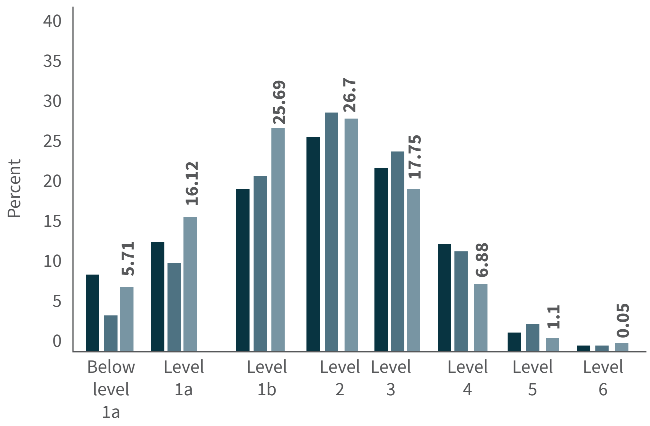


Figure 10: Student Performance in Reading (Non-OECD: Other Countries)



Source: PISA 2009-2015 (authors' analysis).

Section 3

Indonesia's Overall PISA Performance

The 2009, 2012, and 2015 PISA datasets on Indonesia contain around 17,000 15-year-olds studying in 628 schools. We merge student performance data in reading and mathematics with the characteristics of the school that they are enrolled in and their family background.

Overall Indonesian Student Performance in PISA

Indonesia has a very low share of skilled students in both mathematics and reading (Figures 11 and 12). In 2009, only 54 out of 10,000 Indonesians reached Level 4 and four reached Level 5 in mathematics. The share of reading was slightly higher–around 76 out of 10,000 Indonesian students reached Level 4 but only two people out of 10,000 reached Level 5. Conditions improved by 2015. Although the vast majority, 72 percent in mathematics, were still below PISA Level 2, the proportion of Indonesians that could reach Level 4 has increased almost four-fold, to 208 per 10,000, while the rate of those who could reach at least Level 5 was around 46 out of 10,000. The increase in the proportion of Level 4 and above in reading between 2009 and 2015 was, however, lower–from 76 to 114 out of 10,000. Despite this improvement, the shares remain extremely low for both reading and mathematics.

Figure 11: Indonesian Students Mathematics Performance by Proficiency Level

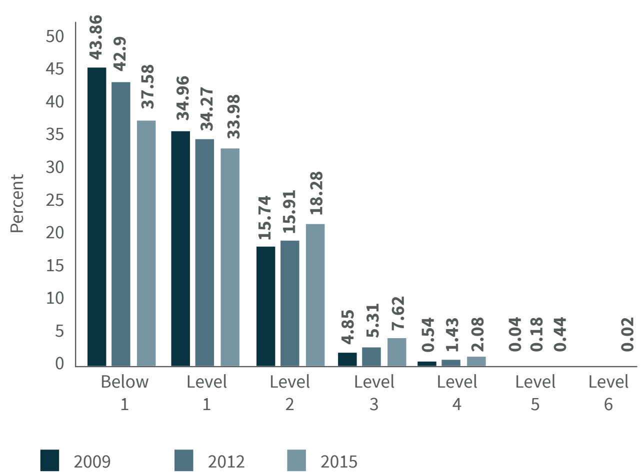
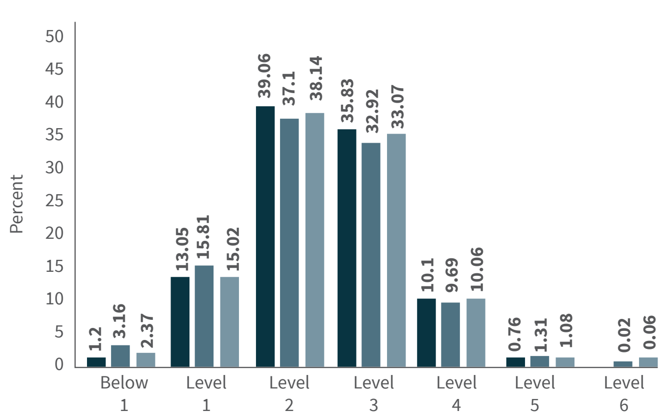


Figure 12: Indonesian Students Reading Performance by Proficiency Level

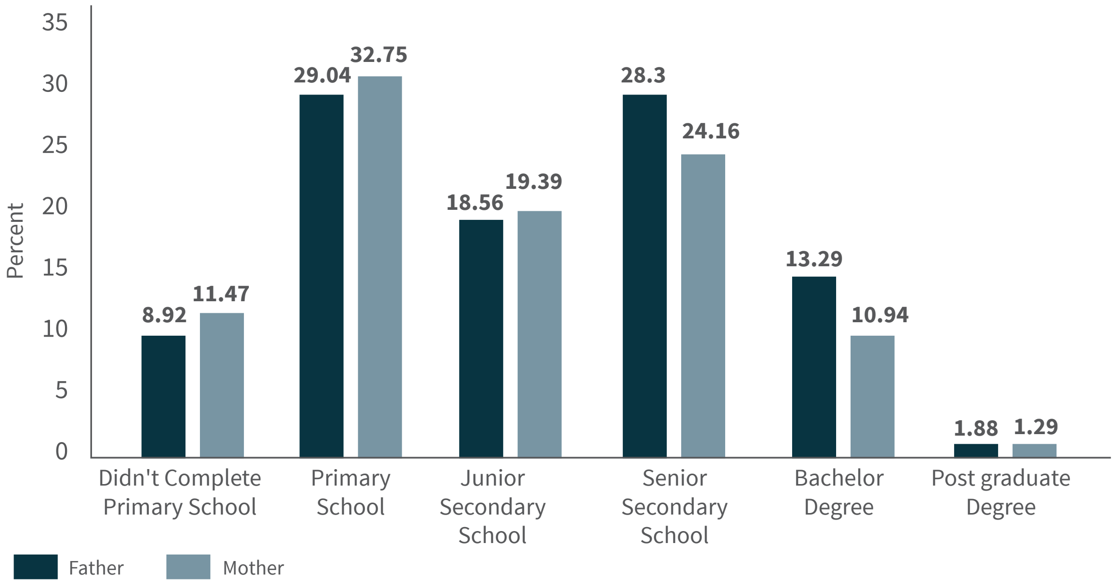


Source: PISA 2009-2015 (authors' analysis).

Indonesian Students' Background Characteristics

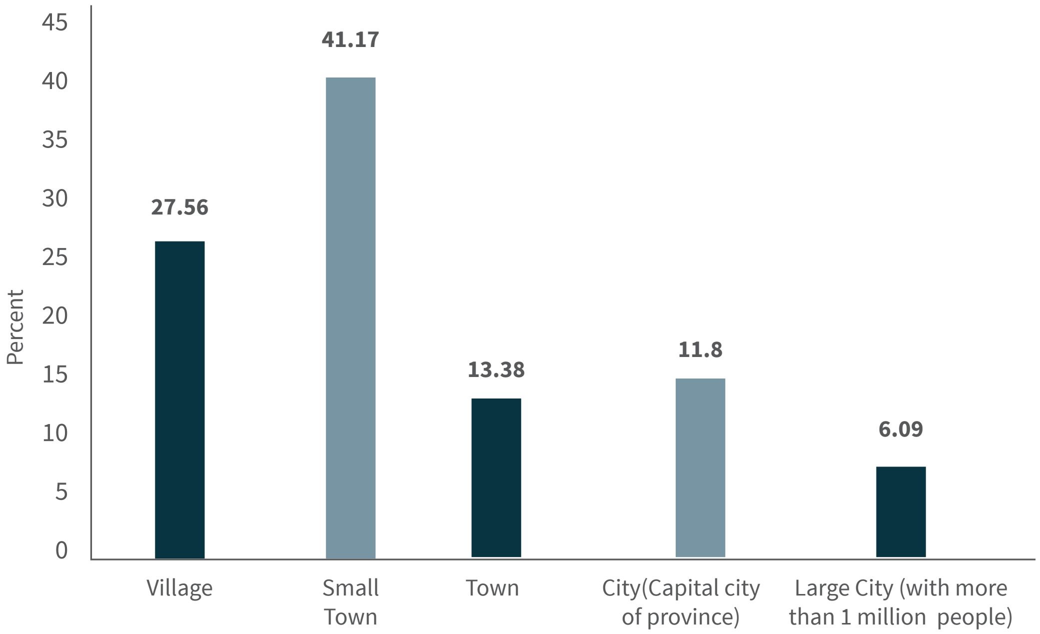
The study has disaggregated the data by gender, place of residence and parents' educational achievement level. One-half of Indonesian students participating in PISA 2009–2015 are female (51 percent). Figure 13 shows that across all students, around 60 percent of their parents only have nine years of schooling or lower. Around four out of ten students have parents who attended senior secondary school or higher. Figure 14 shows that 68 percent of students are living in villages or small towns.

Figure 13: Distribution of Parental Education Attainment (2009-2015)



Source: PISA 2009-2015 (authors' analysis).

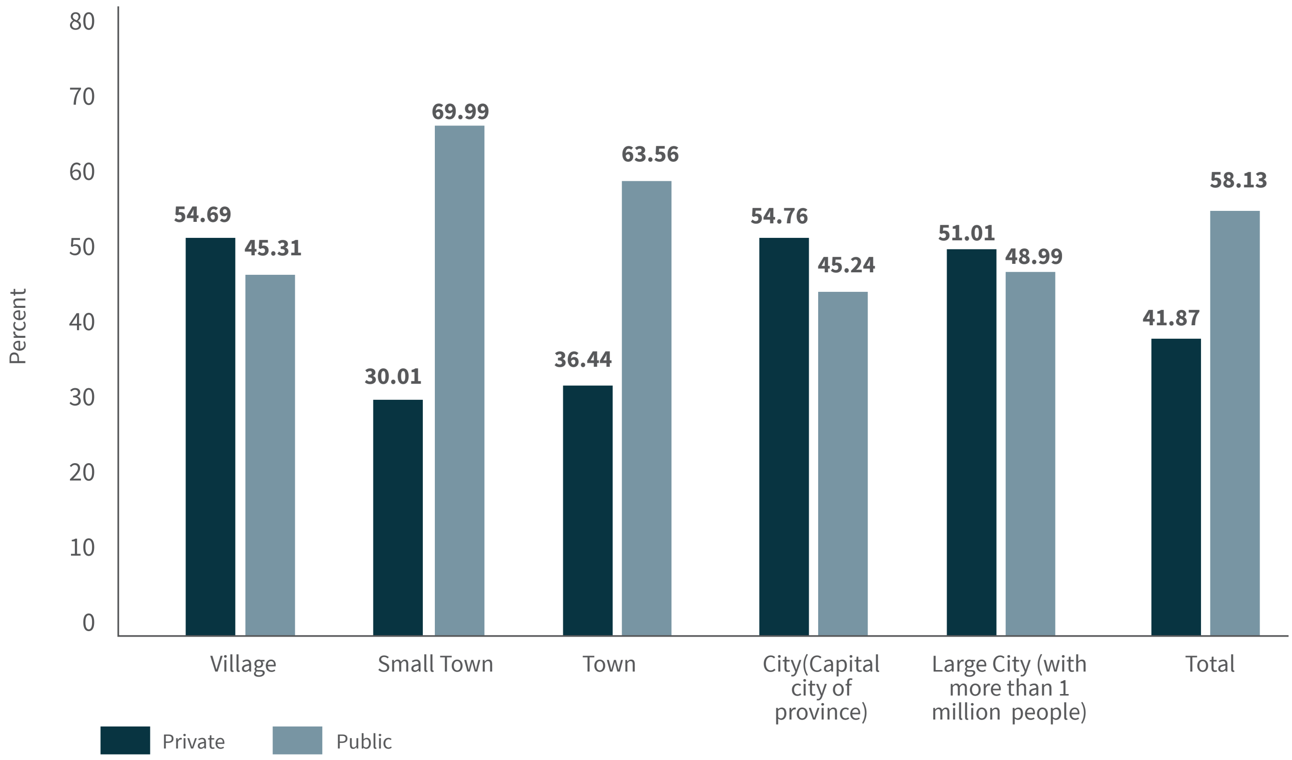
Figure 14: Indonesian Students by Residence (2009-2015)



Source: PISA 2009-2015 (authors' analysis).

With regards to school type, around 58 percent of the sampled students were enrolled in a public school, with higher rates in small towns and towns (70 percent and 64 percent respectively) (Figure 15). In villages and cities, more than one-half of the students were enrolled in private schools.

Figure 15: Indonesian Students by Residence and School Type (2009-2015)



Source: PISA 2009-2015 (authors' analysis).

Regarding the students' attendance in kindergarten, 45 percent of all students did not attend early childhood education (kindergarten).[4] Only one in four students attended kindergarten for longer than one year. The proportion of students attending kindergarten varies by region. In villages and small towns, around 59 percent and 46 percent of the sampled students respectively did not attend early-childhood education, whereas in cities less than one-third did not attend kindergarten.

[4] In the PISA questionnaire, Indonesian students were asked whether they attended a *Taman Kanak-Kanak* (kindergarten). A reference in this document to early childhood education, therefore, refers to kindergarten and does not include playgroups (*Taman Bermain*).

Section 4

Stock of Skills in Indonesia

In this section, we conduct separate analyses at the student and school levels for mathematics and reading. First, we examine characteristics of schools that have a relatively high proportion of skilled students. To obtain a sufficient sample size, we consider students to be skilled if they scored at Level 4 or above. Schools are categorised as high-performing schools if more than 10 percent of students are skilled. Second, we investigate factors that are correlated with the probability of being skilled in reading or mathematics by examining the effect of family background characteristics on the probability of being skilled. To increase the sample size, we combine PISA 2009, 2012, and 2015 in this section.

Descriptive Analysis

Schools Where Skilled Students are Enrolled

We find that skilled students in mathematics and/or reading are highly concentrated in a small proportion of schools. The proportion of skilled students in mathematics in a school ranges from zero to 63.6 percent, with an average of 0.6 percent. In reading, the proportion ranges from zero to 42.4 percent, with an average of 0.4 percent. Of all the schools in the sample, 94 percent have no skilled students in mathematics, while 96 percent have no skilled students in reading.

We categorise the schools into three types: schools with no skilled students (Type 1); schools where at most 10 percent of students are skilled (Type 2); and schools where more than 10 percent of students are skilled (Type 3). Schools are the most concentrated for reading skills: 92 percent are Type 1, 6 percent are Type 2, and 2 percent are Type 3, while for mathematics the respective figures are 89 percent for Type 1, 7 percent for Type 2; and 4 percent for Type 3. Tables 1 and 2 below show the descriptive statistics of school characteristics of the three types of schools for reading and mathematics respectively.

Table 1: Descriptive Statistics (Reading)

Characteristic	Type 1: Schools without skilled students in reading (N=504; 92% of sample)		Type 2: Schools with no more than 10% students who are skilled in reading (N=31; 6% of sample)		Type 3: Schools where more than 10% of students are skilled in reading (N=14; 2% of sample)	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
School characteristics						
Student-teacher ratio	15.67	9.14	16.00	6.76	17.00	2.66
Public school (Yes=1)	0.50	0.50	0.74	0.44	0.71	0.47
School is in a city (Yes=1)	0.12	0.32	0.13	0.34	0.36	0.50
School is in a large city (Yes=1)	0.05	0.21	0.13	0.34	0.50	0.52
Principal authority						
Fire teacher (Yes = 1)	0.34	0.47	0.19	0.40	0.36	0.50
Increase teacher salary (Yes=1)	0.33	0.47	0.06	0.25	0.21	0.43
Allocate budget (Yes=1)	0.79	0.41	0.61	0.50	0.86	0.36
Formulate student assessment policy (Yes=1)	0.75	0.44	0.81	0.40	0.86	0.36
Principal practice						
At least once a month - use of student performance results to develop the school (Yes=1)	0.27	0.45	0.32	0.48	0.50	0.52
At least once a month - promote teaching practices based on recent educational research (Yes=1)	0.35	0.48	0.39	0.50	0.71	0.47
At least once a week - take initiative to discuss matters when a teacher has problems (Yes=1)	0.24	0.43	0.26	0.44	0.64	0.50
At least once a week - when a teacher brings up a classroom problem, we solve it (Yes=1)	0.35	0.48	0.39	0.50	0.64	0.50
Teacher characteristics						
Proportion of teachers with professional certification	0.51	0.35	0.76	0.25	0.72	0.26
Proportion of teachers with bachelor's degree or above	0.76	0.26	0.80	0.28	0.75	0.25

Source: PISA 2009-2015.

Table 2: Descriptive Statistics (Mathematics)

Characteristic	Type 1: Schools without skilled students in mathematics (N=487; 89% of sample)		Type 2: Schools with no more than 10% students who are skilled in mathematics (N=38; 7% of sample)		Type 3: Schools where more than 10% of students are skilled in mathematics (N=24; 4% of sample)	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
School characteristics						
Student-teacher ratio	15.55	8.53	15.05	4.56	20.44	17.20
Public school (Yes=1)	0.49	0.50	0.76	0.43	0.71	0.46
School is in a city (Yes=1)	0.11	0.32	0.13	0.34	0.29	0.46
School is in a large city (Yes=1)	0.05	0.21	0.16	0.37	0.25	0.44
Principal authority						
Fire teacher (Yes = 1)	0.34	0.47	0.32	0.47	0.25	0.44
Increase teacher salary (Yes=1)	0.32	0.47	0.26	0.45	0.08	0.28
Allocate budget (Yes=1)	0.78	0.41	0.84	0.37	0.79	0.41
Formulate student assessment policy (Yes=1)	0.74	0.44	0.82	0.39	0.88	0.34
Principal practice						
At least once a month - use of student performance results to develop the school (Yes=1)	0.28	0.45	0.24	0.43	0.42	0.50
At least once a month - promote teaching practices based on recent educational research (Yes=1)	0.36	0.48	0.37	0.49	0.50	0.51
At least once a week - take initiative to discuss matters when a teacher has problems (Yes=1)	0.24	0.43	0.34	0.48	0.42	0.50
At least once a week - when a teacher brings up a classroom problem, we solve it (Yes=1)	0.35	0.48	0.34	0.48	0.54	0.51
Teacher characteristics						
Proportion of teachers with professional certification	0.50	0.35	0.69	0.29	0.73	0.26
Proportion of teachers with bachelor's degree or above	0.76	0.26	0.78	0.30	0.77	0.27

Source: PISA 2009-2015.

Across all schools, the average student-teacher ratio is around 1:16. We find no significant difference in student-teacher ratio between high-performing schools in reading (Type 3) and the rest, however, the high-performing schools in mathematics have a larger student-teacher ratio of 20 students per teacher. In addition, around 54 percent and 86 percent of high-performing schools in mathematics and reading respectively are located in either a city or large city, and around 70 percent of them are public schools.

Principals in high-performing schools seem to show more engagement in supervising and supporting teaching activities in their schools. For example, around 42-64 percent of principals in high-performing schools reported that they often discuss with teachers and solve problems related to teaching. Regardless of the school type, a very high proportion of school principals reported that they are involved in budget allocation and policy formulation on student assessment. On the other hand, only around 25-36 percent of principals in high-performing schools reported that they have authority to dismiss teachers.

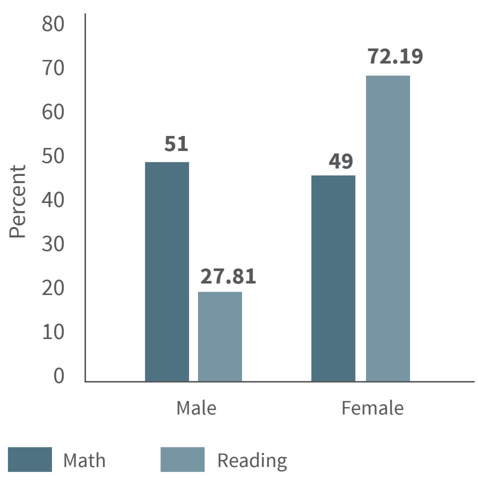
In terms of certified teachers, we find significant differences in the proportion of certified teachers between schools with no high achievers and schools that have high achievers. Only around one-half of teachers in Type 1 schools in either reading or mathematics are certified, while around 70 percent of teachers in Type 2 and 3 schools are certified.

Who are the High-Achieving Students in Indonesia?

Around one-half of students skilled in mathematics are girls (Figure 16), while the proportion of girls skilled in reading is much higher–around 72 percent of top performers are girls. The skilled students also have highly educated parents. Whereas the average adult Indonesian has around eight years of schooling, around 60 percent of the parents of these skilled Indonesian students have a bachelor's degree or higher (Figures 17 and 18).

In addition, more than one-half of these highly skilled individuals live in large cities. Around 56 percent and 65 percent of high-achieving students in mathematics and reading, respectively, live in cities. In cities, around 69 percent and 78 percent of high-performing students in mathematics and reading respectively are enrolled in public schools (Figures 19 and 20), however, in villages and small towns, private schools produced a higher percentage of top performers in reading.

Figure 16: Skilled Students by Sex



Source: PISA 2009-2015.

Figure 17: Skilled Students in Reading by Parental Education Attainment

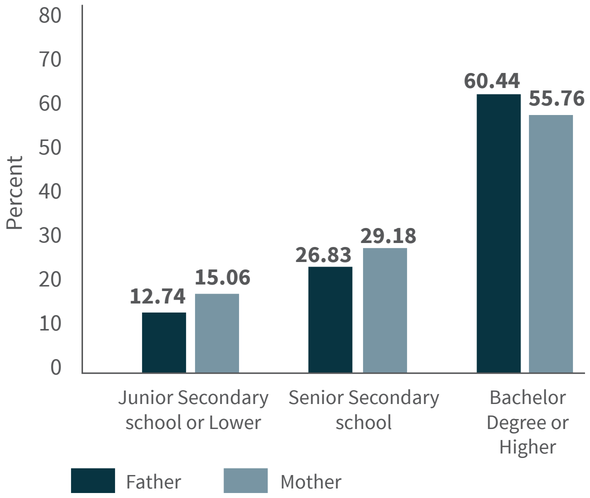
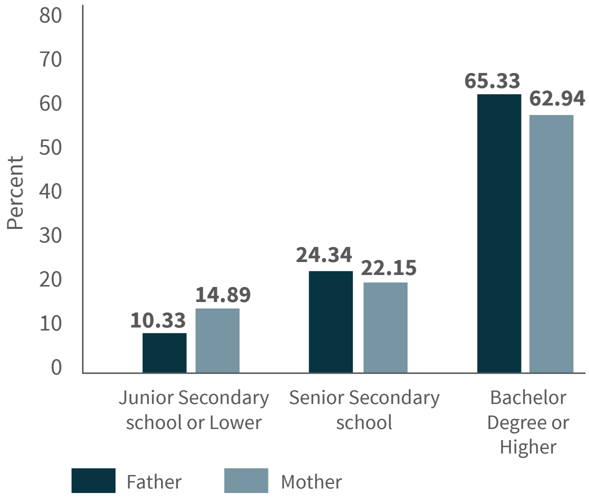


Figure 18: Skilled Students in Mathematics by Parental Education Attainment



Source: PISA 2009-2015.

Figure 19: Highly Skilled Individuals in Mathematics by School Status and Residence

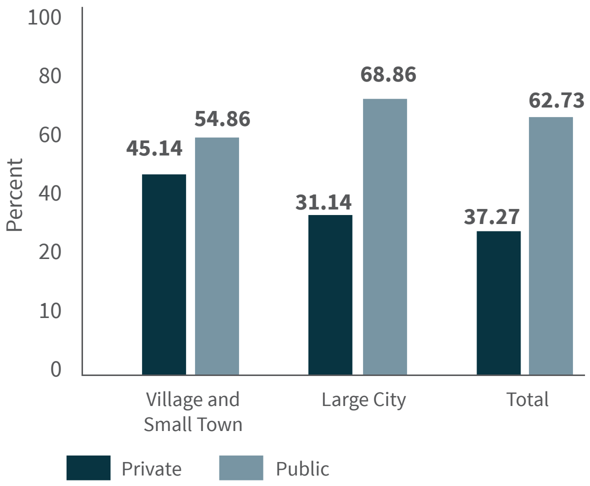
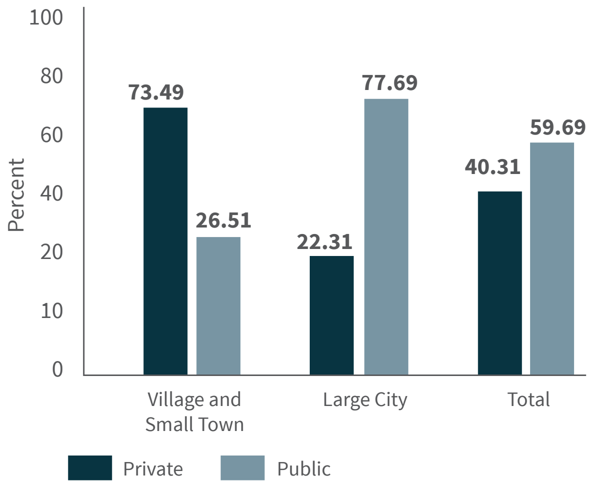


Figure 20: Highly Skilled Individuals in Reading by School Status and Residence



Source: PISA 2009-2015.

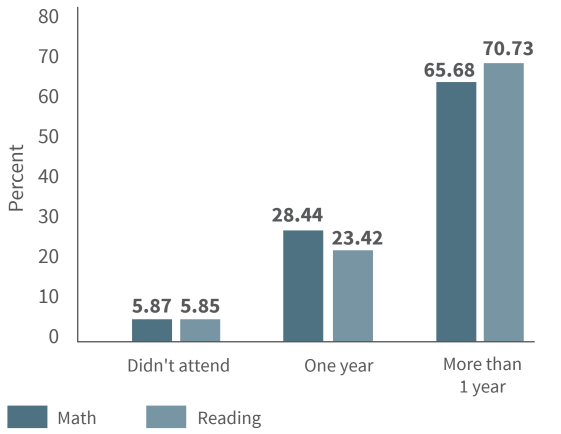
Table 3 shows the descriptive statistics of skilled students. Only one to two percent of students achieved Level 4 or higher in reading and mathematics respectively. We observe significant differences between the characteristics of students on Level 4 or higher and those Level 3 or lower. Some of the starkest differences include pre-school attendance, parental education, and home resources index. The table shows that Indonesia's top student performers have clearly distinct characteristics.

Table 3: Descriptive Statistics

Student Level Summary Statistics	Full Sample (N=15,275)		Mathematics Level 4 or Higher (N=288)		Mathematics Level 3 or Lower (N=14,987)		Reading Level 4 or Higher (N=178)		Reading Level 3 or Lower (N=15,097)	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Learning outcomes										
Achieves mathematics level 4 or higher (Yes=1)	0.02	0.14								
Achieves reading level 4 or higher (Yes=1)	0.01	0.11								
Individual characteristics										
Current school grade	9.46	0.74	9.96	0.46	9.45	0.74	9.96	0.41	9.46	0.74
Female (Yes=1)	0.52	0.50	0.49	0.50	0.52	0.50	0.71	0.45	0.51	0.50
Attended more than one year of pre-school (Yes=1)	0.26	0.44	0.63	0.48	0.26	0.44	0.68	0.47	0.26	0.44
Home and background characteristics										
Has more than 100 books at home (Yes=1)	0.10	0.30	0.29	0.45	0.10	0.30	0.34	0.47	0.10	0.30
Has a quiet place at home to study (Yes=1)	0.58	0.49	0.80	0.40	0.57	0.49	0.80	0.40	0.58	0.49
Mother completed tertiary education (Yes=1)	0.13	0.34	0.60	0.49	0.12	0.33	0.54	0.50	0.12	0.33
Father completed tertiary education (Yes=1)	0.16	0.37	0.61	0.49	0.15	0.36	0.60	0.49	0.16	0.36
Home resources index	0.02	1.47	2.34	2.01	-0.03	1.42	2.35	2.01	-0.01	1.44

Source: PISA 2009-2015.

Figure 21: Percentage of Skilled Students by Kindergarten Attendance



Source: PISA 2009-2015 (authors' analysis).

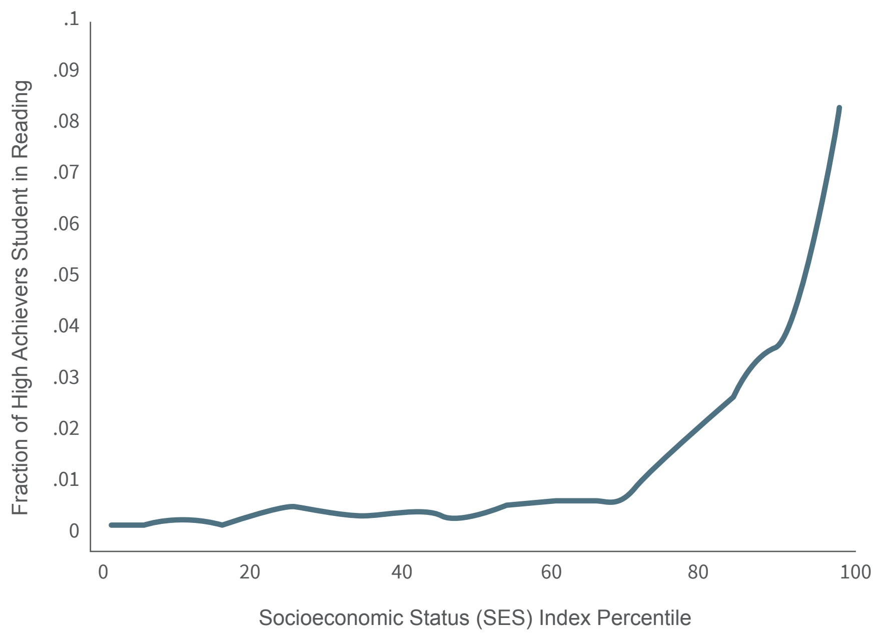
Finally, Figure 21 shows that 94 percent of highly skilled individuals attended at least one year of early childhood education. When we disaggregate by residence, most of the highly skilled individuals in cities (higher than 70 percent) attended more than one year at kindergarten. Meanwhile, only around one-half of top performers in villages and small towns attended early childhood education.

With regards to parental income, we plot the relationship between fraction of skilled students and family socioeconomic status (SES). The family SES index is constructed by PISA based on parents' highest level of education, parents' highest occupation status, and home possessions as a proxy for family wealth (OECD 2016). PISA also adjusted the SES index for trend analysis. We use the adjusted index that is comparable over cycles for our analysis below.

In general, the higher the SES index, the higher the probability of being a skilled student. The findings are similar to those of Aghion et al. (2017) and Bell et al. (2019) who find an exponential increase in rates of innovators with parental income. As with their findings, we also find that an upward-sloping relationship between skilled students' rates and SES is even steeper among families with an SES above the 90th percentile.

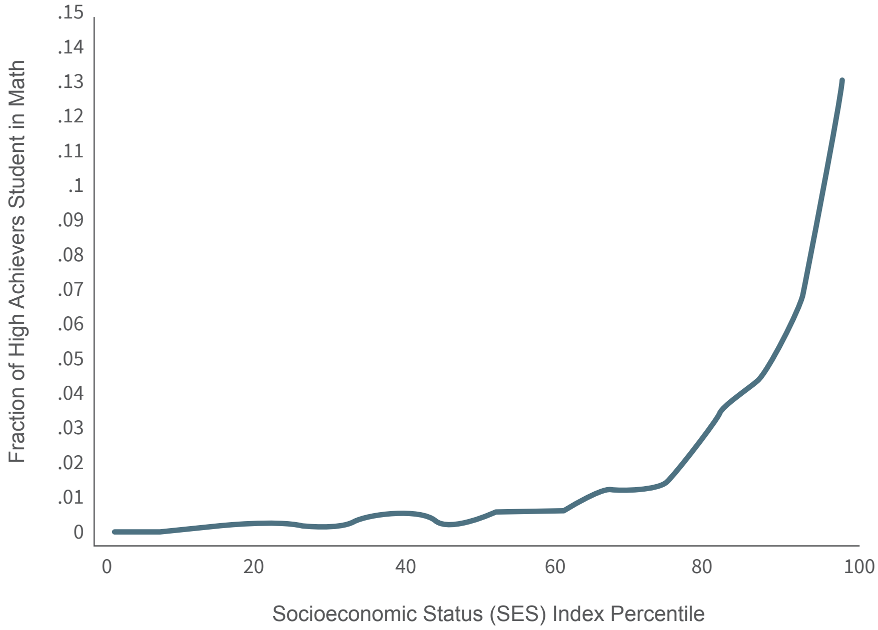
Among families at the top percentile, there are around 8 in 100 students who are skilled in reading (Figure 22), while in mathematics the probability is higher–around 13 in 100 students are skilled (Figure 23). On the other hand, students from lower than the 60th percentile have a negligible chance to be skilled in reading and/or mathematics.

Figure 22: Relationship Between Family SES and Skilled Students in Reading



Source: PISA 2009-2015 (authors' analysis).

Figure 23: Relationship Between Family SES and Skilled Students in Mathematics



Source: PISA 2009-2015 (authors' analysis).

Regression Results

In this section, we estimate the correlates of schools with skilled students. Specifically, we examine the following aspects: (i) principal authority; (ii) principal practice; (iii) teacher qualification; and (iv) basic school characteristics such as student-teacher ratio and location of school. We then look at the parental background and home conditions of the skilled students. Given the nature of PISA data, the estimates show correlations, not causal relationships.

Characteristics of Schools With Skilled Students

For mathematics, we find no evidence that principal authority or practice are correlated with the proportion of skilled students in a school (Table 4). The point estimates of these variables are also very small. In contrast, teacher qualifications have a mixed correlation with having skilled students. Schools with a higher proportion of teachers with professional certification are more likely to have more skilled students and the correlation is large. A standard deviation (0.35) increase in the proportion of teachers with certification increases the probability of a school to be a Type 3 by about 1.8 percentage points. As mentioned above, only 4 percent of schools in our sample are Type 3 in mathematics.

Table 4: Characteristics of Schools with Skilled Students in Mathematics

Student Level Summary Statistics	Schools without skilled students in mathematics (1)	Schools with no more than 10% students who are skilled in mathematics (2)	Schools where more than 10% of students are skilled in mathematics (3)
Principal authority			
Fire teacher (Yes = 1)	-0.031	0.016	0.015
	(0.035)	(0.018)	(0.016)
Increase teacher salary (Yes=1)	0.069 *	-0.036 *	-0.033 *
	(0.037)	(0.019)	(0.019)
Allocate budget (Yes=1)	0.004	-0.002	-0.002
	(0.034)	(0.018)	(0.016)
Formulate student assessment policy (Yes=1)	-0.043	0.022	0.020
	(0.032)	(0.017)	(0.015)
Principal practice			
At least once a month - use of student performance results to develop the school (Yes=1)	0.002	-0.001	-0.001
	(0.028)	(0.015)	(0.013)
At least once a month - promote teaching practices based on recent educational research (Yes=1)	0.000	0.000	0.000
	(0.026)	(0.014)	(0.012)
At least once a week - take initiative to discuss matters when a teacher has problems (Yes=1)	-0.037	0.020	0.018
	(0.033)	(0.018)	(0.016)
At least once a week - when a teacher brings up a classroom problem, we solve it (Yes=1)	0.022	-0.011	-0.010
	(0.033)	(0.018)	(0.015)
Teacher qualifications			
Proportion of teachers with professional certification	-0.111 ***	0.059 ***	0.053 ***
	(0.043)	(0.023)	(0.022)
Proportion of teachers with bachelor's degree or above	0.120 **	-0.063 **	-0.057 **
	(0.055)	(0.030)	(0.027)
School characteristics			
Student-teacher ratio	-0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Public school (Yes=1)	-0.068 **	0.036 **	0.032 **
	(0.030)	(0.016)	(0.014)

Characteristic	Schools without skilled students in mathematics (1)	Schools with no more than 10% students who are skilled in mathematics (2)	Schools where more than 10% of students are skilled in mathematics (3)
School location (ref: in a village)			
School is in a city (Yes=1)	-0.087 ***	0.046 ***	0.041 ***
	(0.033)	(0.018)	(0.017)
School is in a large city (Yes=1)	-0.149 ***	0.078 ***	0.070 ***
	(0.039)	(0.022)	(0.021)
Year fixed effects		Yes	
R-squared		0.15	
Number of observations		549	

Notes: *** 1% significance; ** 5% significance; * 10% significance; Multinomial probit regression; Coefficients are average marginal effects; standard errors in parentheses.

Our second proxy for teacher qualifications–the proportion of teachers with a bachelor's degree or above–shows a negative correlation with having high mathematics performers. A standard deviation (0.26) increase in the proportion of teachers with a bachelor's degree–controlling for the share of teachers with certification–is associated with a 1.4 percentage-point lower probability to be a Type 3 school. While this seems counterintuitive, the explanation is that teachers need a bachelor's degree to receive certification. Holding the share of certified teachers constant, a higher share of teachers with a bachelor's degree, therefore, indicates that more of these teachers are not yet certified.

On school characteristics, we find that public schools have a significantly higher likelihood to be Type 2 or Type 3, by about 3.6 and 3.2 percentage points respectively. Finally, schools in a city or a large city have a much higher chance to be a Type 2 or Type 3 school compared to schools in a village.

Higher principal authority, specifically to increase teacher salary or to allocate budget, is negatively associated with the probability of being a Type 2 or Type 3 school in reading (Table 5). Together with the previous results on mathematics, we find no evidence that principal authority or practice has any correlation with the proportion of reading superstars in a school.

Table 5 shows that a higher proportion of certified teachers is positively associated with the probability of being a Type 2 or Type 3 school. A standard deviation increase in this particular teacher qualification increases the probability of a school being in Type 3 by 1.6 percentage points. This is a very large correlation given that only 2 percent of schools in our sample are Type 3 in reading.

In contrast to mathematics superstars, public schools are not more likely to be in Type 2 or 3 than private schools. Regarding location, we find that schools in a large city are significantly more likely to have reading superstars.

Table 5: Characteristics of Schools with Skilled Students in Reading

Characteristic	Schools without students skilled in reading (1)	Schools with no more than 10% students who are skilled in reading (2)	Schools where more than 10% of students are skilled in reading (3)
Principal authority			
Fire teacher (Yes = 1)	-0.030	0.019	0.012
	(0.028)	(0.018)	(0.011)
Increase teacher salary (Yes=1)	0.067 **	-0.041 *	-0.025 **
	(0.032)	(0.021)	(0.012)
Allocate budget (Yes=1)	0.055 **	-0.034 ***	-0.021 ***
	(0.025)	(0.017)	(0.010)
Formulate student assessment policy (Yes=1)	-0.030	0.018	0.011
	(0.027)	(0.017)	(0.010)
Principal practice			
At least once a month - use of student performance results to develop the school (Yes=1)	0.000	0.000	0.000
	(0.022)	(0.013)	(0.008)
At least once a month - promote teaching practices based on recent educational research (Yes=1)	-0.019	0.012	0.007
	(0.020)	(0.013)	(0.008)
At least once a week - take initiative to discuss matters when a teacher has problems (Yes=1)	-0.025	0.015	0.010
	(0.028)	(0.017)	(0.011)
At least once a week - when a teacher brings up a classroom problem, we solve it (Yes=1)	-0.028	0.017	0.011
	(0.027)	(0.017)	(0.010)
Teacher qualifications			
Proportion of teachers with professional certification	-0.120 ***	0.074 ***	0.046 ***
	(0.038)	(0.025)	(0.017)
Proportion of teachers with bachelor's degree or above	0.067	-0.041	-0.026
	(0.049)	(0.030)	(0.020)
School characteristics			
Student-teacher ratio	-0.001	0.000	0.000
	(0.001)	(0.001)	(0.000)
Public school (Yes=1)	-0.045 *	0.028 *	0.017 *
	(0.026)	(0.017)	(0.010)

Characteristic	Schools without students skilled in reading (1)	Schools with no more than 10% students who are skilled in reading (2)	Schools where more than 10% of students are skilled in reading (3)
School location (ref: in a village)			
School is in a city (Yes=1)	-0.055 *	0.034 *	0.021 *
	(0.029)	(0.018)	(0.013)
School is in a large city (Yes=1)	-0.158 ***	0.098 ***	0.060 ***
	(0.033)	(0.022)	(0.018)
Year fixed effects		**Yes**	
R-squared		**0.19**	
Number of observations		**549**	

Notes:*** 1% significance; ** 5% significance; * 10% significance; Multinomial probit regression; Coefficients are average marginal effects; standard errors in parentheses.

Home Conditions and Parental Education Levels of Skilled Students

We now look at the characteristics of skilled students.
Attending more than one year of kindergarten doubles the chance to be a skilled student in mathematics at the age of 15 while having a tertiary-educated mother triples the chance to be a skilled student (Table 6). Having a tertiary-educated father has a lower effect, although it is still positive and large. Of the home conditions, having many books at home and living in well-off households (proxied by the home asset index) is positively correlated with being a skilled student. Given what we know about very high-performing individuals–for example, inventors in Finland (Aghion et al. 2017) and the United States (Bell et al. 2019)–these results show that skilled students come from privileged backgrounds.

Table 6: Characteristics of Skilled Students in Mathematics

Characteristic	Whole Sample		Female		Male	
	(1)	(2)	(3)	(4)	(5)	(6)
Individual Characteristics						
Current school grade	0.010***	0.004*	0.007***	0.001	0.013***	0.006*
	(0.001)	(0.002)	(0.002)	(0.004)	(0.002)	(0.003)
Female (Yes=1)	-0.003	-0.008***				
	(0.002)	(0.002)				
Attended more than one year of kindergarten (Yes=1)	0.019***	0.000	0.020***	0.001	0.019***	-0.001
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.005)
Parental Education						
Mother has tertiary education (Yes=1)	0.040***	0.016***	0.039***	0.014**	0.041***	0.019**
	(0.006)	(0.005)	(0.008)	(0.007)	(0.008)	(0.008)

Characteristic	Whole Sample		Female		Male	
	(1)	(2)	(3)	(4)	(5)	(6)
Father has tertiary education (Yes=1)	0.012***	0.004	0.013**	0.003	0.012*	0.002
	(0.005)	(0.004)	(0.007)	(0.006)	(0.007)	(0.007)
Home Conditions						
Has more than 100 books at home (Yes=1)	0.014***	0.007	0.012*	0.005	0.017**	0.008
	(0.005)	(0.005)	(0.007)	(0.006)	(0.008)	(0.008)
Has a quiet place to study at home (Yes=1)	0.002	0.001	0.001	-0.001	0.003	0.004
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Home asset index	0.011***	0.002	0.010***	-0.000	0.013***	0.004**
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Constant	-0.097***	-0.022	-0.073***	0.003	-0.123***	-0.039
	(0.011)	(0.022)	(0.015)	(0.034)	(0.017)	(0.027)
Year fixed effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
School fixed effects	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
R-squared	**0.071**	**0.288**	**0.065**	**0.339**	**0.078**	**0.297**
Number of observations	**15,275**	**15,275**	**7,878**	**7,878**	**7,397**	**7,397**
Sample mean of dependent variable	**0.019**		**0.018**		**0.019**	

Notes:*** 1% significance; ** 5% significance; * 10% significance; Multinomial probit regression; Coefficients are average marginal effects; standard errors in parentheses.

When we include school fixed effects, virtually all individual-level estimates become much smaller and lose their statistical significance. The only exceptions are females, who now have a 0.8 percentage points lower chance of becoming a skilled student (42 percent from the mean). The results suggest that there may be a within-school barrier to females becoming skilled. Unfortunately, we cannot further investigate this issue due to data limitations. Students with tertiary-educated mothers also continue to have a higher chance of becoming skilled. The point estimate, however, is more than halved.

The results indicate that there is little variation in these variables within schools while, in contrast, student background appears to be correlated with school choice. For example, there are significantly more students with tertiary-educated mothers in Type 3 schools than in Type 1 schools. This finding indicates that schools in Indonesia are segregated–students from privileged backgrounds are enrolled in one set of schools and other students are enrolled in a different set of schools. We find very similar results when we disaggregate the sample by sex (Columns 3-6).

We find that females have a significantly higher chance of becoming skilled in reading (Table 7). The point estimate of 0.9 percentage points is large relative to the proportion of skilled students in reading. We also find that attending more than one year of kindergarten more than doubles the probability of becoming a skilled student at the age of 15. We find similar point estimates for mother's education and book availability at home. Meanwhile, a father's education and home asset ownership also positively affect the probability of being skilled in reading–albeit with a smaller magnitude compared to the mother's education.

Unlike the results in Table 6, the statistical significance and effect size of sex remains robust after we include school fixed effects (Column 2). The positive effect of attending kindergarten remains significant, although the size declines to 0.5 percentage points. All other previously significant variables become very small and statistically insignificant.

Table 7: Characteristics of Skilled Students in Mathematics

Characteristic	Whole Sample		Female		Male	
	(1)	(2)	(3)	(4)	(5)	(6)
Individual Characteristics						
Current school grade	0.005***	0.002	0.006***	0.003	0.004***	0.002
	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)	(0.002)
Female (Yes=1)	0.009***	0.006***				
	(0.002)	(0.002)				
Attended more than one year of kindergarten (Yes=1)	0.015***	0.005**	0.022***	0.008**	0.006**	0.001
	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)	(0.003)
Parental Education						
Mother has tertiary education (Yes=1)	0.016***	0.001	0.023***	-0.001	0.009*	-0.000
	(0.005)	(0.005)	(0.008)	(0.008)	(0.005)	(0.005)
Father has tertiary education (Yes=1)	0.009**	-0.000	0.010	-0.005	0.008*	0.004
	(0.004)	(0.004)	(0.007)	(0.007)	(0.005)	(0.005)
Home Conditions						
Has more than 100 books at home (Yes=1)	0.014***	0.008*	0.019***	0.012*	0.008	0.002
	(0.004)	(0.004)	(0.007)	(0.007)	(0.005)	(0.005)
Has a quiet place to study at home (Yes=1)	0.000	0.000	0.000	-0.000	0.000	-0.000
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Home asset index	0.008***	0.000	0.011***	0.001	0.005***	0.001
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Constant	-0.054***	-0.014	-0.056***	-0.011	-0.041***	-0.012
	(0.008)	(0.016)	(0.014)	(0.031)	(0.009)	(0.016)
Year fixed effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
School fixed effects	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
R-squared	**0.044**	**0.198**	**0.058**	**0.266**	**0.026**	**0.169**
Number of observations	**15,275**	**15,275**	**7,878**	**7,878**	**7,397**	**7,397**
Sample mean of dependent variable	**0.012**		**0.017**		**0.007**	

Notes:*** 1% significance; ** 5% significance; * 10% significance; Multinomial probit regression; Coefficients are average marginal effects; standard errors in parentheses.

We also find evidence of sex heterogeneity in the individual and background characteristics of students skilled in reading. First, 1.7 percent of female students are skilled in reading, more than double the rate among males. Second, attending kindergarten and home asset ownership have a positive and sizeable effect for both males and females, but the latter is much greater. Similarly, having a tertiary-educated mother or book availability at home significantly increases the probability of being skilled in reading–but only for females. Once school fixed effects are included, no individual characteristic remains significant for males. Overall, our model can explain between 5.8 percent to 26.6 percent of variations among females, but only 2.6 percent to 16.9 percent of variations among males. Comparing across Tables 6 and 7, we therefore have the least evidence on the correlates of becoming skilled at reading among males.

Section 5
Conclusions

This study is the first step to measuring the stock of skills in Indonesia.
Using an international benchmark, we find that Indonesia has an extremely small proportion of individuals skilled in literacy and numeracy. Between 2009 and 2015 the PISA results indicate an increasing trend, however, the absolute number remains very low. Only around 79,000 students out of 3.1 million in 2015 can be considered as skilled in mathematics. Of that number, 14,300 individuals have high mathematics skills. The number of individuals skilled in reading is even lower. Only 35,900 individuals could be considered as skilled, and 1,900 of those have high literacy skills.

We find that the probability of being a skilled individual is correlated with maternal education attainment and SES. Even among the top 10th percentile of the family SES index, the positive slope between these two variables is steeper. On the other hand, students from the bottom 60th percentiles have a negligible chance to be skilled. Early childhood education attendance and home asset ownership have sizeable effects on a higher probability of being skilled, particularly for females.

Our regression results indicate that the proportion of high-achieving students is associated with the proportion of certified teachers. Meanwhile, we find no evidence that a principal's authority or practice are correlated with the proportion of these skilled individuals in a school. We also find that skilled students are concentrated in a relatively small number of schools. Students within these schools have similar characteristics–indicating the strong influence of parental choice.

On the question of whether an individual's skill levels at the age of 15 come from talent or nurture, unfortunately, we have no data on the former but our results indicate that nurture is critical in the formation of skills. Nurture could be stronger at home–for example from high-income and highly educated parents–or it could come from school, for example from high-quality teaching. Separately measuring these effects requires the measurement of school value added, which is not available from PISA.

In closing, with such a small stock of skills, Indonesian policy makers face two challenges: (i) an active policy to identify and nurture talent must be in place; and (ii) ensuring an efficient allocation of skills is critical. The literature shows that, to realise the optimal social benefit, the most skilled individuals must be engaged in occupations that would give them the highest private returns and simultaneously the highest social returns. This is a huge endeavour requiring policy reforms in the health, education, social protection, and labour market sectors.

References

Aghion, P., U. Akcigit, A. Hyytinen, and O. Toivanen. 2017. *The Social Origins of Inventors* (Working Paper No. 24110). Cambridge MA: National Bureau of Economic Research.

Bell, A., R. Chetty, X. Jaravel, N. Petkova, and J. Van Reenen. 2018. *"Who becomes an inventor in America? The importance of exposure to innovation".* The Quarterly Journal of Economics, 134(2), 647-713.

Benzell, S.G. and E. Brynjolfsson. 2019. *Digital Abundance and Scarce Genius: Implications for Wages, Interest Rates, and Growth (*Working Paper No. 25585). Cambridge MA: National Bureau of Economic Research.

Burhan, N.A.S., M.R. Mohamad, Y. Kurniawan, and A.H. Sidek. 2014. "*The impact of low, average, and high IQ on economic growth and technological progress: Do all individuals contribute equally?*" Intelligence, 46, 1-8.

Card, D. and L. Giuliano. 2014. *Does Gifted Education Work? For Which Students?* (Working Paper No. 20453). Cambridge MA: National Bureau of Economic Research.

Hanushek, E.A. and L. Woessmann. 2008. *"The Role of Cognitive Skills in Economic Development"*. Journal of Economic Literature, 46:3, 607-68.

Kaplan, S.N. and J. Rauh. 2013. *"It's the Market: The Broad-Based Rise in the Return to Top Talent"*. Journal of Economic Perspectives, 27(3), 35-56.

Kim, M. 2016. *"A Meta-Analysis of the Effects of Enrichment Programs on Gifted Students"*. Gifted Child Quarterly, 60(2), 102-116.

Murphy, K.M., A. Shleifer, and R.W. Vishny. 1991. *"The Allocation of Talent: Implications for Growth"*. The Quarterly Journal of Economics, 106(2), 503-530.

OECD. 2010. PISA 2009 Results (Volume I): *What Students Know and Can Do-Student Performance in Reading, Mathematics and Science.* Paris: OECD Publishing.

OECD. 2016. PISA 2015 Results (Volume I): *Excellence and Equity in Education*. Paris: OECD Publishing. http://dx.doi.org/10.1787/9789264266490-en

Pritchett, L. and M. Viarengo. 2009. *Producing superstars for the economic mundial: Mexican predicament with quality of education*. Program on Education Policy and Governance Working Paper PEPG 09-01. Cambridge, MA: Harvard Kennedy School.

Rindermann, H., O. Kodila-Tedika, and G. Christainsen. 2015. *"Cognitive capital, good governance, and the wealth of nations"*. Intelligence, 51, 98-108.

Rosen, S. 1981. *"The Economics of Superstars"*. The American Economic Review, 71(5), 845-858.

THE NATIONAL TEAM FOR THE ACCELERATION OF POVERTY REDUCTION

Office of the Vice President's Secretariat
Jl. Kebon Sirih Raya No.14, Jakarta Pusat, 10110

Telephone : (021) 3912812
Facsmili : (021) 3912511
Email : info@tnp2k.go.id
Website : www.tnp2k.go.id