3

A Profile of Student Resilience

INTRODUCTION

Chapter 2 characterised resilience and contrasted it with low performance among disadvantaged students. It also explored differences in the main individual background characteristics between these two groups of disadvantaged students: resilient and disadvantaged low achievers.

This chapter extends this analysis to student approaches to learning and school factors that may be related to performance. In particular, the chapter examines whether differences in student approaches to learning, in student engagement in science courses and time spent learning science and learning environments at school, may help to explain performance differences between resilient and disadvantaged low achievers. Chapter 4 extends this analysis to all students and explores the factors that may help disadvantaged students close the achievement gap with more advantaged students.

The chapter is structured on the basis of three themes – approaches to learning, engagement in science courses, and learning environments at school – that may be associated with disadvantaged students being resilient. For each domain, the chapter first provides a brief description of the indicators available from PISA. These are generally in the form of indices based on the responses of students and the principals at their schools. It then explores the differences between resilient students and disadvantaged low achievers, both on the overall indices and on each of the single items used in the construction of the indices. Thirdly, the chapter analyses whether the indicators are associated with the probability that disadvantaged students will be resilient.[1]

With respect to students' approaches to learning, the chapter identifies four broad areas that the literature suggests are particularly associated with academic success among disadvantaged students: *i)* motivation to learn science, *ii)* engagement in science activities outside the school, *iii)* confidence in science abilities and *iv)* perspectives towards science-related careers. With respect to engagement in science courses, the second domain, the chapter examines *i)* the number of science courses students take and *ii)* the amount of time they spend learning science at school. And with respect to the learning environment at school, the third domain, the chapter considers school factors that are commonly believed to be associated with performance, in particular: *i)* school management, competition and admittance policies and *ii)* school resources.

The chapter concludes by developing a model which includes measures of all three areas (approaches to learning, hours spent and courses taken, and learning environment at school), aimed at evaluating whether the relationships found for each factor separately are robust to the inclusion of full information on students' circumstances.

STUDENTS' ATTITUDES AND BEHAVIOURS AND THE LEARNING ENVIRONMENT AT SCHOOL: DEFINITIONS AND OVERVIEW

As discussed in Chapter 1, empirical studies indicate that student approaches to learning, such as their motivation, engagement and confidence, as well as learning time are strongly associated with academic success. For example, students with greater motivation to learn, who have greater confidence in their abilities and who exert greater effort on their coursework tend to have higher achievement scores than students with less motivation and confidence and who put less effort into learning (Deci *et al.*,1991; Eccles *et al.*, 1998; OECD, 2003a; OECD, 2003b; OECD, 2009a).

The chapter identifies ten indices that describe students' approaches to learning and engagement in science courses: *i)* motivation to learn science, *ii)* engagement in science activities outside the school, *iii)* confidence in science abilities, *iv)* perspectives towards science-related careers, *v)* the number of science courses students take and *vi)* the amount of time they spend learning science at school. These indices are constructed using information on a subset of the measures included in the PISA student and school

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questionnaires that could potentially characterise how students approach science learning, the hours spent and the courses taken to learn science. The full array of constructs included within PISA was considered for this analysis with the selected indices chosen because the literature highlighted their relative importance in explaining the academic performance of resilient students. Details on the methods used to construct these indices can be found in the PISA 2006 Technical Report (OECD, 2009b).

Box 3.1. **Interpreting the PISA indices on students' approaches to learning**

The OECD constructed a set of indices to describe students' approaches to learning for which the average OECD student (*e.g.*, the student with an average level of interest) was given an index value of zero and about two-thirds of the OECD student population were between the values of -1 and 1 (*i.e.* the index has a standard deviation of 1). Therefore, if a student group has a negative mean index value, this does not necessarily imply that the student group responded negatively to the underlying questions. Rather, students in this group responded less positively than students on average across OECD countries. (The standardisation procedure on the indices was carried out using the full student population in OECD countries not just resilient and disadvantaged low achievers.) Likewise positive mean index values indicate that students in that group responded more positively on average than the average student among OECD countries. While every effort was made to make these indices comparable across countries, cultural differences may be reflected in results on the association between students' approaches to learning and academic success and therefore care should be taken when interpreting findings across countries (OECD, 2009b).

The number and type of courses in which students decide to enrol reflect both the way they approach learning as well as the school's learning environment. While in some cases students are required to take certain courses, in most circumstances students have the possibility to choose whether to take one course or the other. In this report, the measures capturing the number of courses and the time spent in regular classes are based on student reports. There are therefore certain limitations to the use of these data and the results presented below should be analysed with these caveats in mind. Still, these measures approximate an important element in how students approach and engage in learning at school, namely how they use their time there.

The PISA 2006 indices for the learning environment at school are based on school principals' reports and answers to the school questionnaire. They cover a broad range of issues, including the management and funding of the school, admittance policies and the quality and use of school resources. In particular, the report looks at five school learning environment variables: *i)* private/public management, *ii)* school competition, *iii)* admittance policies, *iv)* school resources and *v)* school activities to promote science learning. The report also uses some school variables that were produced by aggregating the answers of the students in the same school, such as the average socio-economic intake of the school. Annex A5 provides detailed definitions for each of these variables. The PISA 2006 report and the technical publications provide a full description of how these indices were constructed (OECD, 2007a, 2007b and 2009b).

PISA data on the learning environment at school present some limitations and this report can only address these issues up to a point. There are important contextual factors that international comparative surveys cannot capture. For example, PISA does not examine processes over time and the responses of the school principals refer to the circumstances that students might have faced for a relatively short period of time. Box 3.2 presents in more detail the limitations of these measures.

Except for courses and hours, all variables characterising students' approaches to learning are standardised to have a mean of zero and a standard deviation of 1 across OECD students. Negative values on these indices therefore indicate that the mean student group index value is below the average index value among OECD students. (See Box 3.1 for detailed information on how to interpret the indices and Annex A5 for a detailed description of these measures.)

Box 3.2. **Interpreting the data from schools and their relationship to student performance**

Several limitations of the information collected from principals should be taken into account in the interpretation of the data. On average, only 300 principals were surveyed in each OECD country and in seven countries fewer than 170 principals were surveyed. Although principals are able to provide information about their schools, generalising from a single source of information for each school (and then matching that information with students' reports) is not straightforward. Most importantly, students' performance usually relates to the work of many teachers in various subject areas.

The learning environment in which 15-year-olds find themselves and which PISA examines may only be partially indicative of the learning environment that shaped their educational experiences earlier in their schooling career, particularly in education systems where students progress through different types of educational institutions at the lower secondary and upper secondary levels. To the extent that the current learning environment of 15-year-olds differs from that of their earlier school years, the contextual data collected by PISA is an imperfect proxy for the cumulative learning environments of students and their association with learning outcomes is therefore likely to be underestimated.

The definition of the school in which students are taught is not straightforward in some countries, because 15-year-olds may be in different school types that vary in the level of education provided or the programme destination. Because of the manner in which students were sampled, the within-school variation includes variation between classes as well as variation between students.

The study of school resources requires precision that might not be easily captured in surveys, especially surveys with time restrictions that affect what can be requested of respondents. For example, a principal may not have accurate data on such matters as class sizes in specific subjects, nor the time or resources to gather such data. Moreover, it is important to associate specific resources with specific students rather than school averages to ascertain how a change in one type of resource might impact student performance.

The combination of these restrictions limits the ability of PISA to provide direct statistical estimates of the relationships of school resources with educational outcomes. Caution is therefore required in interpreting the school resource indicators bearing in mind that there are potential measurement problems and omitted variables. However, despite these caveats, the information from the school questionnaire can be instructive as it provides important insights into the ways in which national and sub-national authorities implement their educational objectives.

In using results from non-experimental data on school performance such as the PISA database, it is also important to bear in mind the distinction between school effects and the effects of schooling, particularly when interpreting the modest association between factors such as school resources,

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policies and institutional characteristics and student performance. The effect of schooling is the influence on performance of not being schooled versus being schooled, which can have significant impact not only on knowledge but also on fundamental cognition.

School effects are education researchers' shorthand way of referring to the effect on academic performance of attending one school or another, usually schools that differ in resources or policies or institutional characteristics. Where schools and school systems do not vary in fundamental ways, the school effect can be modest. Nevertheless, modest school effects should not be confused with a lack of an effect by schooling.

Where data based on reports from school principals or parents are presented in this report, it has been weighted so that it reflects the number of 15-year-olds enrolled in each school.

THE ANALYSIS: A BRIEF DESCRIPTION OF THE MODELS PRESENTED IN THIS CHAPTER

This chapter focuses on comparisons across disadvantaged students, namely between resilient students and disadvantaged low achievers. The goal is to provide an answer to these two questions: How are resilient and disadvantaged low achievers different in terms of the variables described above? And which of these factors are associated with the likelihood that a disadvantaged student will beat the odds? To address these questions, the chapter presents three perspectives, proceeding from general and simple comparison to more complex models that adjust for student and school characteristics. Annex A5 discusses all the details for each of these models.

First, the chapter presents the difference in raw measures as collected in the PISA student and school questionnaires. These can give a precise idea of what different groups of students responded on average to different questions. They provide a rough approximation to differences among both groups. Here the chapter reports simply the proportion of resilient and disadvantaged low achievers that responded a certain way to a particular question.

Second, the chapter explores differences in a range of PISA indices constructed to aggregate these answers along a broad set of issues. These differences are a good way to summarise the raw answers of students and school principals. They provide insights into how different these students are but they fail to account for factors other than the ones measured by these indices that may help explain those differences. Here the chapter looks at the difference in the average index for each of the two groups of students, resilient and disadvantaged low achievers.

Third, the chapter presents predictive models on the likelihood of being resilient. Box 3.3 describes how to interpret these results. These models go from a simple model including only the measure of interest to more complex models that adjust for student and school socio-economic and demographic characteristics.

STUDENT APPROACHES TO LEARNING

Student motivation to learn science

Students who are more motivated to learn science achieve higher levels of performance than students with less motivation (Deci and Ryan, 1985; OECD, 2007a; Wigfield *et al.*, 1998). In particular, disadvantaged students who are motivated are significantly more likely to be resilient than disadvantaged students who are not motivated (Connell *et al.*, 1994; Martin, 2002).

Two PISA indices characterise student motivation to learn science. The index of general interest in science is an indicator of students' internal motivation. Students' views of the importance of science for future academic and professional pursuits constitute the elements of the index of instrumental motivation to learn science, which captures students' external motivation.

Box 3.3. Interpreting predictive models on the likelihood of being resilient

The results for these predictive models are presented in terms of odds ratios. The odds ratios reported here compare the probability of being resilient for two groups of students. These two groups are identified by a one unit increase in the variable measuring the factor of interest. For variables such as gender or private school, a one unit increase is the difference between male and female or private and public schools. For the PISA indices, a unit difference is taken from the mean and represents a standard deviation increase in the index.

Odds ratios over one indicate that higher values of a particular factor are associated with a greater likelihood that a disadvantaged student will be resilient, while odds ratios below one are suggestive of a negative relationship between the factor and resilience. For example, if the estimated odds ratio for private is 2.0, this implies that students at private schools are two times more likely to be resilient than students at public schools.

By comparing estimates of the relationship between different factors and resilience obtained in the simple model and those adjusting for individual and school characteristics, the chapter examines to which extend the estimated relationships are explained by differences in individual characteristics and the schools which students attend.

The index of general interest in science combines students' responses on the extent to which they are interested or very interested in: topics in physics, topics in chemistry, the biology of plants, human biology, topics in astronomy, topics in geology, ways scientists design experiments and what is required for scientific explanations. Annex A5 includes the actual questions addressed to students.

Resilient students tend to show more interest in science topics than disadvantaged low achievers. While around 60% of resilient students in OECD countries report being interested in chemistry, astronomy and physics, less than 40% of disadvantaged low achievers show similar levels of interest. For partner countries and economies, with some exceptions, resilient and disadvantaged low achievers are not very different in terms of their interest in science topics (Table A2.1a). The greatest level of interest expressed is in relation to human biology – over 70% of resilient students and almost 60% of disadvantaged low achievers in OECD countries – while the least interest is in learning about what is required for scientific explanations – 40% of resilient students and less than 30% of disadvantaged low achievers. In all countries except Latvia and the Russian Federation, a larger share of resilient students expresses interest in human biology than disadvantaged low achievers. Differences are particularly large (above 20 percentage points) in Australia, Iceland, Ireland, Japan, Norway, Portugal and Switzerland among OECD countries and in Azerbaijan and Hong Kong-China among partner countries and economies. Similarly, in all countries and economies except the United States and Latvia a larger share of resilient students than disadvantaged low achievers is interested in learning about what is required for scientific explanations. Among OECD countries, differences across resilient and disadvantaged low achievers on this item are particularly pronounced in Australia, Denmark, Iceland, Ireland, Japan, Korea, Norway, Sweden and Spain while among partner countries and economies differences are particularly strong in Hong Kong-China and Chinese Taipei (Table A2.1a).

As Figure 3.1 shows, the higher levels of interest shown by resilient students in most topics result in higher average indice of general interest in science among resilient students than disadvantaged low achievers in all OECD countries. Furthermore, resilient students in all OECD countries except the Netherlands have mean index values that are above the OECD students' average, while the mean index values for disadvantaged

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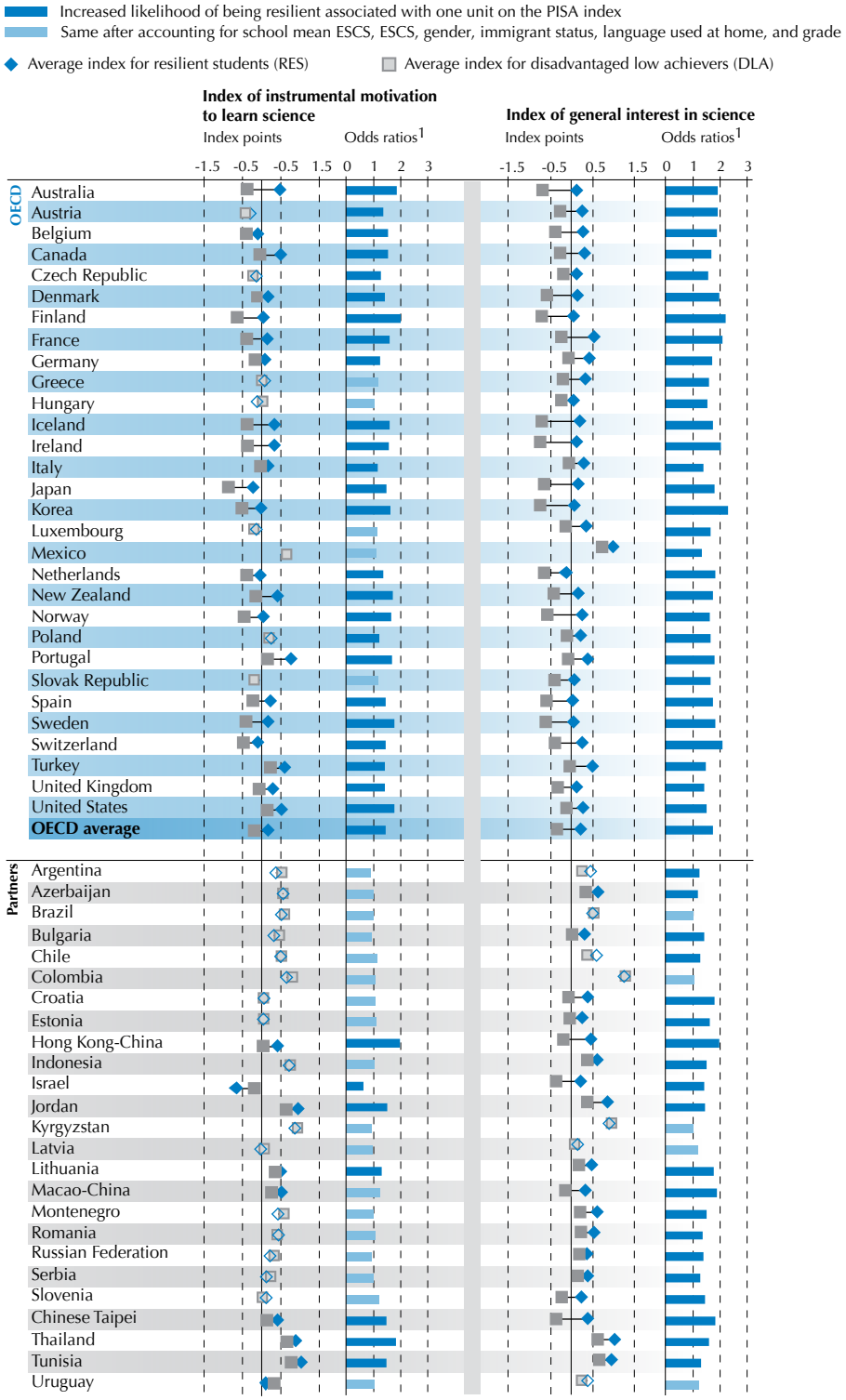
Figure 3.1
Internal and external motivation to learn science



1. Odds ratios stand for the increase in the likelihood of being resilient associated with an increase of one standard deviation in the index. The results reported here refer to the logistic regressions explained in Annex A2.
2. Statistically significant differences are marked in a darker tone.
Note: Countries have been ordered alphabetically.
Source: *OECD PISA 2006 Database*, Table A2.1c and Table A2.2c.

low achievers in all OECD countries (except Mexico) and some partner countries and economies are below the average of OECD students (Table A2.1b). Differences in means within all OECD countries and within 18 of the 25 partner countries and economies suggest that resilient students have greater general interest in science.[2] On average, across OECD countries, this difference is rather large, more than half of a standard deviation in the index and it is particularly marked in Australia, Denmark, Finland, France, Iceland, Ireland, Japan, Korea and Norway where it reaches more than three quarters of a standard deviation. This pattern is less marked among partner countries and economies with the exception of the partner economy Chinese Taipei where the difference in the index is close to three quarters of a standard deviation (Table A2.1b).

Disadvantaged students who have greater general interest in science (*i.e.* are internally motivated) are more likely to be resilient than disadvantaged students with low levels of internal motivation. This is quite a strong relationship. As Table A2.1c indicates, disadvantaged students in OECD countries who have a value on the index of general interest in science of 1 (that is a high value) are on average 1.66 times more likely to be resilient in science than the disadvantaged student who has an average interest in science. Apart from a few cases, odds ratios do not change dramatically across OECD countries when controlling for individual characteristics such as gender, immigration background, grade attended, language spoken and socio-economic background in the individual controls model (second column in Table A2.1c) and for the average socio-economic background of students attending the same school as the respondent in the full model (third column in Table A2.1c). The association between general interest in science and resilience is strongest in Korea where the estimated resilient odds ratio after accounting for school and student factors is 2.3. It is above two in Finland, France, Ireland and Switzerland. Except for Croatia, Lithuania, Macao-China and Chinese Taipei where the odds ratios are all above 1.75, estimated odds ratios in partner countries and economies are smaller and in some cases there appears to be no relationship between general interest in science and resilience (Table A2.1c).

The index of instrumental motivation to learn science measures the importance students attach to learning science for their own future academic and professional pursuits. This index combines students' responses on the extent to which they believe that making an effort in learning science will help them at work or in their future studies, will improve their career prospects and will help them find a job.

Both resilient students and disadvantaged low achievers appreciate the importance of scientific knowledge to achieve success in their future studies and in the labour market, but resilient students generally show a greater awareness of the career enhancing potential of science. For example, over 65% of resilient students in OECD countries agree that studying science will improve their career prospects while only less than 55% of disadvantaged low achievers do so. Resilient students in all OECD countries except Hungary perceive science as important for their future career, more so than disadvantaged low achievers. The difference is higher than 25 percentage points in four coun tries (Australia, Ireland, Korea and New Zealand). Most students believe that studying science is useful to them, but while over 70% of resilient students in OECD countries do so, only around 55% of disadvantaged low achievers agree on the usefulness of studying science (Table A2.2a). Among OECD countries, the difference between resilient and disadvantaged low achievers in the extent to which they believe learning science will help them in their future work is positive in all OECD countries except for the Czech Republic, Germany, Greece, Hungary, Luxembourg, Mexico, Poland and the Slovak Republic. This difference is particularly large in Australia, Finland, Iceland, Japan, Sweden and Portugal. In contrast, in most partner countries and economies disadvantaged low achievers report a higher awareness than resilient students on the extent to which learning science will help them in their future work. In 13 out of 25 partner countries and economies more disadvantaged low achievers than resilient students also report that studying science will improve their career prospects (Table A2.2a).

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As summarised by differences in values on the index of instrumental motivation to learn science (see Table A2.2b), resilient students express a greater degree of instrumental motivation to learn science than disadvantaged low achievers in the majority of OECD countries and to a lesser extent in partner countries and economies. Figure 3.1 also indicates that differences in levels of instrumental motivation between resilient and disadvantaged low achievers are generally fewer and smaller than they are for the index of general interest in science (*i.e.* internal motivation). In eight out of 30 OECD countries and six out of 15 partner countries and economies the differences apparent in relation to general interest disappear when external motivation is considered (Table A2.2c).

Contrary to the findings for internal motivation, in several OECD countries disadvantaged students with greater instrumental motivation to learn science are not performing better than other less externally motivated disadvantaged students. Figure 3.1 highlights that the estimated odds ratios for instrumental motivation are smaller than for internal motivation and that the association with resilience disappears in practically all partner countries and economies (Table A2.2c). In the base model where factors such as gender and immigrant background are not taken into account, disadvantaged students who believe learning science will help them in their future work have a greater likelihood of being resilient in 22 out of 30 OECD countries and in eight partner countries and economies. This relationship is moderately strong. When individual and school-level information is taken into account, the relationship between instrumental motivation and academic resilience is positive in a further three OECD countries (Austria, the Czech Republic and Poland) but falls somewhat in two countries (Japan and Portugal). The base model (first column of Table A2.2c) shows that disadvantaged students who believe learning science will help them in their future work have a greater likelihood of being resilient in only eight partner countries and economies, with no major shift in the strength of the association occurring when individual and school-level variables are added to the model.

The evidence presented in this section suggests that student motivation to learn science, internal motivation more so than external is associated with resilience in most OECD countries and in some partner countries and economies. Fostering motivation to learn science among disadvantaged students could therefore lead to improvements in performance.

Student engagement with science activities outside of school

Increased awareness of the connections between science and everyday life is associated with higher academic achievement as students become more engaged with the academic material (OECD, 2003b; OECD, 2007a). Research indicates that resilient students have higher rates of engagement with science than low performing disadvantaged students (Borman and Overman, 2004; Catterall, 1998). This section presents analyses of the relationship between student engagement with science and student resilience using the index of engagement in science-related activities. Student engagement with science is measured by the frequency of their involvement in the following science-related activities: watching TV programmes about science, borrowing or buying books on science topics, visiting websites about science topics, listening to radio programmes about advances in science, reading science magazines or science articles in newspapers and attending a science club.

Across most science-related activities, resilient students are more engaged than disadvantaged low achievers. As evident in Table A2.3a, on average a larger share of resilient students than disadvantaged low achievers reports watching TV programmes about science, borrowing or buying books about science and reading science magazines or science articles, while more disadvantaged low achievers than resilient students listen to radio programmes about advances in science and attend a science club (possibly because such clubs offer remedial courses to low-performing students).

Overall, students in OECD countries report fairly low levels of engagement in science activities outside of school. The most popular activities, watching TV programmes about science and reading science magazines or science articles, were reported on average by only around 25% of resilient students and less than 18% of disadvantaged low achievers. Across OECD countries, even fewer students borrow or buy books on science topics (9% of resilient students and 7% of disadvantaged low achievers), visit web sites about science (12% of resilient students and 9% of disadvantaged low achievers), listen to radio programmes about advances in science (5% of resilient students and 8% of disadvantaged low achievers) and attend a science club (3% of resilient students and 5% of disadvantaged low achievers) (Table A2.3a).

Levels of engagement are generally higher in partner countries and economies. For example, while approximately 25% of resilient students and 18% of disadvantaged low achievers in OECD countries watch TV programmes about science, many more do so in partner countries and economies (Table A2.3a). Across OECD countries only in Poland and Portugal do over half of all resilient students watch TV programmes about science, while the majority of resilient students in five partner countries and economies do so (Azerbaijan, Chile, Colombia, Kyrgyzstan and Thailand). Participation rates are higher in partner countries and economies, especially among disadvantaged low achievers. For example, over 30% of disadvantaged low achievers borrow or buy books about science topics in Argentina, Azerbaijan, Brazil, Colombia, Kyrgyzstan and Tunisia and listen to radio programmes about advances in science in Azerbaijan, Colombia, Jordan, Kyrgyzstan, Montenegro and Tunisia (Table A2.3a).

Using the index of engagement in science-related activities, Figure 3.2 shows that resilient students generally participate in more science-related activities than disadvantaged low achievers. In all OECD countries except Poland and Mexico, the index of engagement in science-related activities is higher for the average resilient student than for the average disadvantaged low-achieving students (Table A2.3b). On average across OECD countries, this difference is about a third of a standard deviation, ranging from 0.15 of a standard deviation in the Czech Republic to more than 0.70 of a standard deviation in Iceland. The pattern is weaker across partner countries and economies but similar in that resilient students appear to be more engaged in seven partner countries and economies. However, the opposite is true in Brazil, Kyrgyzstan and Tunisia (Table A2.3b).

Figure 3.2 shows that disadvantaged students in OECD countries except Mexico and Poland who participate more in science-related activities have a greater likelihood of being resilient than disadvantaged students who do not participate in such activities. This relationship is moderately strong. In contrast, in most partner countries and economies participation in science-related activities is not associated with resilience except in Chile, Croatia, Hong Kong-China, Macao-China, Slovenia, Chinese Taipei and Thailand. Resilient odds ratios are relatively modest, even in OECD countries, ranging from 1.24 in the Czech Republic to 1.81 in Iceland. In fact, estimates of resilient odds ratios for most countries are under 1.5, suggesting that the odds of being resilient for a disadvantaged student who has an average value on the participation in science-related activities index that is one standard deviation above the OECD average is less than 1.5 times greater than those of a similarly disadvantaged student whose participation is the same as the average OECD student. In almost all OECD countries, adjusting for individual characteristics and the average socio-economic background at the school level strengthens the association between participation in science-related activities and the likelihood of being resilient (except Italy, Japan, Korea and Turkey as well as Poland) (Table A2.3c).

The evidence presented here suggests that student participation in science-related activities is associated with resilience in most OECD countries and in some partner countries and economies. Fostering student participation in science-related activities could therefore lead to improvements in performance in some countries.

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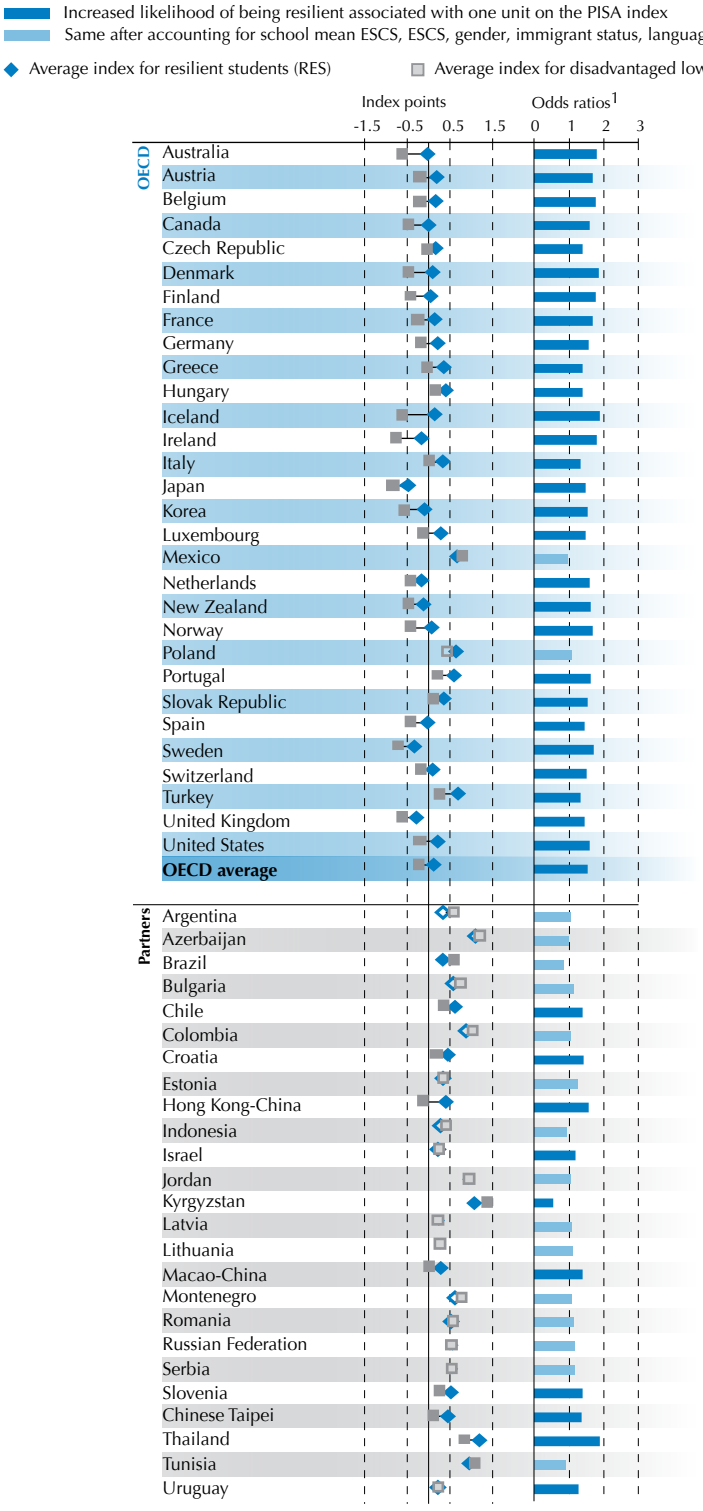
Figure 3.2
Engagement in science-related activities



1. Resilient odds ratios stand for the increase in the likelihood of being resilient associated with an increase of one standard deviation in the index. The results reported here refer to the logistic regressions explained in Annex A2.
2. Statistically significant differences are marked in a darker tone.
Note: Countries have been ordered alphabetically.
Source: *OECD PISA 2006 Database,* Table A2.3c.

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Student confidence in their science ability

Student beliefs about their academic abilities can facilitate or hamper their academic performance (Bandura, 1994; Marsh, 1986; OECD, 2007a). Previous research has found resilient students to have greater confidence in their abilities than other disadvantaged students (Borman and Overman, 2004; Shumow *et al.*, 1999). This analysis considers two measures: the index of student self-efficacy in science and the index of student self-concept in science. Higher values on both measures indicate greater confidence. The index of student self-efficacy in science assesses how much students believe in their own ability to handle tasks effectively and overcome difficulties and the ease with which students believe they can carry out specific tasks involving the application of scientific knowledge and skills. The index of student self-concept in science assesses students' beliefs in their own academic abilities.

The index of student self-efficacy in science measures whether students are able to do the following six tasks easily or with a bit of effort: recognise the science question that underlies a newspaper report on a health issue, explain why earthquakes occur more frequently in some areas than in others, describe the role of antibiotics in the treatment of disease, identify the science question associated with the disposal of garbage, predict how changes to an environment will affect the survival of certain species and interpret the scientific information provided on the labelling of food items.

Resilient students report greater ease in tackling all of these tasks in practically all OECD countries. For example, as depicted in Table A2.4a, in 18 out of 30 OECD countries 80% or more of resilient students recognise the science question that underlies a newspaper report on a health issue while in all OECD countries except Mexico and the Slovak Republic less than 70% of disadvantaged low achievers do so (Table A2.4a). Differences in the share of resilient and disadvantaged low achievers who can explain why earthquakes occur more frequently in some areas than in others exceeds 20% in all OECD countries (except Mexico). Over 70% of resilient students in partner countries and economies (expect Azerbaijan, Chile, Montenegro and Indonesia) recognise the science question that underlies a newspaper report on a health issue. The same can be said of disadvantaged low-achieving students in only Israel, Kyrgyzstan and Uruguay. Differences between resilient and disadvantaged low achievers in partner countries and economies range between around 2 percentage points in Azerbaijan and Kyrgyzstan to over 25 percentage points in Estonia and Chinese Taipei (Table A2.4a).

As Figure 3.3 shows, resilient students believe that they learn science with greater ease than disadvantaged low achievers and are more confident in their ability to apply their science knowledge. On the index of student self-efficacy, resilient students in most OECD countries report self-efficacy around one standard deviation greater than that of disadvantaged low achievers. In all countries except Azerbaijan and Kyrgyzstan, there is a sizable difference in favour of resilient students in self-efficacy. Across OECD countries on average the gap between the two groups of students is 0.8 of a standard deviation, almost reaching 1.2 of a standard deviation in the United Kingdom (Table A2.4b).

Disadvantaged students who believe in their own ability to handle tasks effectively and overcome difficulties are significantly more likely to excel in science than disadvantaged students with low levels of self-efficacy in all OECD and partner countries and economies. Not only is the relationship between self-efficacy and student resilience an essentially universal phenomenon, it is also quantitatively important. On average across OECD countries, self-efficacy has the strongest association with resilience of any of the variables considered in this chapter. In fact, in all OECD countries except Greece, Japan, Luxembourg, Mexico, the Netherlands, Turkey and the United States the increase in the odds of being resilient associated with an increase of one standard deviation in the self-efficacy index is above 2.0 and is as high as 3.1 in the United Kingdom. A similar pattern emerges for partner countries and economies. Odds ratios range between 1.1 in Azerbaijan and 2.8 in Estonia and are above 2.0 in eight partner countries and economies. When

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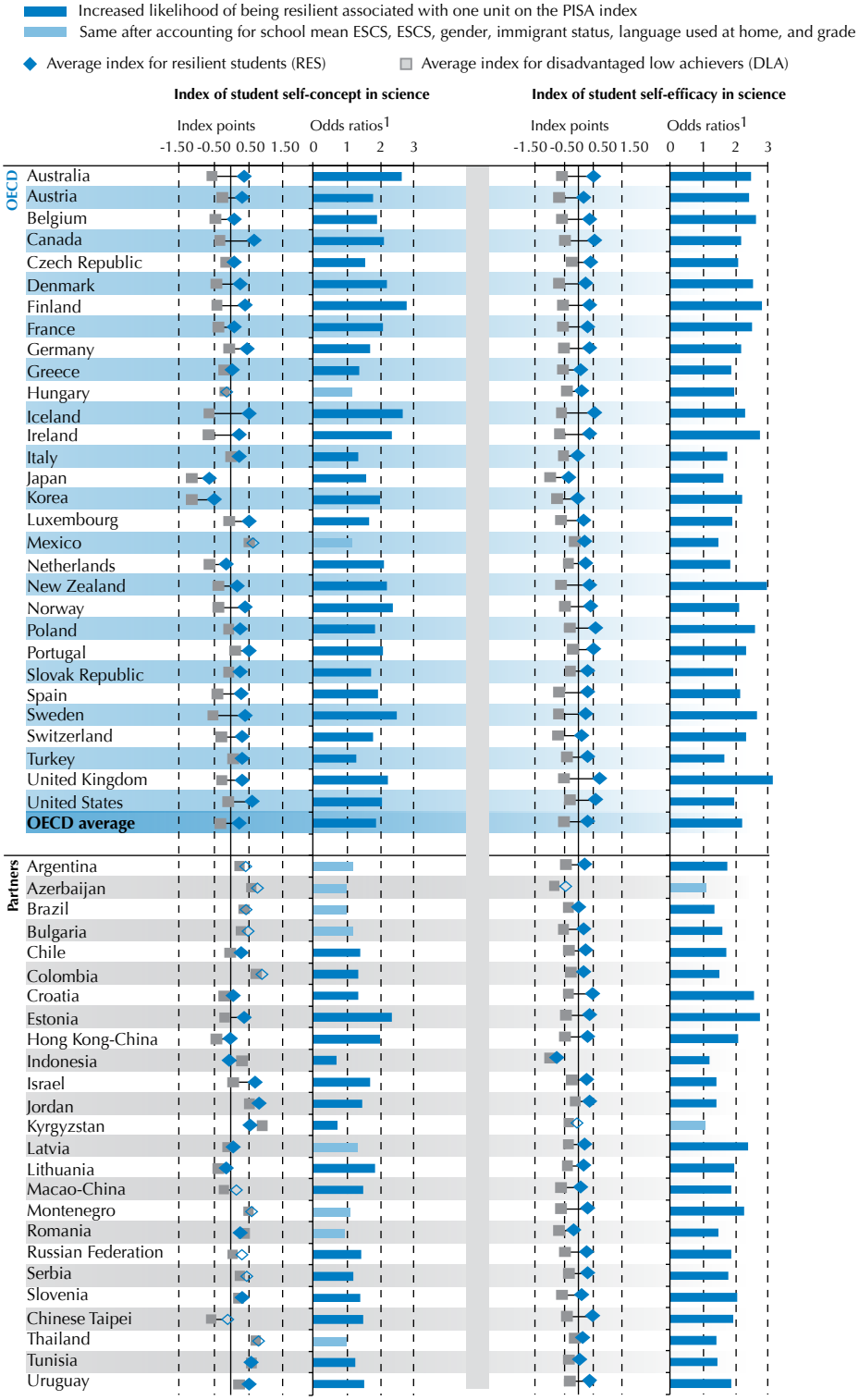
Figure 3.3
Student self-confidence in their science ability



1. Resilient odds ratios stand for the increase in the likelihood of being resilient associated with an increase of one standard deviation in the index. The results reported here refer to the logistic regressions explained in Annex A2.
2. Statistically significant differences are marked in a darker tone.
Note: Countries have been ordered alphabetically.
Source: *OECD PISA 2006 Database*, Tables A2.4c and A2.5c.

individual and school-level factors are included in the models, estimates of the change in the likelihood of being resilient remain significant and remarkably similar in strength in most countries, thus indicating little variation across demographic groups and schools in this relationship.

The index of self-concept combines students' responses regarding the extent that they agree with the following: learning advanced science topics would be easy for them, they can usually give good answers to test questions on science topics, they learn science topics quickly, they consider science topics easy, they believe that when they are being taught science, they can understand the concepts very well and they can easily understand new ideas in science.

Resilient students in general show greater confidence in their own academic abilities than disadvantaged low achievers. Across OECD countries over 50% of resilient students believe that learning advanced science topics would be easy for them compared to only about 40% of disadvantaged low achievers (Table A2.5a). Approximately 75% of resilient students believe they can give good answers to test questions on science topics while only about 50% of disadvantaged low achievers share this belief. There are however some exceptions. For example, disadvantaged low achievers report greater self-confidence in the Czech Republic, Hungary, Mexico, the Netherlands and Poland with respect to the ease with which they would learn advanced science topics and in Hungary with respect to the extent to which science topics are easy for them (Table A2.5a).

With respect to differences between resilient and disadvantaged low achievers in mean values on the index of self-concept, results show that resilient students have more confidence than disadvantaged low achievers (Table A2.5b). This is true in all but two OECD countries (Mexico and Hungary). The differences range from 0.22 standard deviations in the Czech Republic to 1.12 standard deviations in Iceland. There are differences in 14 of 25 partner countries and economies and all but two (Indonesia and Kyrgyzstan) indicate that resilient students learn science with greater ease than disadvantaged low achievers. The range of these significant differences is smaller than among OECD countries – from 0.13 standard deviations in the Russian Federation to 0.60 standard deviations in Israel. In Indonesia and Kyrgyzstan, disadvantaged low achievers show more confidence than resilient students (Table A2.5b).

While not as strong as for self-efficacy, disadvantaged students with more confidence in their own academic abilities are significantly more likely to be resilient than students with lower perceptions of their abilities. This is a strong relationship. As Figure 3.3 shows, the increase in the likelihood associated with a one unit increase in the self-concept index (corresponding to a change in 1 standard deviation at the mean) is statistically significant in all OECD countries except Hungary and Mexico, with odds ratios ranging between 1.32 in Greece and 2.84 in Finland. In Indonesia and Kyrgyzstan students with higher levels of self-concept are less likely to be resilient, while in many other partner countries and economies the association is significant and in the expected direction. In several OECD countries the association between students' confidence in their abilities and the likelihood that they will be resilient becomes stronger as individual and school factors are taken into account in the modelling, most notably in France where the estimated odds ratios are 1.56 in the base model, 1.9 after adjusting for individual characteristics and 2.1 in the full model (Table A2.5c).

The evidence presented on self-confidence shows that student confidence is associated with resilience in most countries. The evidence is particularly consistent in relation to self-efficacy where the relationship is significant in all OECD and partner countries and economies. Fostering students' self-confidence, particularly their self-efficacy, may therefore be a means of improving the performance of disadvantaged students. As discussed in next chapter, targeting is an important issue to consider when implementing policies to foster the motivation and engagement of students. It may prove harder to engage disadvantaged students and it is possible that policies to foster engagement across all socio-economic groups of students lead to a widening of the achievement gap between advantaged and disadvantaged students.

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Student perspectives towards science-related careers

Indices developed to examine students' motivation to learn science, students' engagement with science and students' self-confidence in their science abilities describe the extent to which science material studied at school is perceived to be relevant by students and the extent to which science is an integral part of students' lives. For example, instrumental motivation to learn science measures students' perceptions on the role of science in their future academic and professional pursuits while the students' participation in science activities index explores whether science-related activities are part of students' leisure time.

The PISA student questionnaires allow the identification of a fourth dimension that characterises students' approaches to learning and that delves further into the theme of how relevant students perceive the science material they study at school. Students who feel stronger connections between this material and their career pursuits upon graduation may in fact perform better in school than students who view the studied material as less relevant to their future careers. This report considers the following two indices: the index of school preparation for science-related careers and the index of student information about science-related careers. The two are related: students who possess more information about science-related careers view these as a more likely occupational opportunity and thus view their current studies as more relevant for their future careers.

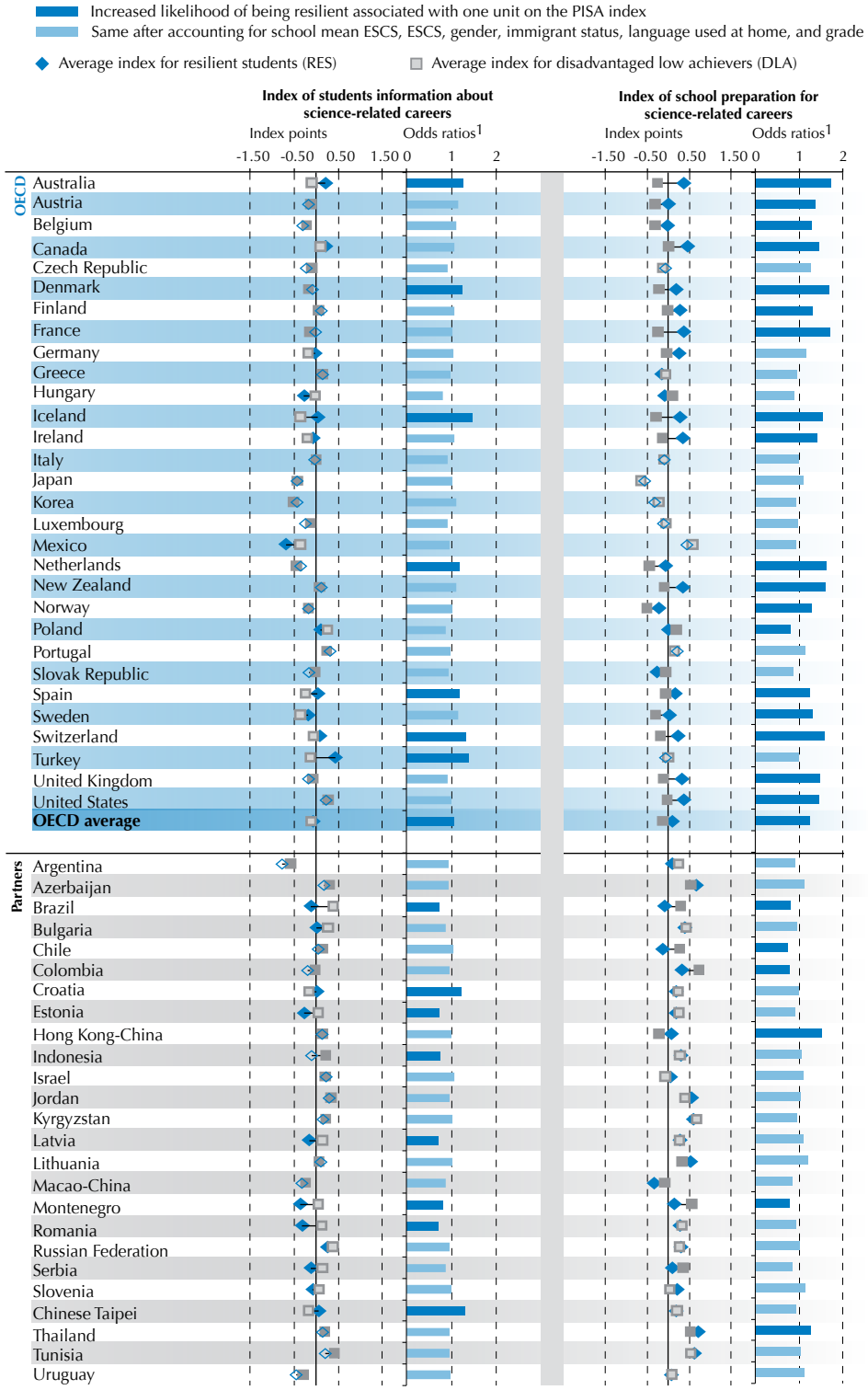
The index of school preparation for science-related careers measures how well students feel the curriculum provided by their schools prepares them for science-related careers. The school preparation for science-related careers index measures the extent to which students agree with the following four statements: the subjects available at my school provide students with the basic skills and knowledge for a science-related career, science subjects at my school provide students with the basic skills and knowledge for many different careers, the subjects I study provide me with the basic skills and knowledge for a science-related career, my teachers equip me with the basic skills and knowledge I need for a science-related career.

Across the OECD countries, disadvantaged students report their schools prepare them well for a science career. In most OECD countries there are small differences in favour of resilient students in specific areas of school preparation, but in only a small number of countries are these differences significant. For example, 80% of resilient students in France report that the subjects they study will provide them with the basic skills and knowledge for a science-related career, while only 58% of disadvantaged low achievers report this. Across partner countries and economies, the proportion of disadvantaged students who report being well prepared by their schools is even higher than in OECD countries and the differences between resilient and low achievers are smaller (Table A2.6a).

Using the index of school preparation for science-related careers, Table A2.6b shows that resilient students in OECD countries generally report feeling their schools prepare them for science-related careers to a greater extent than disadvantaged low achievers. There is a difference in 21 of the 30 OECD countries. In all countries except Hungary, Poland and the Slovak Republic, the results indicate that resilient students feel more prepared than disadvantaged low achievers. Differences are significant in ten out of 25 partner countries and economies; however no strong pattern emerges. In six of these partners resilient students feel more prepared than disadvantaged low achievers while in the others disadvantaged low achievers feel more prepared than resilient students (Table A2.6b).

Disadvantaged students who believe that they are receiving good preparation for science-related careers are more likely than other students to be resilient. This is a relatively weak relationship. As Figure 3.4 shows, in almost two thirds of OECD countries, the estimated resilient odds ratios are above 1.0. Only in Hungary and Poland is the likelihood that a disadvantaged student will be resilient reduced when the student reports greater school preparation for a science career. Estimated odds ratios are not affected by the inclusion of

Figure 3.4
Students' perspectives towards science related careers



1. Resilient odds ratios stand for the increase in the likelihood of being resilient associated with an increase of one standard deviation in the index. The results reported here refer to the logistic regressions explained in Annex A2.
2. Statistically significant differences are marked in a darker tone.
Note: Countries have been ordered alphabetically.
Source: *OECD PISA 2006 Database*, Tables A2.6c and A2.7c.

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student characteristics and school factors in the models. Their size suggests that while the relationship between school preparation for science careers and student resilience is fairly widespread across OECD countries, it is not particularly strong. Odds ratios range between 1.26 in Spain and 1.73 in Australia in the full model. Contrary to findings for OECD countries, disadvantaged students in partner countries and economies who report that their school prepares them well for science-related careers are generally equally likely to be resilient as other disadvantaged students. Results presented in the full model indicate that the association between school preparation for science and resilience is statistically significant and positive only in Hong Kong-China and Thailand (odds ratios of 1.52 and 1.28 respectively), while it is significant and negative in four other countries: Brazil, Chile, Colombia and Montenegro (Table A2.6c).

The index of student information about science-related careers assesses how well informed students are about where science-related jobs are and what they need to do in order to work in such a job. The student information about science-related careers index combines students' responses on how well informed they are on the following four topics: science-related careers that are available in the job market, where to find information about science-related careers, the steps a student needs to take if they want a science-related career, and employers or companies that hire people to work in science-related careers.

Only a minority of resilient and disadvantaged low achievers in OECD countries is well informed about employers and companies that hire people to work in science-related careers. In all countries except Iceland, Korea and Turkey, a higher proportion of disadvantaged low achievers report being better informed on this aspect than resilient students (Table A2.7a). Students in partner countries and economies appear to be equally poorly informed about employers and companies that offer science-related job opportunities and results indicate that, as in OECD countries, resilient students are the ones that lack information the most. In addition, over half of resilient students in 15 out of 30 OECD countries reported that they are not sufficiently informed as to where they can find information about science-related careers. Over half of disadvantaged low achievers are not sufficiently informed on the steps they need to take if they want a science-related career in 21 out of 30 OECD countries (Table A2.7a).

Disadvantaged students who reported being better informed about science careers are not generally more resilient than students who feel less well informed. As Figure 3.4 depicts only in Australia, Denmark, Iceland, the Netherlands, Spain, Switzerland and Turkey is more information about science careers associated with an increase in the likelihood that a disadvantaged student will be resilient. While statistically significant, the association is quantitatively small. In the full model, odds ratios range from 1.18 in Spain to 1.46 in Iceland (Table A2.7c). The student information on science careers index is significantly associated with the likelihood that a disadvantaged student will be resilient in eight out of the 25 partner countries and economies. The association is, however, positive only in two countries and economies (Croatia and Chinese Taipei) and is quantitatively very small in both cases (odds ratios are at or below 1.3). In other partner countries and economies disadvantaged students who feel informed about science careers are generally less likely to be resilient than other disadvantaged students (Table A2.7c).

The evidence presented here suggests that students' perspectives on science-related careers are weakly related to student resilience, being somewhat stronger for school preparation than for student information about science-related careers. From this analysis there is little evidence that providing more career information is a strong contender as a policy option for raising the performance of disadvantaged students.

STUDENT ENGAGEMENT IN SCIENCE COURSES AT SCHOOL AND TIME SPENT LEARNING

In many schools, students can choose whether they want to enrol in science courses and if so, whether they prefer to attend general courses about science or discipline-specific modules such as physics, chemistry and biology. This section presents estimates of the association between participation in science courses and hours spent learning science at school and resilience. It uses two indicators to characterise students' participation in compulsory science courses and one indicator to characterise the time students spend learning science topics at school. The results for these indicators cannot be directly compared with the results for the PISA indices presented in earlier sections of this chapter because the scales are very different. In the indices presented earlier, student responses were converted to a standardised value to facilitate comparison to the average student in OECD countries. Thus, a one point difference in these indices equates to a one standard deviation difference. Here, the original response metrics are used.

The indicators for participation in science courses are derived from questions on the PISA student background questionnaire. These questions asked students whether they attended compulsory general science classes at school in the year in which the PISA assessment took place or in the previous year. They also asked students whether they attended compulsory classes in the year of the PISA assessment or the previous year in any of the following science topics: general science, biology, physics or chemistry. Annex A5 includes the questions addressed to students in this regard and a description of how the indicators were constructed.

In general, student resilience is associated with attending a compulsory general science course – across OECD countries on average this is the second strongest association found between resilience and the factors considered in this chapter. All students in nine OECD countries – Austria, France, Greece, Hungary, Japan, Luxembourg, Norway, Poland and the Slovak Republic – report having attended a compulsory general science course. In 15 of the other 21 OECD countries, a higher proportion of resilient students attended a compulsory general science course in the last two years than disadvantaged low achievers. Only in two countries, Italy and Spain, is the reverse true (Table A2.8a). The same pattern is apparent among partner countries and economies, where the differences are very similar and in the same direction (in this case with only one exception, Slovenia). After accounting for individual student and school characteristics, attending a compulsory general science course is associated with an increase in the likelihood of being resilient in 13 of the 21 OECD countries which have appropriate data for analysing this question. For both Italy and Spain, attending a compulsory science course is associated with a lower likelihood only when student and school background characteristics are not taken in account (Table A2.8b).

In relation to the number of science-related compulsory courses attended, the second indicator, the association with resilience is weaker, as Figure 3.5 depicts. In 19 of the 28 OECD countries for which data are available, the average resilient student engages in a larger number of courses than the average disadvantaged low achiever (Table A2.9a). The value of the indicator ranges between zero and eight, representing the total number of compulsory science courses students attended over a two-year period. The difference between the two student groups is more than three courses in Belgium and two courses in the United Kingdom, Sweden and Macao-China. The pattern is similar among partner countries and economies. After accounting for student and school background characteristics, the additional number of compulsory courses attended is associated with an increase in resilience in 20 of the 28 OECD countries.

The association is however weak in all cases (the highest odds ratio is slightly over 1.4 in France). Partner countries and economies have a similar pattern to OECD countries but in this case there is a relationship in every country and economy and (except in Argentina, Colombia and Thailand) all estimated odd ratios are above one (Table A2.9b).

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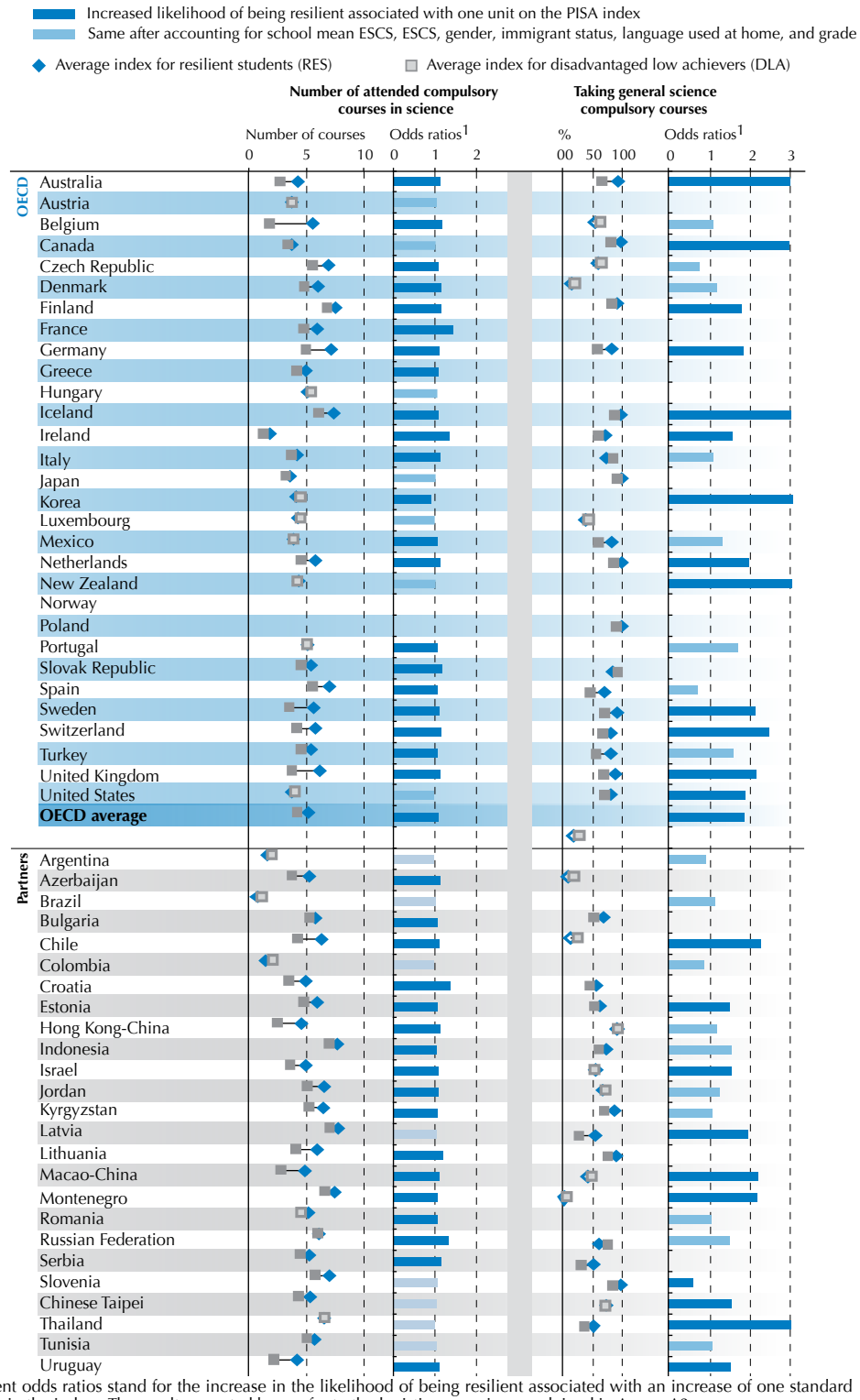
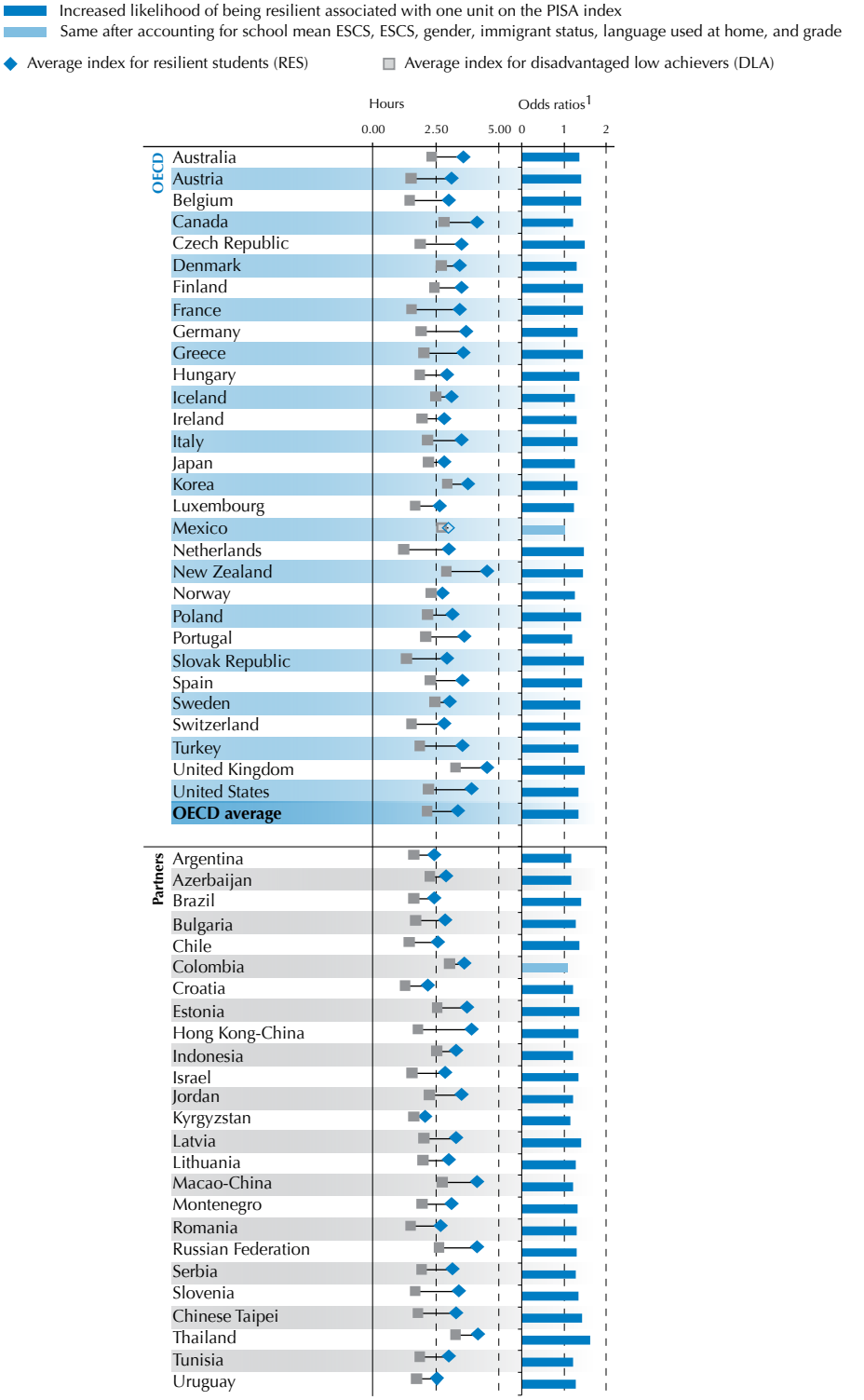
Figure 3.5
Student engagement in science courses at school



1. Resilient odds ratios stand for the increase in the likelihood of being resilient associated with an increase of one standard deviation in the index. The results reported here refer to the logistic regressions explained in Annex A2.
2. Statistically significant differences are marked in a darker tone.
Note: Countries have been ordered alphabetically.
Source: *OECD PISA 2006 Database*, Table A2.8c and Table A2.9c.

Figure 3.6
Hours in science regular lessons at school



1. Resilient odds ratios stand for the increase in the likelihood of being resilient associated with an increase of one standard deviation in the index. The results reported here refer to the logistic regressions explained in Annex A2.
Note: Countries have been ordered alphabetically.
Source: *OECD PISA 2006 Database*, Table A2.10c.

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The indicator for time spent learning science at school is the number of hours that students report spending in regular lessons at school learning science. This is also based on a question in the PISA student background questionnaire. The question asks students about the amount of time they spend each week studying science, mathematics, language and other subjects in regular school lessons, out-of-school time lessons and study or homework students do by themselves. Figure 3.6 highlights that in all OECD countries except Mexico and all partner countries and economies the average resilient student spends more time studying science at school than the average disadvantaged low achiever. On average the difference is between one and two hours (Table A2.10a). The association between more learning time at school in science and the likelihood of being resilient is strong; the relationship is consistent across almost all OECD countries but the estimated odd ratios are smaller than for compulsory courses. In all countries except for Mexico and Colombia, the more time a student spends the higher are his or her chances of being resilient. The estimated odd ratios in OECD countries range from less than 1.19 in Portugal to more than 1.5 the United Kingdom and the Czech Republic (Table A2.10b).

While increasing time spent at school will not alone raise overall performance, these results suggest that learning time at school is an important factor to take into account when designing interventions that raise the performance of disadvantaged students. Making science courses compulsory may be an option in some circumstances but the association between performance and an increase in the number of compulsory science courses is weak. One way to interpret these results is that it is not only the quantity of time spent in school matters but how that time is administered matters as well. Some disadvantaged students are vulnerable because they might end up in tracks or schools where there is very little choice and no possibility to take science courses, which does not help them in overcoming their disadvantaged socio-economic background.

LEARNING ENVIRONMENT AT SCHOOL

This section presents estimates of the association between the characteristics of the schools disadvantaged students attend and their resilience. Two broad areas of school factors are considered. First, school management, competition and admittance policies; then school resources its quality and use to promote science-related activities.

School management, competition and admittance policies are all areas the literature has identified as potential factors associated with student performance. This report presents results on whether schools are public or private (school management), whether they compete for students with other schools in their area (competition) and whether they use student academic records in admittance policies (academic selectivity). The PISA 2006 initial report (OECD, 2007a) presented results for all students. This section extends the analysis by comparing different groups of disadvantaged students. Given the definition of disadvantaged students used in this report, this focus implies analysing only a third of the sample of students that participated in PISA 2006. As a result, there are not enough data to offer reliable estimates for some of these variables. In particular, only in seven OECD countries do sizeable proportions of disadvantaged students attend a private school and only in 13 countries do sizeable proportions of disadvantaged students attend an academically selective school.[3] Annex A5 provides detailed information on how these variables were constructed. The PISA 2006 initial report and the Technical Report also provide details and summary statistics for these variables (OECD, 2007a and 2009b).

The PISA data show little association between school management and student resilience (Figure 3.7), *i.e.* in general, resilient students are as likely to be found in private schools as disadvantaged low achievers. Among the seven OECD countries with enough data, only in Spain is the proportion of resilient students in private schools higher than the proportion of disadvantaged low achievers and in Japan the opposite holds true (Table A2.11a). In terms of the likelihood of being resilient, only one OECD country, Japan, shows an association: in this country disadvantaged students attending private school are less likely to be resilient,

although adjusting for individual and school characteristics lowers the estimated odds ratio (Table A2.11b). Among partner countries and economies, only in Argentina, Chile, Jordan and Macao-China is there a difference between the proportions observed: in this case resilient students are more likely to be found in private schools than are disadvantaged low achievers (the opposite is true in Chinese Taipei) (Table A2.11a). In terms of the likelihood of being resilient, there is a relationship in only a few partner countries and economies, all (except in Chinese Taipei) indicating that being at a private school increases the likelihood of resilience, but these associations disappear once student and school characteristics are taken into account (with two exceptions, each in a different direction: Jordan and Chinese Taipei) (Table A2.11b).

As Figure 3.7 shows, there is little evidence of an association between school competition and student resilience. Among OECD countries, it is only in Germany and Turkey that the proportion of resilient students in schools that compete with other schools for their students is higher than the proportion of disadvantaged low achievers. The opposite is true, however, in Korea. In the other OECD countries for which data are available, there is no difference between the two estimates. Among partner countries and economies the proportion resilient students in schools that compete with other schools for their students is higher than the proportion of disadvantaged lower achievers only in Argentina and Slovenia (Table A2.12a). After accounting for student and school factors, no country presents evidence of an association between school competition and the likelihood of being resilient (Table A2.12b).

In terms of school admittance policies, as Figure 3.8 displays, the proportion of resilient students in schools that use student academic records in admittance policies is higher than the proportion of disadvantaged low achievers in 8 countries out of the 13 OECD countries with sufficient data for this analysis and as well as in 13 countries out of the 21 partner countries and economies (Table A2.13a). However, the relationships with the likelihood of being resilient, which are also in favour of selective schools, disappear once student and school characteristics are taken into account in all countries except in Austria, Czech Republic, Hungary and Turkey as well as partner economy Chinese Taipei (Table A2.13b).

While the literature identifies these school characteristics as important factors associated with performance, there is no evidence in PISA 2006 supporting any widespread relationships between these factors and student resilience. Where an association was found, it turned out that students enrolled in schools that are privately managed (Japan) or that use academic selectivity (Austria) tend to have lower odds of being resilient, even after accounting for student and school characteristics. This evidence, however, is very limited and cannot be generalised as it could simply reflect country-specific circumstances.

The quality and use of school resources are also commonly thought to be associated with performance. For this second broad area of school characteristics, the report uses two measures, one on the overall quality of school resources and the other on a particular use schools can make of those resources, namely whether they organise school activities to promote science learning.

The quality of educational resources is measured in PISA by questions that ask school principals to rate how much their school's capacity to provide instruction is hindered by the lack of a series of resources such as laboratories or an internet connection. An index of the quality of educational resources is then constructed, with a mean of 0 and a standard deviation of 1 across the OECD, and where a higher value implies better quality. Therefore, a negative value simply means that the students in these schools enjoy a lower quality than the average OECD student.

Principals in schools with resilient and disadvantaged low achievers reported very similar levels of quality in terms of school resources (Figure 3.9). For example, in the Slovak Republic, about three quarters of both resilient and disadvantaged low achievers were in schools where the principals reported that the capacity of the school to provide instruction was hindered by the lack of or inadequacy of science laboratories. In

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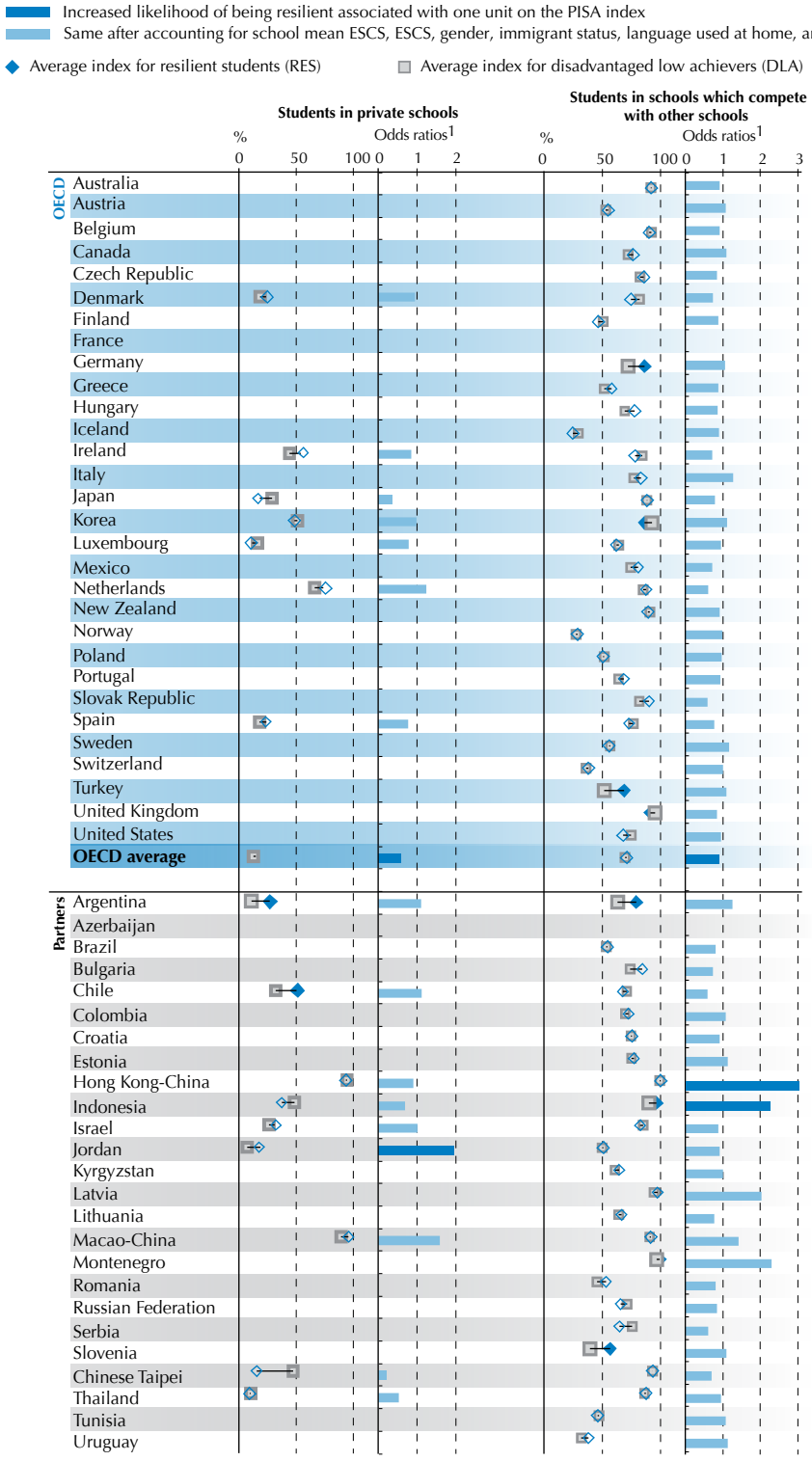
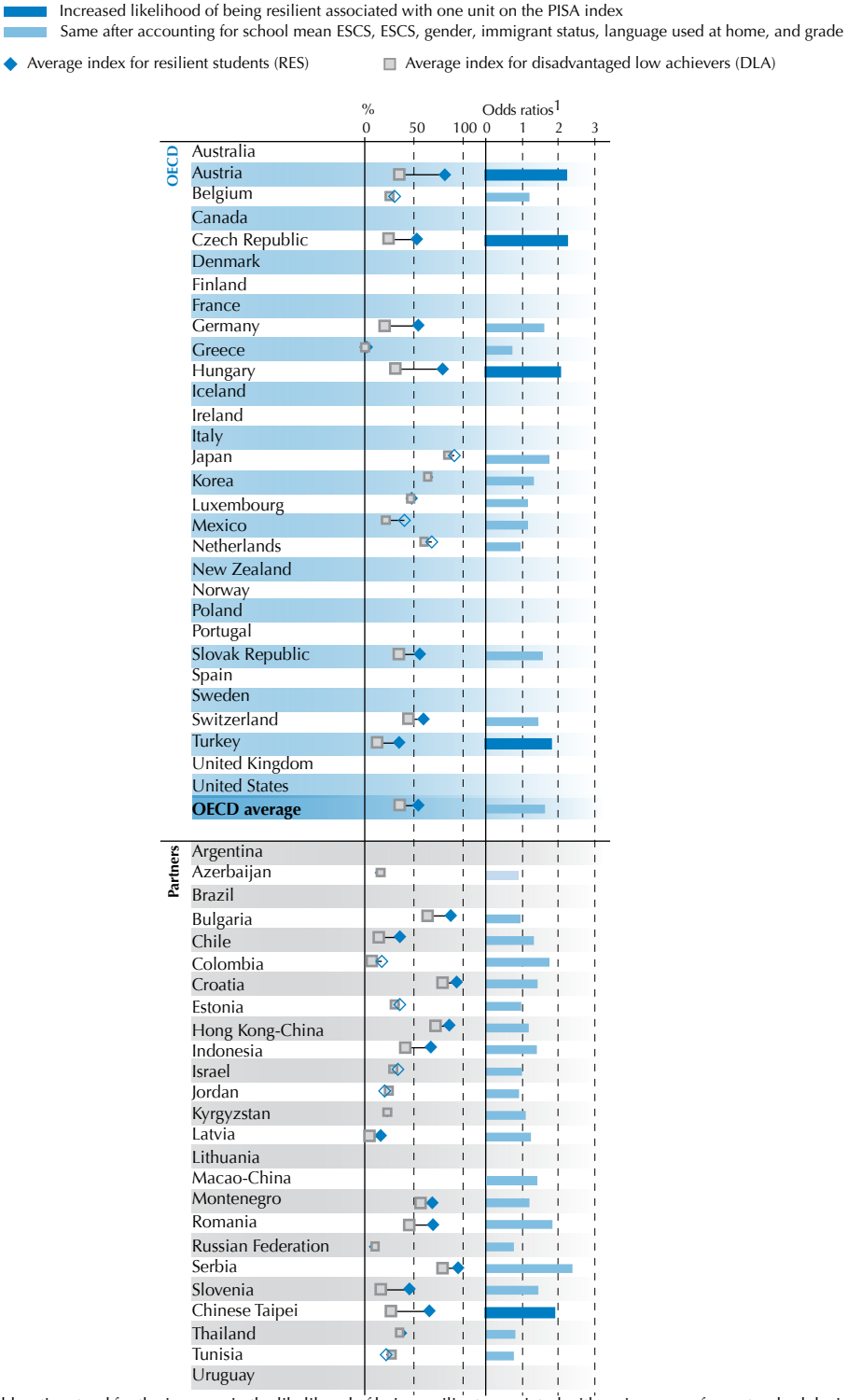
Figure 3.7
Schools' competition, and management



1. Resilient odds ratios stand for the increase in the likelihood of being resilient associated with an increase of one standard deviation in the index. The results reported here refer to the logistic regressions explained in Annex A2.
2. Statistically significant differences are marked in a darker tone.
Note: Countries have been ordered alphabetically.
Source: *OECD PISA 2006 Database,* Tables A2.11c and A2.12c.

Figure 3.8
Schools' academic selectivity



1. Resilient odds ratios stand for the increase in the likelihood of being resilient associated with an increase of one standard deviation in the index. The results reported here refer to the logistic regressions explained in Annex A2.
2. Statistically significant differences are marked in a darker tone.
Note: Countries have been ordered alphabetically.
Source: *OECD PISA 2006 Database,* Table A2.13c.

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Japan, 24% of resilient students and 26% of disadvantaged low achievers were in schools whose principals reported a lack or the inadequacy of science laboratories hindered instruction (Table A2.14a). The same patterns are present for other school resources such as computers available for instruction, library materials and audio-visual resources. Differences between the two student groups appear only in exceptional cases.

On the index of quality of school educational resources, only six OECD countries (Denmark, Greece, Iceland, Italy, Mexico and Switzerland) have higher values for resilient students than for disadvantaged low achievers (a higher value on this index implies better quality resources). The size of the advantage for resilient students is modest, between 0.15 and 0.33 of a standard deviation across OECD countries (Table A2.14b). Where there is a difference, however, it is always in favour of resilient students; that is resilient students enjoy better resources than disadvantaged low achievers. The same pattern is observed among partner countries and economies. In this case, only Argentina, Brazil, Chile, Romania and Thailand have differences in favour of resilient students. But in these cases the gap tends to be larger, the differences in these countries range from a less than a third to close to two-thirds of a standard deviation.

Switzerland is the only OECD country where there is a statistically significant association between the quality of school resources index and the likelihood of being resilient. The estimated odds ratio is, however, very close to one after accounting for student and school characteristics. This result indicates that even in the case of Switzerland an increase of one standard deviation in the index is associated with only a marginal increase in the likelihood of being resilient. Among partner countries and economies, only in Macao-China is there evidence of an association and the estimated odds ratio is also very close to one (Table A2.14c).

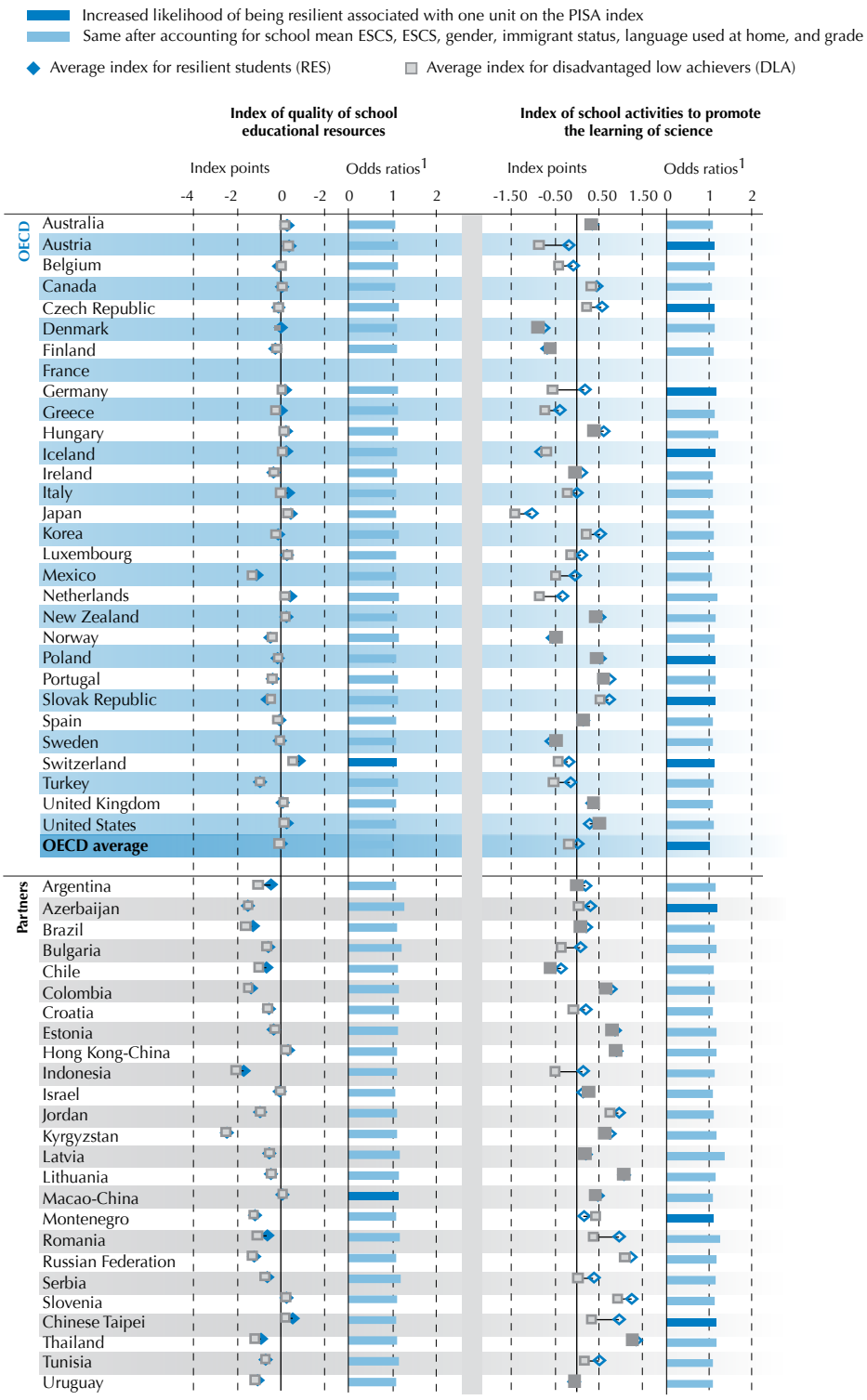
A potential use for school resources is to offer school activities to promote the learning of science, such as organising science clubs, excursions and field trips or science competitions. PISA 2006 explored whether schools offered these kinds of activities by asking school principals to asses. An index of school activities to promote the learning of science was then constructed, with a mean of 0 and a standard deviation of 1 across the OECD, and where a higher value implies more involvement. Therefore, a negative value simply means that the students in these schools enjoy less a lower quality than the average OECD student.

Resilient and disadvantaged low achievers do not differ very much in the extent to which the schools they attend are involved in the promotion of activities aimed at enhancing science learning (with some exemptions). Excursions and field trips is the activity most commonly reported, across the OECD 89% of resilient students and 88% of disadvantaged low achievers attend schools that are involved in this activities. Only in a few cases there is a gap in this regard between these groups of disadvantaged students. For example, in Germany 57% of resilient students and 20% of disadvantaged low achievers attend schools that are involved in science competitions. In Austria, 39% of resilient students and 15% of disadvantaged low achievers attend schools involved in science fairs (Table A2.15a).

The index of school activities to promote the learning of science shows some differences between resilient and disadvantaged students. There is an advantage in favour of resilient students in 15 OECD countries. Only in Iceland the advantage is in favour of disadvantaged low achievers. Across OECD countries the difference ranges from one tenth (in Canada) to more than two thirds (in Austria) of a standard deviation (Table A2.15b). Among partner countries and economies, resilient students have a higher index of school activities to promote the learning of science in 11 countries while the reverse is true only in one. On average size of the difference is in general larger than for OECD countries but they still range from one tenth (in the Russian Federation) to more than two thirds of a standard deviation (in Indonesia and Chinese Taipei).

While the basic model shows an increased likelihood of resilience being associated with activities to promote the learning of science in quite a few countries (both OECD and partner countries and economies), after accounting for student and school factors, science promotion activity is generally not associated with

Figure 3.9
School resources and science promotion activities



1. Resilient odds ratios stand for the increase in the likelihood of being resilient associated with an increase of one standard deviation in the index. The results reported here refer to the logistic regressions explained in Annex A2.
2. Statistically significant differences are marked in a darker tone.
Note: Countries have been ordered alphabetically.
Source: *OECD PISA 2006 Database,* Tables A2.17c and A2.18c.

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a higher likelihood of being resilient. An association is apparent in only seven OECD countries (Austria, Czech Republic, Germany, Iceland, Poland the Slovak Republic and Switzerland). In each of these the odds ratios are close to one indicating that a standard deviation in the index predicts that disadvantaged students at schools with science promotion activities are only marginally more likely to be resilient than students at schools that don't promote science activities (Table A2.15c). The same pattern is apparent for partner countries and economies, where there is evidence of an association in only four countries (Azerbaijan, Indonesia, Montenegro and Chinese Taipei. Only in Indonesia, with an estimate of nearly 1.4, is the odd ratio of a size worth some consideration.

These results provide little evidence that school resources, either their quality or use, are associated with student resilience across the board. The PISA 2006 data show that there is little difference among different groups of disadvantaged students in either the quality of school resources they experience or in the degree to which these resources are used to promote science learning activities at school. Similarly, the data show that neither resource quality nor resource use, as captured by PISA 2006, are consistently associated with an increased likelihood of resilience among disadvantaged students. These results ought to be interpreted with caution, however, as it is possible that not all the principals interpreted the questions in the same way, even within a country. One other possible reason for the lack of evidence of an association is that these measures are only a very rough approximation of the information they were intended to capture.

COMBINED EFFECTS OF STUDENT AND SCHOOL FACTORS ON STUDENT RESILIENCE

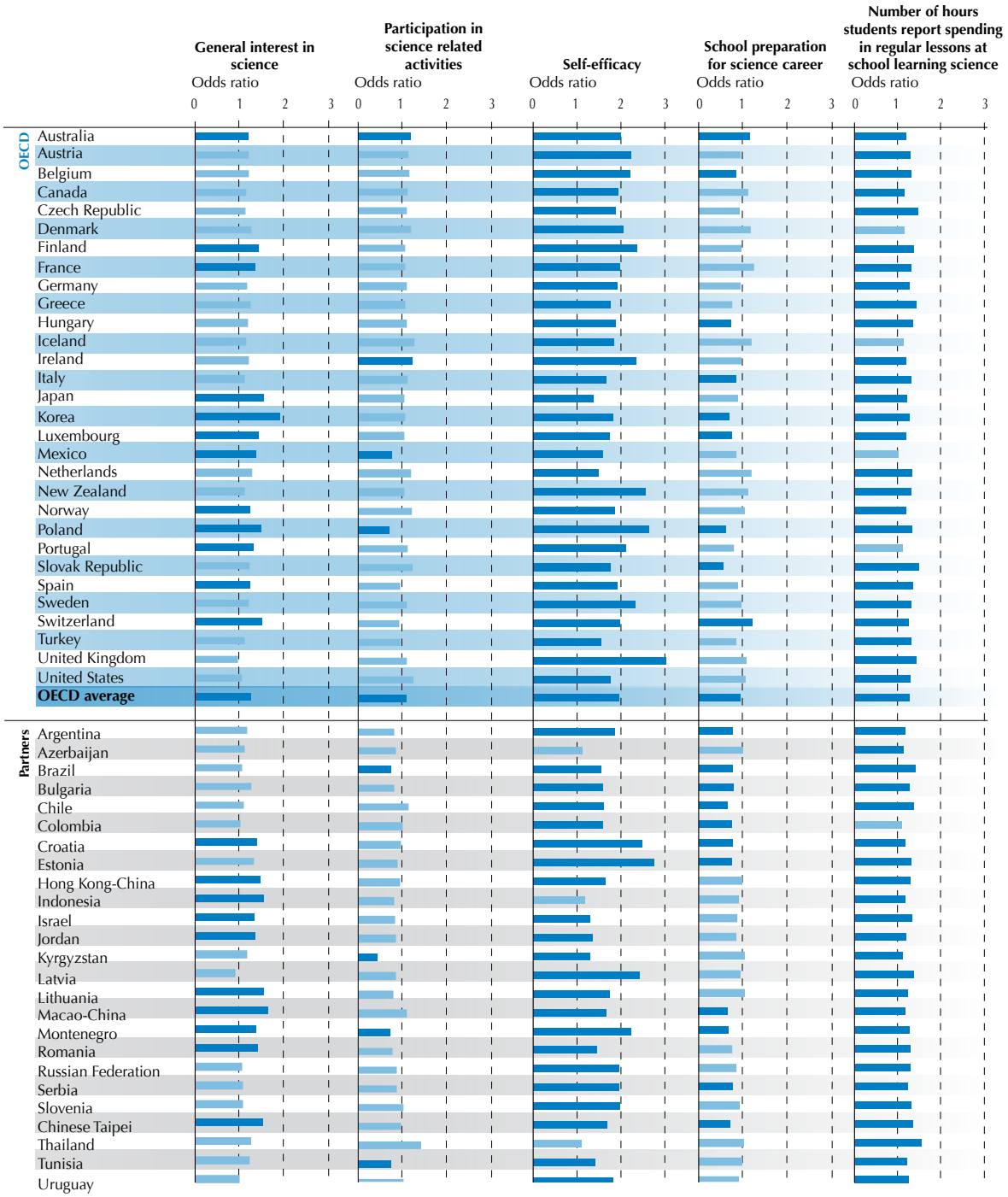
Having reviewed how student approaches to learning, engagement in courses and hours spent, and the learning environment at school are separately associated with resilience, the chapter now turns to a combined analysis of the relationships between these measures and resilience. For each of the areas, based on the previous analysis, the variable with the strongest relationship with the likelihood of resilience was included in the combined model. Annex A5 presents the details of this combined model. The main goal of this section is to analyse which relationships are robust to the inclusion of other important variables in the predictive model. As for the results presented above, the analysis is reported in terms of odds ratios for resilience.

A combined model allows for the estimation of the relative association with resilience for each factor accounting for all of the factors included. In the combined model the estimated coefficients are therefore relative; they assume all other factors remain constant. A comparison of the combined model with the previous models gives a sense of the degree to which other measures included in the model exert mediating effects on the measures of interest's association with performance. In general, given these mediating effects it is normal that the size of the estimates is smaller in the combined model.

Figure 3.10 highlights the strong association between resilience and the measures of student self-efficacy and number of hours, students report spending in regular lessons at school learning science. For the rest of the variables included in the model – internal motivation, participation in science-related activities, school preparation for science careers, school management, school competition, admission policies, the quality of resources and the promotion of science-related activities – the estimated associations (with some exceptions) are either close to one or there is no evidence of an association with the likelihood of resilience (Table A2.16).

Thus student confidence, represented in the model by the index of student self-efficacy, is the approach to learning that is most consistently associated with an increased likelihood that disadvantaged students will beat the odds, even when other factors are taken into account. This is the case in all OECD and almost all partner countries and economies (the exceptions being Azerbaijan, Indonesia and Thailand). Students who are more confident in their ability to carry out specific tasks involving the application of scientific

Figure 3.10 [Part 1/2]
Combined model



1. Statistically significant differences are marked in a darker tone.
Source: *OECD PISA 2006 Database,* Table 3.16c.

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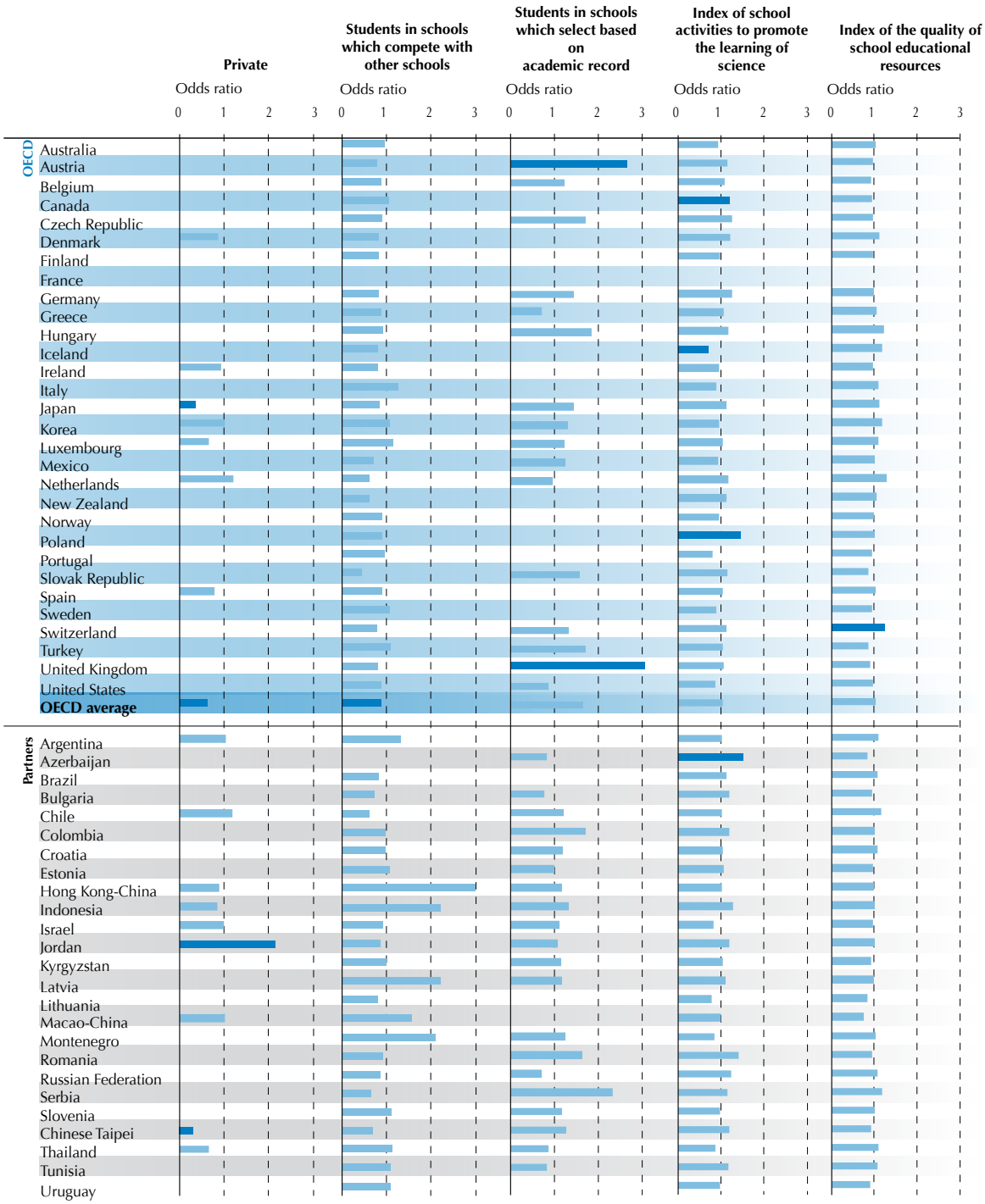
Figure 3.10 [Part 2/2]
Combined model



1. Statistically significant differences are marked in a darker tone.
Source: *OECD PISA 2006 Database,* Table 3.16c.

knowledge have higher odds of being resilient than students who are less confident in their abilities. The association between student resilience and self-efficacy is strong in most countries. In a third of OECD countries, the odds ratios are above 2.0 and in many of the remaining countries they are over 1.9.

Motivation, particularly internal motivation as captured by the index of general interest in science, is also positively associated with the likelihood that disadvantaged students will be resilient, but less consistently so than self-efficacy. This association is seen in fewer than half of the OECD countries (12 out of 30) and in 10 out of 25 partner countries and economies (Table A2.16). In countries where the relationship between interest in science and academic resilience is significant, the odds ratios are smaller than for self-efficacy. They are below 1.5 except in Japan and Switzerland and in four partner countries and economies (Indonesia, Lithuania, Macao-China and Chinese Taipei).

The number of hours of regular science lessons at school is associated with greater odds of being resilient in all OECD countries except four (France, Iceland, Mexico and Portugal) and in all partner countries and economies except Colombia. As depicted in Figure 3.10, the association between learning time and resilience remains strong across the board when other factors are taken into account. Among OECD countries the estimated odds ratios range from about 1.2 in Canada to more than 1.4 in the Czech Republic, Greece, the Slovak Republic and the United Kingdom,. The range is even larger across partner countries and economies, from 1.12 in Azerbaijan to 1.58 in Thailand (Table A2.16). For OECD countries on average, the odds ratio for this measure (1.27) is about the same as the odds ratio for internal motivation (1.25), these two providing the strongest associations behind science efficacy (1.96).

The relationship between participation in science-related activities and student resilience is rather weak when other factors are taken into account (Figure 3.10). Across OECD countries, the relationship between participation in science-related activities and resilience is positive in only two countries (Australia and Ireland) and the relationships are very weak (Table A2.16). In most partner countries and economies students who participate in science-related activities are just as likely to be resilient as fellow students who do not participate in such activities. In four countries (Brazil, Kyrgyzstan, Montenegro and Tunisia) students who take part in science activities are less likely to be resilient than students who do not take part in such activities, although the association is quantitatively small.

Disadvantaged students who report being better prepared for science-related careers generally have no greater odds of being resilient than students who report being less prepared, when other factors are taken into account. Figure 3.10 shows that odds ratios for school preparation for science careers are below one in nine OECD countries and in 11 partner countries and economies (Table A2.16). Only in Switzerland and the United Kingdom are disadvantaged students who report better school preparation for a science career more likely to be resilient than other disadvantaged students.

The generally negative relationship between school preparation for science careers and resilience should be interpreted carefully. In OECD countries, students who perform satisfactorily at school on average tend to continue their education well beyond the age of 15. Conversely, students who are poor performers may be more likely to abandon school to enter the labour market immediately after completion of their compulsory education. Therefore, students who excel academically and plan on embarking on further studies are more likely to perceive the labour market in rather abstract terms. As a result, they may feel poorly prepared for science-related careers. On the other hand, poorly performing students may have already begun to evaluate different career opportunities and may have received additional support at school to help them in their early transition to the labour market.

The associations between school factors and resilience do not change when other variables are taken into account in the combined predictive model. Only in Japan, among OECD countries, and among the partner

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countries, Jordan and Chinese Taipei, there is an association between school management and the odds of being resilient: disadvantaged students who attend private schools in Japan and Jordan have lower odds of being resilient, whereas the opposite is true in Chinese Taipei. Further, as Figure 3.10 displays, there is evidence of an association between the quality of resources and/or the use schools make of them in only a small number of countries. Across both variables there are only five cases where there is an association; in four cases the estimated odds ratios are above one and in one case it is below one (Table A2.16).

The evidence from the combined model confirms the results of the previous analysis, highlighting the importance of students' confidence and learning time. With a small number of exceptions, there is very little evidence in PISA 2006 of associations between the other factors analysed in this report and student resilience. One possibility is that no relationships exist, but it is also possible that the data limitations in PISA 2006 are preventing associations from being found. Therefore, one should not conclude that there is no relationship, but rather that no relationship has been observed. What is clear, however, is that student confidence and learning time are closely associated with academic success among disadvantaged students across most OECD and partner countries and economies.

CONCLUSION

Having established a definition and measure of student resilience, Chapter 2 described the main individual features that characterise resilient students and disadvantaged low achievers. Chapter 3 extends this analysis to the approaches to learning, hours and courses, and the school's learning environment of these students. It shows that resilient students are engaged students who feel confident about their academic capabilities. Resilient students are more motivated, more engaged and more self-confident than their disadvantaged low-achieving peers.

Students' confidence in their academic abilities is one of the strongest predictors of resilience. Holding student demographics, school characteristics and other approaches to learning constant, the more confident students are, the greater are their odds of being resilient. Motivation, and in particular internal rather than instrumental motivation, is also associated with student resilience in many countries but the relationship is weaker.

Learning time is also one of the strongest predictors of resilience, even after accounting for student demographics, school characteristics and other factors that are considered to be closely related with performance.

PISA 2006 offers very little evidence of an association between school factors, such as the type of school management, admittance policies, school competition and school resources, and resilience. One should not interpret this as meaning that these factors are irrelevant, but rather that there is no empirical support in PISA 2006 for these hypotheses.

The results suggest that schools may have an important role to play in promoting resilience by developing activities, classroom practices and modes of instruction that foster disadvantaged students' motivation and confidence in their abilities and also by providing opportunities for disadvantaged students to spend more time learning science at school.

Notes

1. See Annex A5 for a technical description of the models used in analyses predicting the association between students' approaches to learning and the likelihood that disadvantaged students will be resilient.

2. Through the entire report, only statistically significant differences at 95% confidence levels are reported. If the estimates are not significant at this level they are not referred to in the main text of this report.

3. Because of sample size issues, no country-level estimates for a country are provided whenever a group considered in analyses is composed of less than 3% of the study population in the country.

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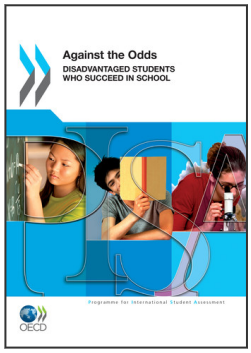

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