



## ANNEX A6

### TESTING RESULTS IN VOLUME IV

This annex presents the diagnostic tools and parallel analyses to test the system-level results shown in this volume, as referred to in Box IV.1.1.

In Volume IV, *What Makes a School Successful?* **zero-order correlations** and **partial correlations** are used to identify relationships between system-level attributes. These relationships include the correlation between organisational characteristics of school systems and measures of reading performance and equity (Table IV.2.1) as well as the correlation between organisational characteristics of school systems (Figure IV.2.10). As a statistical tool, correlations at the system level may be subject to a potential lack of robustness, and these results may not be replicable when the specification of how they are calculated is changed slightly. Correlations at the system level may also suffer from other weaknesses: relationships may be spurious; aggregation bias may occur; and different relationships at the school and system levels may obscure the direction and type of relationship.

### ROBUSTNESS

From statistical inference theory, some relationships will be identified as statistically significant when they do not hold in the population. This is especially possible when analyses are run with a limited set of cases, such as the correlation analyses using countries and economies as cases. To test whether this error is present, the correlations presented in this volume are also conducted for mathematics and science scores. As shown in Table A6.1, the relationships between system-level characteristics and performance in mathematics and science are similar, in direction and magnitude, to the relationships between system-level characteristics and reading performance shown in Table IV.2.1.

Furthermore, **rank-order correlations** are used instead of **zero-order correlations** to test whether similar relationships are found across these other specifications. The results of **rank-order correlations** are not affected by cases with extreme values. As shown in Table A6.2, the relationships shown in Table IV.2.1 are also present, and in similar magnitude and direction, when measuring them with rank-order correlations.

A further test of robustness lies in the fact that most of the relationships identified in Chapter 2 were also reported in prior PISA reports (OECD, 2007).

### SPURIOUS RELATIONSHIPS

Correlations assess the association between two variables by measuring the degree to which they vary in the same or opposite direction. A correlation between two variables will be close to one, for example, when variable A increases, variable B also increases. In some cases, variables A and B may be associated, but this association may be driven by a third variable C. After taking into account the relationship between C and A, and between C and B, the relationship between A and B may no longer be observed; the relationship between A and B is said to be a spurious relationship.

The analyses in Volume IV, *What Makes a School Successful?* show the correlation between two variables and only accounting for a country's GDP per capita (partial correlation). Thus, the relationships observed may still be subject to spuriousness.

To this extent the variables that have been found to be statistically significant in a correlation analysis were included in a system-level ordinary least squares (OLS) regression (Table A6.3). Two models are tested: one includes seven system-level variables; the other includes five system-level variables without including two system-level variables for which many countries do not have data. The robustness of this model was tested with equivalent mixed effects models that allow for random estimates at the school and system levels for intercepts (estimated with SAS® 9.2 Software). These models are fitted using seven system-level variables with and without including school- and student-level socio-economic and demographic background variables (Table A6.4a). Models in Table A6.4b are fitted using five system-level variables without including two system-level variables for which many countries do not have data.

As presented in Figure IV.2.10, some system-level characteristics are related each other. After accounting for other system-level variables, therefore, certain attributes lose statistical significance. The percentage of student in schools that transfer student to other schools due to low achievement, behavioural problems or special learning needs and teachers' salaries relative to GDP per capita remain significantly related to performance even after including other system-level variables (Model 1 in Table A6.4a). Further accounting for student- and school-level background variables, the existence of standards-based external examinations and teachers' salaries are significantly related to performance at least at the 10% level (Model 2 in Table A6.4a).

Even though these models include other variables to be accounted for, the relationships assessed do not imply a causal link. Although this link can be supported with evidence from other studies or theoretical arguments, the inability to establish causal relationships is inherent in a cross-sectional study like PISA and is true at any level of analysis. It is particularly true, however, at the system-level because the array of variables that have been measured is limited, the literature regarding the relationship between system-level variables and performance is limited, and the limited number of cases increases the risk of omitted variables being associated with the particularities of one or two specific cases.

[Part 1/1]


**Bivariate zero-order correlations between system-level characteristics and average performance in reading, mathematics and science (OECD countries)**

Table A6.1

			Reading performance		Mathematics performance		Science performance	
			Without accounting for GDP/capita	With accounting for GDP/capita	Without accounting for GDP/capita	With accounting for GDP/capita	Without accounting for GDP/capita	With accounting for GDP/capita
Selecting and grouping students	Vertical differentiation	Average age of entry into primary school	-0.21	-0.15	-0.08	0.02	-0.15	-0.08
		Percentage of students who repeated one or more grades	-0.32	<b>-0.39</b>	-0.22	-0.31	-0.30	<b>-0.37</b>
	Horizontal differentiation at the system level	Each additional year of selection prior to the age of 15	-0.19	-0.18	0.09	0.11	-0.02	-0.01
		Number of school types or distinct educational programmes available for 15-year-olds	-0.20	-0.23	0.07	0.05	-0.06	-0.08
		Percentage of students in selective schools	-0.08	-0.06	0.08	0.12	0.05	0.08
	Horizontal differentiation at the school level	Percentage of students in schools that group students by ability in all subjects	-0.29	<b>-0.42</b>	-0.16	-0.32	-0.27	<b>-0.4</b>
		Percentage of students in schools that transfer students to other schools due to low achievement, behavioural problems or special learning needs	<b>-0.53</b>	<b>-0.61</b>	-0.33	<b>-0.42</b>	<b>-0.46</b>	<b>-0.53</b>
School governance	School autonomy	Average index of school responsibility for curriculum and assessment and assessment	<b>0.45</b>	<b>0.49</b>	<b>0.43</b>	<b>0.49</b>	<b>0.51</b>	<b>0.56</b>
		Average index of school responsibility for resource allocation	0.02	0.03	0.07	0.08	0.11	0.13
	School competition	Percentage of students in schools that compete with other schools in the same area	0.06	0.10	-0.01	0.05	0.06	0.11
		Percentage of students in private schools	0.05	0.04	-0.01	-0.04	0.05	0.03
Assessment and accountability policies	Use of standardised assessments	Percentage of students in schools that assess students with standardised tests	0.15	0.14	-0.01	-0.03	-0.01	-0.03
		Existence of standards-based external examinations	<i>0.32</i>	<i>0.32</i>	<i>0.28</i>	<i>0.28</i>	<b>0.35</b>	<i>0.35</i>
	Percentage of students in schools that use assessment or achievement data to:	Provide comparative information to parents (relative to national/regional population)	0.08	0.15	-0.12	-0.04	-0.02	0.04
		Compare the school with other schools	0.02	0.06	-0.10	-0.06	-0.02	0.02
		Monitor progress over time	-0.09	0.04	-0.28	-0.15	-0.15	-0.03
		Post achievement data publicly	0.04	0.03	-0.11	-0.12	-0.03	-0.04
		Have their progress tracked by administrative authorities	-0.14	-0.12	-0.28	-0.25	-0.23	-0.21
		Make curricular decisions	-0.03	0.04	-0.16	-0.08	-0.08	-0.02
		Allocate resources	-0.08	-0.09	-0.31	-0.34	-0.19	-0.20
		Monitor teacher practices	-0.17	-0.05	-0.25	-0.09	-0.15	-0.02
Resources invested in education	Average number of minutes per week spent in regular school lessons on the language of instruction		-0.04	-0.02	-0.24	-0.22	-0.22	-0.20
	Percentage of students who take after-school lessons for:	enrichment	-0.22	-0.12	<b>-0.39</b>	-0.28	<b>-0.36</b>	-0.28
		remedial purposes	-0.07	0.00	-0.09	0.03	-0.09	0.00
	Average class size for the language of instruction		-0.22	-0.13	-0.33	-0.22	-0.24	-0.15
	Average index of extra-curricular activities		0.22	0.26	0.15	0.21	0.26	<i>0.31</i>
	Teachers' salaries relative to GDP/capita (weighted average of upper and lower secondary school teachers')		<b>0.40</b>	<b>0.39</b>	<b>0.53</b>	<b>0.54</b>	<b>0.48</b>	<b>0.48</b>
Cumulative expenditure by educational institutions per student aged 6 to 15		<i>0.30</i>	0.21	<b>0.44</b>	<b>0.35</b>	<i>0.34</i>	0.26	

Note: Values that are statistically significant at the 10% level ( $p < 0.10$ ) are indicated in italics and at the 5% level ( $p < 0.05$ ) are in bold.

1. The average is computed by weighting teachers' salaries for upper and lower secondary school according to the respective 15-year-old students' enrolment (for countries with valid information on whether 15-year-old students are both at the upper and lower secondary levels).

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[Part 1/2]


## Bivariate rank-order correlations between system-level characteristics and educational outcomes

Table A6.2 (OECD countries)

			Reading performance		Variance in reading performance explained by the PISA index of economic, social and cultural status of students		Variance in reading performance explained by the PISA index of economic, social and cultural status of students and schools		Change in reading performance per unit increase in the PISA index of economic, social and cultural status of students	
			Without accounting for GDP/capita	With accounting for GDP/capita	Without accounting for GDP/capita	With accounting for GDP/capita	Without accounting for GDP/capita	With accounting for GDP/capita	Without accounting for GDP/capita	With accounting for GDP/capita
Selecting and grouping students	Vertical differentiation	Average age of entry into primary school	-0.22	-0.08	0.11	0.03	0.27	0.19	-0.11	-0.02
		Percentage of students who repeated one or more grades	<b>-0.34</b>	<b>-0.39</b>	<b>0.58</b>	<b>0.60</b>	<b>0.38</b>	<b>0.41</b>	0.03	0.02
	Horizontal differentiation at the system level	Each additional year of selection prior to the age of 15	-0.25	-0.24	<b>0.42</b>	<b>0.41</b>	0.81	0.82	<b>0.36</b>	<b>0.39</b>
		Number of school types or distinct educational programmes available for 15-year-olds	-0.30	-0.32	0.28	0.28	0.74	0.76	0.25	0.27
		Percentage of students in selective schools	-0.13	-0.09	0.17	0.15	0.70	0.70	<i>0.34</i>	<b>0.38</b>
	Horizontal differentiation at the school level	Percentage of students in schools that group students by ability in all subjects	-0.24	-0.29	0.14	0.16	0.26	0.29	-0.19	-0.21
		Percentage of students in schools that transfer students to other schools due to low achievement, behavioural problems or special learning needs	<b>-0.56</b>	<b>-0.52</b>	<b>0.47</b>	<b>0.44</b>	0.73	0.71	0.16	0.24
School governance	School autonomy	Average index of school responsibility for curriculum and assessment	<b>0.41</b>	<b>0.46</b>	-0.30	-0.31	-0.08	-0.09	<i>0.32</i>	<i>0.34</i>
		Average index of school responsibility for resource allocation	0.12	0.11	0.04	0.05	0.04	0.05	<b>0.35</b>	<b>0.35</b>
	School competition	Percentage of students in schools that compete with other schools in the same area	0.22	0.29	-0.02	-0.04	0.20	0.18	0.26	<i>0.30</i>
		Percentage of students in private schools	-0.03	-0.12	0.14	0.19	0.12	0.18	0.14	0.10
Assessment and accountability policies	Use of standardised assessments	Percentage of students in schools that assess students with standardised tests	0.16	0.15	-0.14	-0.13	<b>-0.36</b>	<b>-0.36</b>	-0.19	-0.21
		Existence of standards-based external examinations	0.20	0.25	<b>-0.30</b>	<b>-0.33</b>	-0.07	-0.09	0.02	0.04
	Percentage of students in schools that use assessment or achievement data to:	Provide comparative information to parents (relative to national/regional population)	0.07	0.16	0.03	-0.01	-0.21	-0.27	0.00	0.05
		Compare the school with other schools	-0.09	0.08	0.06	-0.03	-0.17	<b>-0.31</b>	0.00	0.12
		Monitor progress over time	0.02	0.11	-0.10	-0.15	<b>-0.35</b>	<b>-0.42</b>	-0.05	0.00
		Post achievement data publicly	0.03	0.02	0.17	0.18	-0.11	-0.11	0.10	0.10
		Have their progress tracked by administrative authorities	-0.07	-0.11	0.25	0.28	-0.15	-0.13	0.09	0.07
		Make curricular decisions	-0.02	0.06	0.07	0.03	<b>-0.36</b>	<b>-0.43</b>	-0.08	-0.03
		Allocate resources	0.14	0.28	0.04	-0.03	-0.21	<b>-0.30</b>	-0.01	0.07
		Monitor teacher practices	-0.08	0.18	0.04	-0.10	0.08	-0.08	0.04	0.22
Resources invested in education	Average number of minutes per week spent in regular school lessons on the language of instruction		0.09	0.13	0.02	0.01	-0.34	<b>-0.37</b>	-0.23	-0.22
	Percentage of students who take after-school lessons for:	enrichment	<b>-0.31</b>	-0.08	-0.13	<b>-0.35</b>	0.01	-0.21	-0.23	-0.11
		remedial purposes	<b>-0.31</b>	-0.14	-0.08	-0.22	0.21	0.10	-0.15	-0.03
	Average class size for the language of instruction		-0.17	0.02	0.17	0.09	<b>0.34</b>	0.26	0.12	0.26
	Average index of extra-curricular activities		0.12	0.25	0.20	0.15	0.14	0.07	0.23	0.32
	Teachers' salaries relative to GDP/capita (weighted average of upper and lower secondary school teachers')		0.31	0.31	0.25	0.26	0.21	0.23	-0.05	-0.05
	Cumulative expenditure by educational institutions per student aged 6 to 15		0.28	-0.16	-0.13	0.10	-0.13	0.20	0.20	-0.02

Note: Values that are statistically significant at the 10% level ( $p < 0.10$ ) are indicated in italics and at the 5% level ( $p < 0.05$ ) are in bold.

1. The average is computed by weighting teachers' salaries for upper and lower secondary school according to the respective 15-year-old students' enrolment (for countries with valid information on whether 15-year-old students are both at the upper and lower secondary levels).

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[Part 2/2]


## Bivariate rank-order correlations between system-level characteristics and educational outcomes

Table A6.2 (OECD countries)

			Change in reading performance per unit increase in the PISA index of economic, social and cultural status of schools		Change in reading performance per unit increase in the PISA index of economic, social and cultural status of students in the average school		Standard deviation of reading performance		Percentage of variance in reading performance that lies between schools	
			Without accounting for GDP/capita	With accounting for GDP/capita	Without accounting for GDP/capita	With accounting for GDP/capita	Without accounting for GDP/capita	With accounting for GDP/capita	Without accounting for GDP/capita	With accounting for GDP/capita
Selecting and grouping students	Vertical differentiation	Average age of entry into primary school	0.06	0.08	-0.27	-0.11	<b>-0.37</b>	-0.24	0.20	0.09
		Percentage of students who repeated one or more grades	0.10	0.10	-0.29	-0.33	0.08	0.07	<b>0.39</b>	<b>0.42</b>
	Horizontal differentiation at the system level	Each additional year of selection prior to the age of 15	0.64	0.64	<b>-0.53</b>	<b>-0.55</b>	0.00	0.04	0.70	0.71
		Number of school types or distinct educational programmes available for 15-year-olds	<b>0.63</b>	<b>0.63</b>	<b>-0.58</b>	<b>-0.63</b>	0.07	0.09	0.73	0.76
		Percentage of students in selective schools	0.73	0.74	<b>-0.59</b>	<b>-0.61</b>	0.07	0.14	0.72	0.73
	Horizontal differentiation at the school level	Percentage of students in schools that group students by ability in all subjects	0.20	0.20	<b>-0.36</b>	<b>-0.43</b>	0.10	0.08	0.28	0.32
		Percentage of students in schools that transfer students to other schools due to low achievement, behavioural problems or special learning needs	<b>0.47</b>	<b>0.50</b>	-0.65	<b>-0.62</b>	0.10	0.25	0.71	0.69
School governance	School autonomy	Average index of school responsibility for curriculum and assessment	0.29	0.29	0.15	0.19	0.13	0.17	-0.04	-0.05
		Average index of school responsibility for resource allocation	0.23	0.23	0.15	0.14	0.06	0.04	-0.03	-0.02
	School competition	Percentage of students in schools that compete with other schools in the same area	<b>0.42</b>	<b>0.43</b>	-0.18	-0.14	0.10	0.19	0.28	0.25
		Percentage of students in private schools	0.21	0.21	-0.05	-0.15	0.01	-0.10	0.20	0.28
Assessment and accountability policies	Use of standardised assessments	Percentage of students in schools that assess students with standardised tests	<b>-0.36</b>	<b>-0.36</b>	<b>0.45</b>	<b>0.47</b>	-0.22	-0.28	<b>-0.46</b>	<b>-0.47</b>
		Existence of standards-based external examinations	0.12	0.13	0.08	0.12	-0.05	-0.02	-0.09	-0.12
	Percentage of students in schools that use assessment or achievement data to:	Provide comparative information to parents (relative to national/regional population)	-0.20	-0.20	0.29	<b>0.41</b>	-0.14	-0.07	-0.29	<b>-0.37</b>
		Compare the school with other schools	-0.18	-0.18	0.16	<b>0.41</b>	-0.05	0.18	-0.15	-0.32
		Monitor progress over time	-0.23	-0.23	0.27	<b>0.41</b>	0.05	0.17	-0.30	<b>-0.39</b>
		Post achievement data publicly	-0.11	-0.11	0.28	<i>0.30</i>	-0.08	-0.11	-0.23	-0.24
		Have their progress tracked by administrative authorities	-0.08	-0.08	0.28	0.27	0.10	0.07	-0.16	-0.14
		Make curricular decisions	<i>-0.34</i>	<i>-0.34</i>	<b>0.39</b>	<b>0.54</b>	-0.08	0.01	<b>-0.40</b>	<b>-0.50</b>
		Allocate resources	-0.16	-0.15	0.25	<b>0.43</b>	-0.20	-0.07	-0.32	<b>-0.44</b>
Monitor teacher practices	0.16	0.21	-0.14	0.13	-0.17	0.13	0.13	-0.06		
Resources invested in education	Average number of minutes per week spent in regular school lessons on the language of instruction		<b>-0.34</b>	<i>-0.34</i>	0.22	0.28	-0.02	0.02	<b>-0.34</b>	<b>-0.38</b>
	Percentage of students who take after-school lessons for:	enrichment	-0.04	-0.02	-0.25	0.04	-0.16	0.18	0.13	-0.09
		remedial purposes	0.16	0.21	<b>-0.45</b>	-0.29	-0.10	0.18	0.33	0.21
	Average class size for the language of instruction		<i>0.33</i>	<b>0.39</b>	<b>-0.40</b>	-0.24	-0.12	0.11	<b>0.42</b>	<i>0.33</i>
	Average index of extra-curricular activities		0.21	0.23	0.02	0.15	0.12	0.29	0.10	0.01
	Teachers' salaries relative to GDP/capita (weighted average of upper and lower secondary school teachers')		0.17	0.18	-0.15	-0.17	-0.21	-0.22	0.16	0.18
	Cumulative expenditure by educational institutions per student aged 6 to 15		0.08	0.11	0.28	-0.24	<b>0.45</b>	0.13	-0.22	0.10

Note: Values that are statistically significant at the 10% level ( $p < 0.10$ ) are indicated in italics and at the 5% level ( $p < 0.05$ ) are in bold.

1. The average is computed by weighting teachers' salaries for upper and lower secondary school according to the respective 15-year-old students' enrolment (for countries with valid information on whether 15-year-old students are both at the upper and lower secondary levels).


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[Part 1/1]

Table A6.3 OLS regressions with selected system-level variables

	Model 1 (OLS regression estimates)		Model 2 (OLS regression estimates)	
	Coef.	S.E.	Coef.	S.E.
Intercept	<b>460</b>	(17.07)	<b>486</b>	(8.91)
Percentage of students who repeated one or more grades	-0.49	(0.39)	-0.12	(0.38)
Percentage of students in schools that transfer students to other schools due to low achievement, behavioural problems or special learning needs	-0.39	(0.19)	<b>-0.51</b>	(0.24)
Percentage of students in schools that group students by ability in all subjects	-0.01	(0.36)	-0.35	(0.36)
Average index of school responsibility for curriculum and assessment	4.07	(6.65)	<b>10.33</b>	(6.20)
Existence of standards-based external examinations	1.51	(8.94)		
Teachers' salaries relative to GDP/capita	<b>31.52</b>	(10.50)		
GDP/capita (in thousands)	0.29	(0.31)	<b>0.73</b>	(0.25)
R <sup>2</sup>	0.58		0.50	
N	26		33	

Note: Values that are statistically significant at the 10% level ( $p < 0.10$ ) are indicated in italics and at the 5% level ( $p < 0.05$ ) are in bold.  
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[Part 1/1]

Table A6.4a Mixed-effects models with seven system-level variables


	Model 1 (mixed-effects estimates)		Model 2 (mixed-effects estimates)	
	Coef.	S.E.	Coef.	S.E.
Intercept	<b>457</b>	(14.04)	<b>400</b>	(18.70)
<b>System level</b>				
Percentage of students who repeated one or more grades	-0.28	(0.32)	0.39	(0.42)
Percentage of students in schools that transfer students to other schools due to low achievement, behavioural problems or special learning needs	<b>-0.39</b>	(0.16)	-0.02	(0.21)
Percentage of students in schools that group students by ability in all subjects	-0.15	(0.30)	-0.23	(0.40)
Average index of school responsibility for curriculum and assessment	-0.34	(5.46)	-5.09	(7.27)
Existence of standards-based external examinations	-2.17	(7.33)	<b>15.77</b>	(9.77)
Teachers' salaries relative to GDP/capita	<b>30.38</b>	(8.62)	<b>43.60</b>	(11.48)
GDP/capita (in thousands)	0.30	(0.25)	<b>-0.86</b>	(0.34)
<b>School level</b>				
School size (100 students)			<b>1.46</b>	(0.05)
School average PISA index of economic, social and cultural status			<b>66.21</b>	(0.51)
School in a city (100 000 or more people)			<b>-2.55</b>	(0.52)
School in a small town or village (15 000 or fewer people)			<b>4.94</b>	(0.52)
<b>Student level</b>				
PISA index of economic, social and cultural status of student (ESCS)			<b>19.17</b>	(0.22)
Student is a female			<b>36.32</b>	(0.35)
Student's language at home is the same as the language of assessment			<b>16.87</b>	(0.77)
Student without an immigrant background			<b>12.22</b>	(0.68)
N countries	26		26	
N observations	207 519		187 240	

Note: Values that are statistically significant at the 10% level ( $p < 0.10$ ) are indicated in italics and at the 5% level ( $p < 0.05$ ) are in bold.  
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[Part 1/1]

Table A6.4b Mixed-effects models with five system-level variables

	Model 1 (mixed-effects estimates)		Model 2 (mixed-effects estimates)	
	Coef.	S.E.	Coef.	S.E.
Intercept	<b>483</b>	(9.25)	<b>466</b>	(9.54)
<b>System level</b>				
Percentage of students who repeated one or more grades	-0.02	(0.40)	0.42	(0.41)
Percentage of students in schools that transfer students to other schools due to low achievement, behavioural problems or special learning needs	-0.45	(0.25)	-0.12	(0.25)
Percentage of students in schools that group students by ability in all subjects	-0.41	(0.37)	0.06	(0.38)
Average index of school responsibility for curriculum and assessment	5.54	(6.42)	-1.40	(6.60)
GDP/capita (in thousands)	<b>0.69</b>	(0.26)	<b>-0.84</b>	(0.27)
<b>School level</b>				
School size (100 students)			<b>1.2</b>	(0.04)
School average PISA index of economic, social and cultural status			<b>59.3</b>	(0.39)
School in a city (100 000 or more people)			<b>-3.0</b>	(0.43)
School in a small town or village (15 000 or fewer people)			<b>3.1</b>	(0.44)
<b>Student level</b>				
PISA index of economic, social and cultural status of student (ESCS)			<b>17.7</b>	(0.18)
Student is a female			<b>35.4</b>	(0.29)
Student's language at home is the same as the language of assessment			<b>16.7</b>	(0.65)
Student without an immigrant background			<b>12.2</b>	(0.58)
N countries	33		33	
N observations	294 156		267 553	

Note: Values that are statistically significant at the 10% level ( $p < 0.10$ ) are indicated in italics and at the 5% level ( $p < 0.05$ ) are in bold.  
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## AGGREGATION BIAS

Aggregation bias can occur when variables measured at a lower level (for example, student or school level) are used to make inferences at a higher level (for instance, country or system level). These lower-level variables are aggregated through a summary statistic, such as the mean or proportion, and used as a system-level characteristic in the analyses. One of the risks of aggregation bias is that the aggregated measures confounds both student- and school-level relationships with system-level relationships. System-level relationships may thus be the result of the aggregation of student-level relationships rather than an independent system-level effect. The analyses displayed on Table IV.2.1, for example, are at risk of aggregation bias.


In Table IV.2.1 the relationships between reading performance and grade-repetition rates, student transfer rates, ability grouping and school autonomy for curricular and assessment policies are subject to aggregation bias. Grade-repetition rates are obtained by aggregating students' responses. Student-transfer rates, ability grouping and school autonomy for curricula and assessments are obtained by aggregating school principals' responses (Annex A1). To assess the existence of aggregation bias, these relationships are estimated through mixed-effect models using both the aggregated and non-aggregated variables with and without including the student- and school-level background variables (Models 2 and 3 in Tables A.6.5a to A6.5d). All mixed effects models allow for random estimates at the school and system levels. OLS estimates using only the aggregated variables are presented for comparison purposes. The OLS estimates are used in the report and the similarity between estimates in Model 1 and Models 2 and 3 provide evidence that there is little to no aggregation bias in the estimates used in the report. These models are displayed in Table A6.5a for grade-repetition rates, in Table A6.5b for student-transfer rates, in Table A6.5c for ability grouping and in Table A6.5d for school autonomy for curricular and assessment policies.

[Part 1/1]  
Table A6.5a **Model including grade repetition at both the system and student levels**

	Model 1 (OLS regression estimates)		Model 2 (mixed-effects estimates)		Model 3 (mixed-effects estimates)	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
<b>Intercept</b>	<b>485</b>	(9.98)	<b>482</b>	(9.23)	<b>432</b>	(9.44)
<b>System level</b>						
Percentage of students who repeated one or more grades	<b>-0.75</b>	(0.32)	<b>-0.67</b>	(0.31)	<b>-0.80</b>	(0.32)
GDP/capita (in thousands)	<i>0.56</i>	(0.29)	<b>0.54</b>	(0.26)	<b>0.76</b>	(0.27)
<b>School level</b>						
School size (100 students)					<b>1.09</b>	(0.04)
School average PISA index of economic, social and cultural status <sup>1</sup>					<b>54.17</b>	(0.39)
School in a city (100 000 or more people)					<b>-2.08</b>	(0.42)
School in a small town or village (15 000 or fewer people)					<b>3.31</b>	(0.42)
<b>Student level</b>						
Students who repeated one or more grades <sup>1</sup>					<b>-0.57</b>	(0.00)
PISA index of economic, social and cultural status of student (ESCS) <sup>1</sup>					<b>16.34</b>	(0.18)
Student is a female					<b>33.46</b>	(0.28)
Student's language at home is the same as the language of assessment					<b>15.86</b>	(0.63)
Student without an immigrant background					<b>9.98</b>	(0.57)
N countries	34		34		34	
N observations	-		294 156		267 553	

Notes: Values that are statistically significant at the 10% level ( $p < 0.10$ ) are indicated in italics and at the 5% level ( $p < 0.05$ ) are in bold.

1. This variable is group-mean centred around the system-level means so that within each system the average of this variable is zero (i.e. the system-level means of the variable is subtracted from the variable).


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[Part 1/1]  
Table A6.5b **Model including student transfers at both the system and school levels**

	Model 1 (OLS regression estimates)		Model 2 (mixed-effects estimates)		Model 3 (mixed-effects estimates)	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
<b>Intercept</b>	<b>488</b>	(8.79)	<b>485</b>	(8.35)	<b>430</b>	(8.66)
<b>System level</b>						
Percentage of students in schools that transfer students to other schools due to low achievement, behavioural problems or special learning needs	<b>-0.82</b>	(0.20)	<b>-0.68</b>	(0.19)	<b>-0.71</b>	(0.19)
GDP/capita (in thousands)	<b>0.62</b>	(0.25)	<b>0.58</b>	(0.24)	<b>0.79</b>	(0.25)
<b>School level</b>						
Percentage of students in schools that transfer students to other schools due to low achievement, behavioural problems or special learning needs <sup>1</sup>					<i>0.96</i>	(0.49)
School size (100 students)					<b>1.23</b>	(0.04)
School average PISA index of economic, social and cultural status <sup>1</sup>					<b>59.31</b>	(0.39)
School in a city (100 000 or more people)					<b>-3.06</b>	(0.43)
School in a small town or village (15 000 or fewer people)					<b>3.07</b>	(0.44)
<b>Student level</b>						
PISA index of economic, social and cultural status of student (ESCS) <sup>1</sup>					<b>17.68</b>	(0.18)
Student is a female					<b>35.35</b>	(0.29)
Student's language at home is the same as the language of assessment					<b>16.74</b>	(0.65)
Student without an immigrant background					<b>12.16</b>	(0.58)
N countries	33		33		33	
N observations	-		294 156		267 553	

Notes: Values that are statistically significant at the 10% level ( $p < 0.10$ ) are indicated in italics and at the 5% level ( $p < 0.05$ ) are in bold.

1. This variable is group-mean centred around the system-level means so that within each system the average of this variable is zero (i.e. the system-level means of the variable is subtracted from the variable).

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[Part 1/1]

Table A6.5c Model including ability grouping at both the system and student levels

	Model 1 (OLS regression estimates)		Model 2 (mixed-effects estimates)		Model 3 (mixed-effects estimates)	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
<b>Intercept</b>	<b>482</b>	(9.81)	<b>479</b>	(8.79)	<b>425</b>	(9.23)
<b>System level</b>						
Percentage of students in schools that group students by ability in all subjects	<b>-0.80</b>	(0.32)	<b>-0.74</b>	(0.29)	<b>-0.79</b>	(0.30)
GDP/capita (in thousands)	<b>0.69</b>	(0.30)	<b>0.67</b>	(0.27)	<b>0.89</b>	(0.28)
<b>School level</b>						
School that groups students by ability in all subjects <sup>1</sup>					<b>-3.74</b>	(0.54)
School size (100 students)					<b>1.23</b>	(0.04)
School average PISA index of economic, social and cultural status <sup>1</sup>					<b>59.08</b>	(0.40)
School in a city (100 000 or more people)					<b>-3.24</b>	(0.43)
School in a small town or village (15 000 or fewer people)					<b>2.80</b>	(0.44)
<b>Student level</b>						
PISA index of economic, social and cultural status of student (ESCS) <sup>1</sup>					<b>17.69</b>	(0.18)
Student is a female					<b>35.29</b>	(0.29)
Student's language at home is the same as the language of assessment					<b>16.76</b>	(0.65)
Student without an immigrant background					<b>12.18</b>	(0.59)
N countries	33		33		33	
N observations	-		294 156		265 538	

Notes: Values that are statistically significant at the 10% level ( $p < 0.10$ ) are indicated in italics and at the 5% level ( $p < 0.05$ ) are in bold.

1. This variable is group-mean centred around the system-level means so that within each system the average of this variable is zero (i.e. the system-level means of the variable is subtracted from the variable).

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[Part 1/1]

Table A6.5d Model including school responsibility for curriculum and assessment at both the system and school levels

	Model 1 (OLS regression estimates)		Model 2 (mixed-effects estimates)		Model 3 (mixed-effects estimates)	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
<b>Intercept</b>	<b>478</b>	(9.40)	<b>477</b>	(9.03)	<b>421</b>	(9.15)
<b>System level</b>						
Average index of school responsibility for curriculum and assessment	<b>17.98</b>	(5.86)	<b>11.87</b>	(5.61)	<b>15.11</b>	(5.67)
GDP/capita (in thousands)	<i>0.51</i>	(0.27)	<i>0.48</i>	(0.26)	<b>0.70</b>	(0.26)
<b>School level</b>						
Index of school responsibility for curriculum and assessment <sup>1</sup>					0.05	(0.21)
School size (100 students)					<b>1.21</b>	(0.04)
School average PISA index of economic, social and cultural status <sup>1</sup>					<b>59.24</b>	(0.39)
School in a city (100 000 or more people)					<b>-3.17</b>	(0.43)
School in a small town or village (15 000 or fewer people)					<b>2.91</b>	(0.44)
<b>Student level</b>						
PISA index of economic, social and cultural status of student (ESCS) <sup>1</sup>					<b>17.67</b>	(0.18)
Student is a female					<b>35.33</b>	(0.29)
Student's language at home is the same as the language of assessment					<b>16.73</b>	(0.65)
Student without an immigrant background					<b>12.33</b>	(0.58)
N countries	33		33		33	
N observations	-		294 156		267 425	

Notes: Values that are statistically significant at the 10% level ( $p < 0.10$ ) are indicated in italics and at the 5% level ( $p < 0.05$ ) are in bold.

1. This variable is group-mean centred around the system-level means so that within each system the average of this variable is zero (i.e. the system-level means of the variable is subtracted from the variable).

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Including the original level of measurement, the aggregated variables and student and school background characteristics does not alter the findings of the report. The direction and statistical significance of the correlation analysis are robust to these more complex specifications that account for aggregation bias.

## DIFFERENT DIRECTIONS IN RELATIONSHIPS AT THE SCHOOL AND SYSTEM LEVELS

In some analyses, the direction of the relationship between a system-level aggregated organisational attribute and reading performance is not consistent with the direction of the variable at the student or school level (in its original level of measurement) with students' reading performance. This should not be a cause of concern.

From a theoretical perspective, the relationship at the system level is not necessarily the same as the relationships at the school level within countries. For example, at the system level, transfer rates may be negatively related to performance because schools have fewer incentives to commit to student learning (Table IV.2.1). In school systems where transfers are common, it is likely that the responsibility for promotion lies mostly in the students and less in the teachers and schools. This hypothesis suggests that higher transfer rates produce a learning environment where teachers and schools are less committed to assisting individual students and where students can be segregated.



This system-level relationship is not necessarily mirrored in the school-level relationship in some countries. At the school level within countries, schools that transfer students tend to perform lower in one country and one economy, while schools that transfer students tend to perform better in three countries (Denmark, Switzerland and the partner country Indonesia, Table IV.2.2c). The negative relationship between schools' transferring students and schools' performance in some school systems could be explained by the same hypothesis as the one at the system-level relationship. It is also possible to explain this negative relationship as a result of selection: schools that transfer students perform worse than schools that do not because the former may have a larger intake of low-performing students who are then transferred to other schools.

In contrast, the positive relationship between schools' transferring students and schools' performance in three countries could be explained as follows: low-performing students are transferred out of schools that transfer students, thus those schools' average performance is higher by virtue of selection. In these countries, high- and low-performing students seem to be redistributed into different schools through the practice of transferring students, which results in the performance difference between schools that transfer students and schools that do not transfer students.

When this school-level result is considered together with the system-level results, it becomes clear that individual schools that transfer students might benefit from this practice in some countries, but systems as a whole may not benefit from this practice.

For the other relationships using aggregated variables in Chapter 2, similar arguments can be established. The relationships are studied at both the school and system levels; studying these levels independently provides similar insights to those that stem from more complex analyses that combine both levels (see Tables A6.5a, A6.5b, A6.5c and A6.5d). Studying the relationship at both levels, either simultaneously in mixed-effects models or independently as done in the report, not only provides an honest picture of the relationships, it also signals the complexity behind educational policies and practices.

These processes explaining the observed relationships remain hypothetical, and the report should be interpreted as an invitation to further study by providing some ideas about the processes that may underlie the observed relationships.