# Benchmarking London in the PISA rankings

John Jerrim

Gill Wyness

UCL Institute of Education

February 2016

http://johnjerrim.com/papers/

**Abstract**

The Programme for International Student Assessment (PISA) is an important international study of 15 year olds academic achievement. Although PISA has traditionally been used to draw comparisons across countries, there is growing interest in the production of regional (i.e. city, state or provincial level) results. In this paper we present the first attempt to benchmark London in the PISA rankings. Pooling data across the 2009 and 2012 survey waves, we estimate a 90 percent confidence interval for London's mathematics, reading and science PISA scores. These are compared not only to country-level averages, but also to the scores of other major world cities and states. The paper concludes by discussing how these results should be interpreted, and possible directions for future research.

Acknowledgements: We would like to thank Tim Leunig, Emily Knowles, Siobhan Williams and Susan Crisp for their comments on drafts of this work.

Contact Details: John Jerrim (J.Jerrim@ioe.ac.uk) Department of Quantitative Social Science, Institute of Education, University of London, 20 Bedford Way London, WC1H 0AL

## 1. Introduction

The Programme for International Student Assessment (PISA) is an important cross-national study of 15 year olds educational achievement. Conducted every three years by the Organisation for Economic Co-Operation and Development (OECD), the results are widely cited by academics and policymakers alike. In recent years, a number of countries have also started to produce regional PISA results – benchmarking educational achievement at the city, state or province level. Prominent examples include Spain (e.g. Catalonia), Brazil (e.g. São Paulo, Rio de Janeiro), Italy (e.g. Lombardia, Lazio) and the United States (e.g. Florida). This has not escaped the attention of prominent policymakers in England, who have shown much interest in sub-national PISA results. For instance, Liz Truss MP (former Under Secretary of State for Education) recently stated how '*forward-thinking education authorities in England, like Essex, are…proposing to benchmark themselves internationally*[1]*.'* Greater London Authority (GLA) has shown particular interest in such an exercise, with the Mayor for London (Boris Johnson MP) also reportedly keen to benchmark England's capital city in the PISA rankings (Times Educational Supplement 2014). Greater London Authority (GLA) has also shown interest in such an exercise, with the Mayor for London (Boris Johnson MP) and the London Assembly supporting the benchmarking of England's capital city in the PISA rankings (Times Educational Supplement 2014 and London Assembly 2014).

There has also been much wider interest in benchmarking London's educational performance internationally. This has partly stemmed from a recent and growing literature highlighting the educational 'success' of England's capital city. According to Blanden et al (2015: Figure 1), in 2002 only one-in-three children in inner-London obtained five or more A*- C grades in their GCSEs (including maths and English), compared to half of all children in England as a whole. However, by 2013 inner London's performance had improved to such an extent that levels of academic achievement were consistent with the national average (with around two-thirds of children obtaining at least five good GCSEs). Yet it is the high level of achievement amongst disadvantaged youth in London that is particularly striking. For instance, whereas only 25 percent of children eligible for Free School Meals (FSM) achieve five good GCSE grades in the rest of England, 40 percent of FSM pupils achieve this benchmark in outer London, and up to 50 percent within inner London (Blanden et al 2015: Figure 1). Hence it is the especially

[1] https://www.gov.uk/government/speeches/education-minister-elizabeth-truss-gives-speech-on-international-evidence

strong performance of young people from low income backgrounds in London that has particularly caught policymakers' attention.

Several explanations for this finding have been ventured within the academic literature. A number of policy reports have highlighted recent changes to school policy (Wyness 2011, Hutchings et al 2012), and particularly the effect of the 'London Challenge' programme. Others, such as Burgess (2014), argue that the strong educational performance of London is actually due to the demographic make-up of England's capital city; particularly the number of young people from ethnic minority backgrounds. Yet Blanden et al (2015) have recently countered that the 'London effect' can even be observed at the end of primary school, and that there is little suggestion that this can also be explained by the demographic composition of London's schools.

In this paper, we take a rather different approach to considering the academic skills of young people in London. Specifically, rather than focusing upon London children's performance in national assessments, we attempt to benchmark educational standards in London internationally for the very first time. Not only do we compare England's capital to the leading PISA countries, but also to other major economies (e.g. Singapore), cities (e.g. Madrid) and states (e.g. Ontario). All three major PISA domains are considered (reading, mathematics and science), as well as children's problem solving skills, and sub-domains on the mathematics and reading tests. Moreover, recognising that achievement measures such as PISA capture only one dimension of children's development, we also compare London to other economies in terms of young people's 'non-cognitive' skills.

From a national perspective, this paper contributes to the existing literature by being the first study to consider London's educational standards in an international context. Likewise, we make an international contribution by being the first study to benchmark a number of other important regional economies in the PISA rankings. This includes Attica (Athens), Riga, Reykjavik and Lisbon (amongst others).

The paper now proceeds as follows. Section 2 describes the PISA data, and how individual cities/states within a country can be identified. London's position in the PISA rankings is provided in section 3, with conclusions following in section 4.

## 2. Data

The Programme for International Student Assessment (PISA) is a cross-national study of 15 year olds educational achievement. Children complete a two hour test covering three 'core

domains' (reading, mathematics and science), with one of these being the focus in any given year. In 2009 and 2012, the rounds considered in this paper, the focus was reading in the former and mathematics in the later. The 2012 wave also included an additional assessment of children's problem solving skills. For each cognitive domain, the survey organisers have produced five 'plausible values' using a one-parameter item-response (Rasch) model. These plausible values represent different estimates of children's 'true' proficiency in each subject area, and have a mean of approximately 500 and a standard deviation of 100 across OECD countries. To aid interpretation, the OECD states that one year of schooling is approximately equivalent to a difference of 40 PISA test points (OECD 2010: 110).

The contribution of this paper is to benchmark London, along with a number of other cities and states, in the PISA rankings. As noted in the introduction, some countries (e.g. Italy, United States, Australia, Canada) have purposefully over-sampled within certain geographic areas to facilitate such regional reports. However, although countries like England have not gone through this oversampling process, it is still possible to produce unbiased PISA estimates for certain geographic sub-regions. (The main cost of not oversampling is that all estimates will be accompanied by quite wide confidence intervals, as we shall discuss below).

To identify individual cities and states (including London) in PISA, it is important to understand this study's complex survey design. First, each country selects a set of 'explicit stratification' variables. Although these differ across countries, geographic region and school type are common choices. Detailed information on the explicit stratification variables used for each country in PISA 2012 can be found at: http://pisa2012.acer.edu.au/downloads/M_stu_codebook.pdf . Page 26 of this link gives the twelve explicit strata used in England. These are a combination of four geographic regions (North, Midlands, South and Greater London) and three school types (maintained selective, maintained non-selective and independent). This information, contained within the 'STRATUM' variable in the public use dataset, means London schools can be identified and investigated within our analysis[2].

Within each of these explicit strata, schools are then ranked by a variable (or set of variables) that are likely to be strongly associated with PISA test scores. This is known as implicit stratification, with historic GCSE performance of the school the most important variable used

[2] In PISA 2009, six percent of the London sample attended an independent school, compared to seven percent for England as a whole (sampling weights applied). The analogous figures for PISA 2012 are nine percent (London) and nine percent (England) respectively.

for this purpose in England[3]. Schools are then randomly selected, with probability proportional to size, within each of the explicit strata. This process has important implications; the combination of implicit stratification and random sampling means that a representative sample should be drawn within each explicit stratum. As Greater London was an explicit stratum for England, a representative sample of London schools should have been collected in PISA 2009 and 2012. The same is true for key cities in other countries (e.g. Riga, Attica, Lisbon) which were also used as explicit stratification variables.

The most obvious challenge is sample size; see Table 1. A total of 524 (533) London pupils from 21 (21) London schools participated in PISA 2009 (2012)[4]. Consequently, although we can obtained unbiased estimates of London's PISA scores, these will be accompanied by quite wide confidence intervals (reflecting uncertainty due to sampling variation). To reduce this uncertainty, we pool our analysis across the 2009 and 2012 PISA waves whenever possible[5]. Our population of interest therefore refers to 15 year olds who were attending a London school in either 2009 or 2012[6]. This leads to a total sample size of 1,057 pupils attending 42 London schools. The same process of pooling data across the 2009 and 2012 waves is followed where possible for all other countries/cities/states. (See Table 1 for information on sample sizes).

**<< Table 1 >>**

Table 2 provides further evidence that the PISA data for London is representative of the city's 15 year old population. Specifically, the right-hand side provides information on gender, Free School Meal (FSM) eligibility, and national examination scores at ages 11, 14 and 16 for the PISA 2012 sample (along with the 95 percent confidence interval). The left-hand side provides analogous summary statistics for all 82,290 15 year olds enrolled in London schools in 2012 (i.e. the target population the PISA-London data should represent). By comparing figures across these columns, we are able to gain further insight into the representativeness of the PISA-London sample.

**<< Table 2 >>**

[3] School gender composition and local education authority area also play a role.
[4] As PISA is designed to be representative of the 15 year old school population, the sample includes immigrant pupils, including those who have been in the country a short period of time. This of course represents just one of the many challenges that different countries (and different cities) face.
[5] Combing groups or pooling estimates is a common response to limited sample sizes. Although it does not bias the estimates, it does change the interpretation. In this instance, it means the population of interest is defined as 15 year olds attending London schools *across* 2009 and 2012.
[6] Appendix A, B and C also presents results for the 2009 and 2012 waves separately (some of the key points from this auxiliary analysis are trailed in the section that follows).

The PISA London sample seems to match the population in terms of gender composition (50 percent) and FSM eligibility (25 percent versus 24 percent). Likewise a similar proportion achieved a D or below in their GCSE mathematics exam (25 percent in PISA-London versus 23 percent in the population). Slightly more children in the population gained an A or A* than in the PISA sample (17 percent versus 22 percent) and slightly fewer a grade C (38 percent versus 29 percent). In contrast, the PISA-London sample did slightly better overall across all their GCSEs (Key Stage 4 capped points score of 354 versus 335). However, the 95 percent confidence interval suggests these modest differences are not unexpected given sampling variation. A similar finding emerges with regards Key Stage 2 (age 11) and Key Stage 3 (age 14) test scores. Table 2 therefore suggests that a representative, though moderately sized, sample of London pupils has indeed been collected.

The PISA 2009 and 2012 data contain information on children's reading, science and mathematics test scores. The 2012 wave also includes results on seven mathematics sub-domains[7], with full details available from OECD (2010b). Example questions for each topic can also be found at www.oecd.org/pisa/pisaproducts/pisa2012-2006-rel-items-maths-ENG.pdf. A sub-sample of PISA 2012 children also took a computer-based problem solving test, with example questions available from http://www.oecd.org/pisa/test/. It is important to note that, as these data are available for only a subset of 2012 participants, confidence intervals for these results will be particularly wide.

As part of PISA, children also complete a detailed background questionnaire. In 2012 this included a battery of Likert scale questions designed to capture children's 'work ethic', 'perseverance' and 'attributions to failure' (i.e. whether they blame others or external circumstances for not doing well on a test). Exemplar questions can be found below, with a full list available from Jerrim (2015: Appendix B):

- Work ethic: '*I study until I understand everything'*
- Perseverance: '*When confronted with a problem, I give up easily*'
- Attributions to failure: '*This week I made bad guesses on the quiz*'

Children responded to these questions using a four point scale (from strongly disagree to strongly agree). Responses have been converted into scales by the survey organisers using

[7] These seven sub-domains are formed of four 'content' areas (Change and relationships, Quantity, Space and Shape and Uncertainty and data) and the 'process' skills (Employ, Formulate and Interpret).

item-response theory techniques. Given the now extensive literature on the significance of such 'non-cognitive' skills (Heckman and Rubinstein 2001), it is important we also attempt to benchmark this aspect of London children's development. To aid interpretation, we standardise each scale to mean 0 and standard deviation 1 across countries, for all children with the relevant data available. Thus, when presenting the non-cognitive skills results, all figures can be interpreted as differences in terms of standard deviations.

We follow recommended practise throughout our analysis (OECD 2009b). Final student weights are applied to produce population estimates and to adjust for the small amount of non-random non-response. The complex survey design (stratification and clustering of children) is accounted for via the application of the Balanced-Repeated-Replication (BRR) weights. All estimates involving PISA test scores are produced five times, once using each plausible value, then averaged and aggregated as recommended by OECD (2009). The above is facilitated by the Stata 'repest' command developed by Avvisati and Keslair (2014).

## 3. Results

*Mathematics*

The left-hand column of Table 3 places London into the pooled PISA 2009 and 2012 mathematics rankings. (Appendix A presents separate results for these two years). Overall, London's performance does not appear to be particularly strong; the estimated 90 percent confidence interval ranges between 462 and 496 test points. It is placed 39$^{th}$ in the mathematics rankings (confidence interval ranging between 24$^{th}$ and 45$^{th}$ position), and is significantly below 23 countries including Slovenia, Viet Nam and Macedonia. It is also notable that the point estimate for London (479) is below that for the rest of the UK (495), though this difference is not statistically significant at the conventional thresholds. Moreover, although Appendix A suggests that the mean mathematics score declined from 489 in 2009 to 470 in 2012, this change also does not reach statistical significance at conventional levels. Additional analysis is also provided in Appendix F, where London's position in the PISA mathematics rankings is presented separately for boys and girls. Interestingly, it seems to be the comparatively weak performance of London girls in PISA mathematics (mean score of 462, compared to 495 for London boys) that is driving this result.

**<< Table 3 >>**

How does London compare to other major international cities/states in terms of children's mathematics skills? The answer can be found in Table 4. London sits in 24$^{th}$ position out of the

37 economies included (90 percent confidence interval ranging between 20th and 30th position). A total of 17 cities / states outperform London at the five percent level (including Riga, Reykjavik and Milan), with a further two at the ten percent level (Madrid and Moscow). Notably, children in the top-performing city (Shanghai) are approximately three years of schooling (126 PISA points) ahead of children in England's capital. Indeed, in additional analysis we have found only the top 10 percent of London pupils have mathematics skills equal to the average child in Shanghai[8].

**<< Table 4 >>**

Of course, cities and states differ in their socio-economic and immigrant compositions. How does the ranking of economies presented in Table 4 change once such differences have been taken into account? The answer can be found in Table 5. (Appendix D presents analogous results for the comparison between London and various countries). The left-hand side presents the unconditional difference in mean scores between London and the other international economies (replicating the results of Table 4). In contrast, the right-hand side demonstrates how this changes once the gender, immigrant and socio-economic composition have been taken into account.

**<< Table 5 >>**

There are four notable features of Table 5. First, London's position relative to the spectrum of other cities is largely unchanged. For instance, it moves in the ranking by just one position (24th to 25th) with mathematics scores significantly lower than 18 other cities/ states at the 10 percent level in these conditional rankings (compared to 19 in the unconditional results). Second, the East Asian cities / states at the top of the table further extend their lead. For instance, Shanghai is estimated to be 127 points ahead of London in the unconditional results, with this increasing to 142 points once the gender, immigrant and socio-economic composition of these cities have been taken into account. The same is true for comparisons between London and Singapore (88 versus 101 points), Hong Kong (79 versus 103 points) and Macau-China (52 versus 76 points). Third, in a similar manner, London's lead over some of the poorer world states has been reduced. This includes Port-of-Spain (48 point difference in the unconditional estimates versus 37 points in the conditional estimates), Buenos Aires (61 versus 51 points), Mexico State (58 versus 25 points), Sao Paul (82 versus 52 points) and Rio de Janerio (90 versus 60 points).

[8] The 90th percentile of the PISA mathematics distribution in London is 602 test points. This compares to an average PISA mathematics score of 606 in Shanghai.

Finally, the difference between London and the rest of the UK has shrunk from 16 points (unconditional estimates) to 4 points (conditional estimates). However, on neither occasion are these differences significant at conventional levels.

Table 6 concludes by presenting London children's scores on the PISA mathematics sub-domains. (Recall these estimates are based upon the 2012 data only, and thus have particularly large standard errors). Qualitatively, London pupils follow the national trend of scoring lowest in the 'Space and Shape' content area (i.e. geometry). There are two areas where London scores significantly below the rest of the UK: 'Change and Relationships' (a 30 point difference that is statistically significant at the 10 percent level) and 'Uncertainty and Data' (a difference of 32 points that is statistically significant at the 5 percent level)[9]. In terms of cognitive mathematical processes, London (457) children scored 36 points below the rest of the UK (493) in the 'formulate' category (statistically significant at the 5 percent level). This means children in London struggle to simplify problems to make them amenable to mathematical analysis, and to translate a problem into mathematical language or representation (see OECD 2010b:15). Overall, although Table 6 suggests London's PISA mathematics results are quite low across the board, it also suggests that there may be certain areas of particular weakness.

**<< Table 6 >>**

*Reading*

The middle column of Table 3 turns to London's position in the PISA reading rankings. The mean score is estimated to be 483, with a 90 percent confidence interval ranging between 465 and 500 test points. Although London is placed 34$^{th}$ out of the 76 economies included in these PISA rankings, this wide confidence interval means England's capital city could fall anywhere between Germany (21$^{st}$) and Chile (45$^{th}$). Nevertheless, with a mean score of 483, reading skills in London are significantly below those in countries such as Liechtenstein (507), Estonia (508) and Viet Nam (508). At the same time, mean PISA reading scores are significantly higher in London than Serbia (444), Malta (442) and the UAE (437). However, although the point estimate is below that for the rest of the UK (499), this difference is not statistically significant at conventional thresholds. Similarly, despite mean PISA reading scores being higher in 2009 relative to 2012, the small sample size means one cannot rule out the possibility that this difference is due to sampling variation alone.

[9] Uncertainty and data encompass probability and statistics, including the use and interpretation of graphs.

Table 4 (middle column) compares London's reading scores to other cities / states. London is 26th out of the 37 economies included, though sampling variation means that England's capital could sit anywhere between Belfast (17th) and Dubai (31st). Nevertheless, it is significantly below other major European cities such as Lombardia (Milan) (521), Riga (508) and Madrid (507) at the five percent level, and Belfast (505) at the ten percent level. In contrast, reading achievement in London is significantly above that in a number of South American and Middle Eastern cities such as Rio de Janeiro (411), Buenos Aires (429), Abu Dhabi (431) and Dubai (464)[10].

A breakdown of London test scores across the PISA reading sub-domains is presented in Table 6 panel B. (Recall that this part of the analysis is based upon the 2009 data. Hence point estimates are somewhat higher and standard errors larger. See Appendix B). On all 'aspect categories' and 'text formats', the point estimate for London is around the UK and OECD average. However, confidence intervals are extremely wide. For instance, London's score on the 'access and retrieve' sub-scale could actually fall between 464 and 510 test points (90 percent confidence interval). Broadly similar amounts of uncertainty surround the other reading sub-scale results.

*Science*

The right-hand side of Table 2 presents the PISA science results. London sits in 37th position with a mean score of 497 (90 percent confidence interval ranging from 480 to 513 test points). This level of performance is below 15 other countries at the five percent level, and a further five at the ten percent level, including the leading East Asian economies (e.g. Japan and South Korea), major European countries (e.g. Germany and the Netherlands) and, notably, the rest of the UK. At the other extreme, 34 countries have significantly lower mean science scores, including Greece, Turkey, Chile and the UAE. Again, additional analysis presented in Appendix F highlights the particularly low PISA science scores of London girls (mean score = 484 compared to 509 for London boys).

Analogous results comparing London to other major cities and states can be found in the right hand side of Table 3. The 90 percent confidence interval suggests London is placed between 16th and 28th position in these regional rankings. Average science scores are higher than in many developing cities such as São Paulo (414), Belgrade (465) and Dubai (471), but below

[10] All differences significant at the 5 percent level, except Dubai which is significant at the 10 percent level.

international powerhouses such as Massachusetts (527), Helsinki (546) and Shanghai (577). Although Appendix C indicates that the point estimate for London is higher in 2009 (506) than 2012 (488), one is unable to reject the null hypothesis of there being no genuine difference in science scores between these two time points.

*Problem-solving*

London's score on the PISA problem solving test is presented in Table 7. (Recall that these results are based upon the 2012 data only. Hence the confidence intervals presented are particularly wide). The estimated mean score for London is 505 points, with the 90 percent confidence interval ranging from 483 to 526. This compares to a score of 519 for the rest of the UK (though this difference is not statistically significant at conventional thresholds). Of the 44 jurisdictions included in the left-hand panel, London therefore sits between 8th and 29th position. The right hand side of Table 7 presents the analogous comparison to other major cities and states. Of the 21 other regions considered, the mean score for London is significantly lower than seven (Singapore, Macau, Hong Kong, Lombardia (Milan), Shanghai, British Columbia and Western Australia) and higher than four (Dubai, São Paulo, Rio de Janeiro and Abu Dhabi).

*Non-cognitive skills*

Table 8 compares children in London to children in other cities/states in terms of 'non-cognitive' skills. Recall that as these are based on internationally standardised scales, differences can essentially be interpreted in terms of an effect size. The left-hand and middle columns present results for the work ethic and perseverance scales. Higher values indicate a positive outcome (e.g. greater perseverance or willingness to work hard). On both occasions, London is not significantly different from most other economies. For instance, children in only two out of the 32 comparator regions report a significantly higher work ethic (Dubai and Abu Dhabi), and seven a greater level of perseverance. Indeed, London's score of 0.07 (work ethic) and -0.01 (perseverance) are consistently better than some other major European cities, including Lombardia (Milan) (-0.19 and -0.29), Attica (Athens) (-0.20 and -0.24) and Catalonia (Barcelona) (-0.14 and -0.39).

The right hand column of Table 8 presents analogous results for the 'attributions to failure' scale. Here, higher positive values represent worse outcomes (i.e. a greater tendency to blame others or bad luck for poor performance on a test). Children from London perform well in this respect (-0.30), with only two high performing East Asian cities/states (Shanghai and Singapore) with a superior outcome (-0.39). Indeed, 24 out the 32 other cities / states have a

significantly worse outcome on this scale than London. Together, this indicates that children in England's capital are more likely than those in other cities / states to take responsibility when they perform poorly on a test.

*Why do we not find the 'London effect' in PISA?*

The results in the previous sub-section are somewhat surprising; particularly the fact we find London to perform no better than the rest of the UK. This is perhaps in contrast to what one would expect, given the widespread belief that London schools perform strongly in national examinations (e.g. GCSE exams). We now provide some further insight into this issue, using PISA 2009 and PISA 2012 data that has been linked to the National Pupil Database (NPD) [11]. It is important to note that the analysis in this sub-section refers to state school pupils only (as NPD data for private school pupils could not be linked) and compares London to the rest of England (rather than, as previously, the rest of the UK).

Table 9 provides our results. The column labelled 'M1' illustrates the difference in PISA mathematics scores between children in London and children in the rest of England. The point estimate (-19 points) confirms that children in London do worse on the PISA test, though the magnitude of this difference is imprecisely determined (the 90 percent confidence interval ranges from zero to -37 test points). However, the surprisingly low performance of London schools in PISA is further emphasised by Model 'M2', which controls for children's GCSE mathematics grade and capped Key Stage 4 points scores. The intuition is that we want to see whether London's performance in PISA mathematics is significantly below what one would expect, given children's GCSE scores. There is strong evidence that this is indeed the case; conditional upon GCSE test scores, children in London obtain PISA scores 22 points below their peers in the rest of England (i.e. 22 points below what one would expect). This difference is large, and statistically significant at the five percent level. (In additional analysis, we find that this result also holds within both the 2009 and 2012 cohorts individually).

**<< Table 9 >>**

[11] The NPD-PISA 2012 data for England includes state school children only (see footnote 5). For consistency, the 2009 data has also been restricted to state school pupils only, decreasing the sample from 4,081 to 3,805 observations. Our experimentations with the 2009 data suggest that the restriction to state school pupils only makes little change to our substantive results.

One possible explanation for this finding is that PISA is a low-stakes test (i.e. children and schools have little riding on the result). We explored this possibility in additional analysis by including a control for children's self-reported effort on the PISA test. (This analysis was conducted using the 2012 dataset only, as self-reported effort is not available in the 2009 wave). Specifically, children were asked a battery of questions above how hard they tried on the PISA test, and how this would change were the scores to count towards their final school grade (see Jerrim 2015 for further details). Adding this variable to the model leads to only a small decline in the London parameter estimate (it drops from -22 points down to -18 points), with the difference remaining significant at conventional thresholds. We therefore find little evidence that London's poor PISA performance (compared to the rest of England) is due to the low stakes nature of this test.

Model 'M3' attempts to explain the difference between London and the rest of England in terms of demographic characteristics, with controls added for gender, socio-economic status and ethnicity. This leads to a 50 percent reduction in the London parameter estimate, which now sits at 11 PISA test points, and is no longer statistically significant at conventional thresholds. It therefore seems that at least part of London's disappointing PISA score is driven by the under-performance of certain socio-economic and ethnic groups (compared to how these groups perform in their GCSEs).

Table 9 provides further insight. First, notice the large, negative and statistically significant coefficient for the bottom three socio-economic quintiles. In particular, the most disadvantaged children score 19 fewer points on the PISA test than one would expect, given their performance on the GCSE exams. Second, there are similarly large, negative and significant coefficients for the Black (-19 points), Asian[12] (-30 points) and Other (-26 points) ethnic groups[13]. Again, this suggests that these groups significantly underperform on the PISA mathematics tests (compared to White pupils) relative to their performance in GCSE examples. Moreover, Model 'M4' suggests that the same broad finding continues to hold even if we are to add additional controls for children's scores on their Key Stage 2 (age 11) exams. Of course, as Appendix E illustrates, London has a disproportionate share of children from low socio-economic status

[12] It is important to recognise that 'Asian' pupils within this analysis covers pupils from quite diverse backgrounds, with some likely to be higher achievers (on average) than others. Unfortunately, it has not been possible to conduct a more nuanced analysis of PISA scores by ethnic group within London due to the small sample size. The same holds true for sub-analysis for London pupils with English as an Additional Language (EAL).

[13] As less than one percent of the PISA sample in England are of Chinese ethnicity, they have been included in the 'other' ethnic group. (Chinese pupils tend to be very high achieving pupils, on average, in GCSE exams).

and ethnic minority backgrounds. Together, this therefore explains the substantial decline in the difference between London and the rest of England between M2 and M3.

## 4. Conclusions

PISA is an important international study of 15 year olds educational achievement. Although traditionally used to benchmark educational achievement within individual countries, there is growing international interest in the reporting of PISA results at a more localised level. The contribution of this paper has been to produce the first estimate of PISA test scores for London, alongside several other major international cities. In doing so, this is the first study to place educational standards in London within an international context. Using PISA 2009 and 2012 data, our analysis suggests the average PISA mathematics score in London falls between 462 and 496 test points, reading between 465 and 500 points, and science between 480 and 513 points. Overall, we find strong evidence that educational achievement is higher in London than in a number of developing cities (e.g. São Paulo, Port-of-Spain, Dubai) but behind world leaders such as Massachusetts, New South Wales (Sydney), Ontario and Shanghai.

These findings should of course be interpreted with care, and in light of the limitations of this study. First, despite pooling data across two PISA waves (2009 and 2012), the sample size for London remains limited. Hence all our estimates are surrounded by quite wide confidence intervals, which should always be given when presenting these results. Second, it is not possible to make any concrete statement with regards trends in London's PISA test scores over time. (The breakdown for 2009 and 2012 we provide in the appendices are for reference only – and must not be used to infer any indication of a decline). Third, our results refer to Greater London as a whole, though it should be remembered that England's capital is quite a diverse city. A more detailed geographic breakdown of PISA scores, such as by London borough, would likely yield a more nuanced perspective on our results. Finally, it is important to remember that PISA is cross-sectional data only. It is unable to provide any insight into the extent children improve during their time in compulsory education, or indeed the 'effectiveness' of London schools. Indeed, policymakers should steer clear of suggesting PISA measures the impact of a country's (or a city's) educational system, and remember that other factors (e.g. the home environment and the role of parents) are also at play.

Despite these limitations, this study has the potential to contribute to academic and policy understanding about the skills of London's school pupils. Despite strong performance in England's national examinations, educational achievement in London remains some way

behind that observed in other leading economies. Further progress is therefore needed if London is to produce the global talent needed to keep its economy competing upon the world stage.

**References**


Avvisati, Francesco and François Keslair. 2014. 'REPEST: Stata module to run estimations with weighted replicate samples and plausible values.' Accessed 19/05/2015 from https://ideas.repec.org/c/boc/bocode/s457918.html

Blanden, Jo, Ellen Greaves, Paul Gregg, Lindsey Macmillan and Luke Sibieta. 2015. 'Understanding the improved performance of disadvantaged pupils in London.' Accessed 15/12/2015 from http://sticerd.lse.ac.uk/dps/case/spcc/wp21.pdf

Burgess, Simon. 2014. 'Understanding the success of London's schools.' Accessed 15/12/2015 from http://www.bristol.ac.uk/media-library/sites/cmpo/migrated/documents/wp333.pdf

Heckman, James and Yona Rubinstein. 2001. 'The importance of non-cognitive skills: lessons from the GED testing program.' *The American Economic Review* 91(2):145-149.

Hutchings, Merryn, Charley Greenwood, Sumi Hollingworth, Ayo Mansaray, Anthea Rose, Sarah Minty and Katie Glass. 2012. Evaluation of the City Challenge programme. Department for Education Research Report Research Report DFE-RR215

Jerrim, John. 2015. 'Why do East Asian children perform so well in PISA? An investigation of Western-born children of East Asian descent' *Oxford Review of Education* DOI:10.1080/03054985.2015.1028525

London Assembly. 2014. 'London learners, London lives. Tackling the school places crisis and supporting children to achieve the best they can.' Accessed 19/02/2016 from www.london.gov.uk/sites/default/files/gla_migrate_files_destination/Education%20Report_1.pdf

OECD. 2009. 'Analysis with plausible values'. DOI 10.1787/9789264056275-9-en

OECD. 2009b. 'PISA data analysis manual: SPSS and SAS. Second edition.' Paris: OECD.

OECD. 2010. 'PISA 2009 results. Learning to learn: student engagement strategies and practices'. Paris: OECD.

OECD. 2010b. 'PISA 2012 mathematics framework.' Accessed 19/05/2015 from http://www.oecd.org/pisa/pisaproducts/46961598.pdf

Times Educational Supplement. 2014. 'When it comes to international comparisons, London schools are missing a Pisa the puzzle.' Accessed 19/05/2015 from https://www.tes.co.uk/news/school-news/breaking-news/when-it-comes-international-comparisons-london-schools-are-missing-a

Wyness, Gill. 2011. 'London' schooling: lessons from the capital.' Centreforum. Accessed 15/12/2015 from http://www.centreforum.org/assets/pubs/london-schooling.pdf

**Table 1. Sample sizes for cities / states**

| PISA explicit stratum | Assigned city/state label | 2009 | 2012 | Pooled |
|---|---|---|---|---|
| Macau | Macau | 5,952 | 5,335 | 11,287 |
| Singapore | Singapore | 5,283 | 5,546 | 10,829 |
| Dubai | Dubai | 5,620 | 4,974 | 10,594 |
| Shanghai | Shanghai | 5,115 | 5,177 | 10,292 |
| Hong Kong | Hong Kong | 4,837 | 4,670 | 9,507 |
| Ontario | Ontario | 4,151 | 3,699 | 7,850 |
| Québec | Québec | 3,676 | 4,166 | 7,842 |
| New South Wales | Sydney | 3,313 | 3,447 | 6,760 |
| Victoria | Melbourne | 2,296 | 2,406 | 4,702 |
| Urban Southern Finland | Helsinki | - | 4,312 | 4,312 |
| British Columbia | Vancouver | 2,367 | 1,816 | 4,183 |
| SE Wales | Cardiff | 1,568 | 1,995 | 3,563 |
| Attica | Athens | 1,648 | 1,662 | 3,310 |
| Reykjavik | Reykjavik | 2,148 | 1,123 | 3,271 |
| Western Australia | Perth | 1,486 | 1,738 | 3,224 |
| Abu Dhabi | Abu Dhabi | - | 3,163 | 3,163 |
| São Paulo | São Paulo | 1,164 | 1,948 | 3,112 |
| Lombardia | Milan | 1,512 | 1,523 | 3,035 |
| Madrid | Madrid | 1,453 | 1,542 | 2,995 |
| Lazio | Rome | 1,462 | 1,486 | 2,948 |
| Catalonia | Barcelona | 1,381 | 1,435 | 2,816 |
| Riga | Riga | 1,187 | 1,321 | 2,508 |
| Lisbon | Lisbon | 1,161 | 1,149 | 2,310 |
| Mexico State | Mexico State | 1,245 | 972 | 2,217 |
| Florida | Florida | - | 1,896 | 1,896 |
| Massachusetts | Massachusetts | - | 1,723 | 1,723 |
| Connecticut | Connecticut | - | 1,697 | 1,697 |
| Rio de Janeiro | Rio de Janeiro | 763 | 694 | 1,457 |
| Buenos Aires | Buenos Aires | - | 1,336 | 1,336 |
| Algarve | Algarve | 611 | 723 | 1,334 |
| Belgrade | Belgrade | 1,157 | - | 1,157 |
| SW Wales | Swansea | 549 | 564 | 1,113 |
| Greater London | London | 524 | 533 | 1,057 |
| Port of Spain | Port of Spain | 916 | - | 916 |
| Belfast | Belfast | 379 | 463 | 842 |
| Moscow | Moscow | 480 | - | 480 |
| Limburg | Maastricht | 280 | - | 280 |

**Notes**: Authors' calculations using the PISA 2009 and 2012 datasets.

**Table 2. A comparison on the PISA-London sample to the population**

| | NPD (population) | PISA (sample) | | |
|---|---|---|---|---|
| | **Percent** | **Percent** | **Lower 95% CI** | **Upper 95% CI** |
| **Free School Meals** | | | | |
| % FSM | 24 | 25 | 15 | 36 |
| **Gender** | | | | |
| % Male | 51 | 50 | 45 | 55 |
| **GCSE MATHS Grade** | | | | |
| % A* | 8 | 7 | 5 | 10 |
| % A | 14 | 10 | 6 | 15 |
| % B | 20 | 19 | 16 | 23 |
| % C | 29 | 38 | 32 | 44 |
| % D | 10 | 13 | 10 | 17 |
| % E | 5 | 5 | 3 | 6 |
| % F | 4 | 4 | 2 | 6 |
| % G | 3 | 2 | 0 | 5 |
| % U | 1 | 1 | 0 | 2 |
| Missing | 6 | 0 | - | - |
| **KS3 Maths level** | | | | |
| % Level 2 | 1 | 1 | 0 | 2 |
| % Level 3 | 4 | 3 | 1 | 5 |
| % Level 4 | 11 | 13 | 9 | 16 |
| % Level 5 | 21 | 29 | 21 | 37 |
| % Level 6 | 26 | 29 | 23 | 36 |
| % Level 7 | 20 | 16 | 9 | 22 |
| % Level 8 | 8 | 9 | 6 | 12 |
| % Missing | 6 | 1 | 0 | 2 |
| | **Mean** | **Mean** | **Lower 95% CI** | **Upper 95% CI** |
| **GCSE TPS** | | | | |
| Mean | 335 | 354 | 342.8 | 364.5 |
| **KS2 Maths Score** | | | | |
| Mean | 63.6 | 62.1 | 58 | 66.3 |
| **KS2 Total Score** | | | | |
| Mean | 82.1 | 81.6 | 78.5 | 84.6 |

**Notes**: All figures refer to state school pupils only (children attending independent schools have been excluded). Left-hand side based upon NPD data (for the population of 15 year olds in London). Right-hand side based upon the PISA sample.

## Table 3. London's position in the PISA rankings

| Maths | | | Reading | | | Science | | |
|---|---|---|---|---|---|---|---|---|
| **Country** | **Mean** | | **Country** | **Mean** | | **Country** | **Mean** | |
| Shanghai | 606 | ** | Shanghai | 562 | ** | Shanghai | 577 | ** |
| Singapore | 568 | ** | Hong Kong | 539 | ** | Hong Kong | 552 | ** |
| Hong Kong | 558 | ** | South Korea | 538 | ** | Finland | 550 | ** |
| Chinese Taipei | 551 | ** | Singapore | 534 | ** | Singapore | 547 | ** |
| South Korea | 550 | ** | Finland | 530 | ** | Japan | 543 | ** |
| Liechtenstein | 536 | ** | Japan | 529 | ** | South Korea | 538 | ** |
| Japan | 533 | ** | Canada | 524 | ** | Estonia | 534 | ** |
| Switzerland | 532 | ** | New Zealand | 517 | ** | Viet Nam | 528 | ** |
| Macedonia | 531 | ** | Australia | 513 | ** | Canada | 527 | ** |
| Finland | 530 | ** | Netherlands | 510 | ** | Australia | 524 | ** |
| Netherlands | 524 | ** | Ireland | 510 | ** | New Zealand | 524 | ** |
| Canada | 523 | ** | Chinese Taipei | 509 | ** | Germany | 522 | ** |
| Estonia | 516 | ** | Poland | 509 | ** | Liechtenstein | 522 | ** |
| Belgium | 515 | ** | Viet Nam | 508 | ** | Netherlands | 522 | ** |
| Germany | 513 | ** | Estonia | 508 | ** | Chinese Taipei | 522 | ** |
| Viet Nam | 511 | ** | Belgium | 507 | ** | Poland | 516 | * |
| New Zealand | 510 | ** | Liechtenstein | 507 | ** | Rest of UK | 516 | * |
| Australia | 509 | ** | Switzerland | 505 | ** | Switzerland | 516 | * |
| Poland | 505 | ** | Norway | 504 | * | Macedonia | 516 | * |
| Denmark | 502 | ** | Germany | 502 | * | Ireland | 515 | * |
| Slovenia | 501 | ** | France | 501 | - | Slovenia | 513 | - |
| Austria | 501 | ** | United States | 499 | - | Belgium | 506 | - |
| Iceland | 500 | ** | Rest of UK | 499 | - | Czech Republic | 504 | - |
| France | 496 | - | Macedonia | 497 | - | Austria | 500 | - |
| Czech Republic | 495 | - | Denmark | 496 | - | United States | 500 | - |
| Rest of UK | 495 | - | Iceland | 492 | - | Denmark | 499 | - |
| Ireland | 494 | - | Hungary | 492 | - | Hungary | 499 | - |
| Norway | 494 | - | Sweden | 491 | - | France | 499 | - |
| Slovak Republic | 490 | - | Portugal | 489 | - | Latvia | 497 | - |
| Luxembourg | 489 | - | Italy | 488 | - | Norway | 497 | - |
| Portugal | 487 | - | Latvia | 486 | - | LONDON | 497 | - |
| Sweden | 487 | - | Spain | 484 | - | Lithuania | 493 | - |
| Latvia | 485 | - | Czech Republic | 484 | - | Spain | 492 | - |
| United States | 484 | - | LONDON | 483 | - | Italy | 491 | - |
| Italy | 484 | - | Perm (Russia) | 482 | - | Portugal | 491 | - |
| Hungary | 484 | - | Slovenia | 482 | - | Sweden | 490 | - |
| Spain | 484 | - | Luxembourg | 480 | - | Croatia | 489 | - |
| Perm (Russia) | 484 | - | Croatia | 480 | - | Luxembourg | 488 | - |
| LONDON | 479 | - | Israel | 480 | - | Iceland | 487 | - |
| Lithuania | 478 | - | Greece | 480 | - | Russia | 482 | - |
| Russia | 475 | - | Austria | 480 | - | Slovak Republic | 482 | - |
| Croatia | 466 | - | Lithuania | 472 | - | Perm (Russia) | 480 | - |
| Malta | 463 | - | Slovak Republic | 471 | - | Greece | 468 | ** |
| Greece | 459 | * | Turkey | 470 | - | Israel | 463 | ** |
| Israel | 457 | ** | Russia | 467 | - | Malta | 461 | ** |
| Turkey | 447 | ** | Chile | 446 | ** | Turkey | 459 | ** |
| Serbia | 446 | ** | Serbia | 444 | ** | Chile | 446 | ** |
| Romania | 436 | ** | Malta | 442 | ** | Serbia | 444 | ** |
| Bulgaria | 433 | ** | Costa Rica | 442 | ** | UAE | 443 | ** |
| Azerbaijan | 431 | ** | UAE | 437 | ** | Bulgaria | 443 | ** |

**Notes**: Authors' calculations using the pooled PISA 2009 and 2012 datasets. Table restricted to top 50 performing economies only (results for another 26 not reported). * and ** indicates difference statistically significant at the 10 and 5 percent levels respectively. Final student and replicate weights applied.

**Table 4. London compared to other major international cities and states**

| Maths | | | Reading | | | Science | | |
|---|---|---|---|---|---|---|---|---|
| City / State | Mean | | City / State | Mean | | City / State | Mean | |
| Shanghai | 606 | ** | Shanghai | 562 | ** | Shanghai | 577 | ** |
| Singapore | 568 | ** | Hong Kong | 539 | ** | Hong Kong | 552 | ** |
| Hong Kong | 558 | ** | Singapore | 534 | ** | Singapore | 547 | ** |
| Limburg (Maastricht) | 543 | ** | British Columbia | 530 | ** | Helsinki | 546 | ** |
| Québec | 540 | ** | Ontario | 529 | ** | British Columbia | 540 | ** |
| Macau | 531 | ** | Massachusetts | 527 | ** | Western Australia | 537 | ** |
| British Columbia | 523 | ** | Helsinki | 525 | ** | Limburg (Maastricht) | 533 | ** |
| Western Australia | 522 | ** | Connecticut | 521 | ** | Ontario | 529 | ** |
| Ontario | 520 | ** | Lombardia (Milan) | 521 | ** | New South Wales | 528 | ** |
| Helsinki | 518 | ** | Québec | 521 | ** | Lombardia (Milan) | 527 | ** |
| Lombardia (Milan) | 516 | ** | Western Australia | 520 | ** | Massachusetts | 527 | ** |
| Massachusetts | 514 | ** | Limburg (Maastricht) | 516 | ** | Connecticut | 521 | ** |
| New South Wales | 511 | ** | Victoria | 515 | ** | Québec | 520 | ** |
| Moscow | 510 | * | New South Wales | 514 | ** | Victoria | 519 | ** |
| Reykjavik | 510 | ** | Riga | 508 | ** | Macau | 516 | * |
| Victoria | 506 | ** | Madrid | 507 | ** | Moscow | 515 | - |
| Connecticut | 506 | ** | Belfast | 505 | * | SW Wales | 514 | - |
| Riga | 505 | ** | Moscow | 501 | - | Riga | 513 | - |
| Madrid | 500 | * | Reykjavik | 500 | - | Madrid | 512 | - |
| Catalonia (Barcelona) | 494 | - | Catalonia (Barcelona) | 499 | - | Belfast | 510 | - |
| Lisbon | 488 | - | Macau | 497 | - | LONDON | 497 | - |
| Belfast | 487 | - | SW Wales | 495 | - | Lisbon | 496 | - |
| SW Wales | 484 | - | Lisbon | 494 | - | Reykjavik | 496 | - |
| LONDON | 479 | - | Attica | 494 | - | Catalonia (Barcelona) | 495 | - |
| Lazio (Rome) | 474 | - | Florida | 492 | - | SE Wales | 486 | - |
| Attica | 471 | - | LONDON | 483 | - | Florida | 485 | - |
| Algarve | 470 | - | Lazio (Rome) | 481 | - | Lazio (Rome) | 483 | - |
| Florida | 467 | - | SE Wales | 473 | - | Attica | 482 | - |
| SE Wales | 465 | - | Algarve | 470 | - | Algarve | 476 | * |
| Belgrade | 462 | - | Belgrade | 466 | - | Dubai | 471 | ** |
| Dubai | 459 | * | Dubai | 464 | * | Belgrade | 465 | ** |
| Port of Spain | 431 | ** | Mexico State | 439 | ** | Abu Dhabi | 440 | ** |
| Abu Dhabi | 421 | ** | Port of Spain | 434 | ** | Port of Spain | 433 | ** |
| Mexico State | 421 | ** | Abu Dhabi | 431 | ** | Mexico State | 425 | ** |
| Buenos Aires | 418 | ** | Buenos Aires | 429 | ** | Buenos Aires | 425 | ** |
| São Paulo | 397 | ** | São Paulo | 423 | ** | São Paulo | 414 | ** |
| Rio de Janeiro | 389 | ** | Rio de Janeiro | 411 | ** | Rio de Janeiro | 402 | ** |

**Notes**: Authors' calculations using the pooled PISA 2009 and 2012 datasets. * and ** indicates difference from London statistically significant at the 10 and 5 percent levels respectively. Final student and replicate weights applied.

**Table 5. London's position in the pooled PISA 2009 and 2012 PISA mathematics rankings: before and conditioning upon demographic characteristics**

| Unconditional | | | Conditional | | |
|---|---|---|---|---|---|
| **City/State** | **Difference** | **SE** | **City/State** | **Difference** | **SE** |
| Shanghai | 127** | 10.4 | Shanghai | 142** | 9.9 |
| Singapore | 88** | 10.8 | Hong Kong | 103** | 8.8 |
| Hong Kong | 79** | 10.5 | Singapore | 101** | 9.8 |
| Limburg (Maastricht) | 64** | 15.0 | Macau | 76** | 8.1 |
| Québec | 61** | 10.7 | Limburg (Maastricht) | 58** | 13.9 |
| Macau | 52** | 10.5 | Québec | 52** | 9.2 |
| British Columbia | 44** | 10.8 | Lombardia (Milan) | 38** | 9.8 |
| Western Australia | 43** | 11.2 | Western Australia | 37** | 9.4 |
| Ontario | 41** | 10.7 | British Columbia | 33** | 9.4 |
| Helsinki | 39** | 10.9 | Ontario | 29** | 8.7 |
| Lombardia (Milan) | 37** | 11.2 | Helsinki | 29** | 10.0 |
| Massachusetts | 34** | 12.2 | New South Wales | 26** | 9.7 |
| New South Wales | 32** | 10.9 | Massachusetts | 25** | 10.4 |
| Moscow | 31** | 14.7 | Catalonia (Barcelona) | 24** | 10.2 |
| Reykjavik | 31** | 10.7 | Madrid | 24** | 10.3 |
| Victoria | 27** | 10.7 | Moscow | 23* | 13.6 |
| Connecticut | 27** | 13.6 | Victoria | 21** | 9.3 |
| Riga | 27** | 12.0 | Riga | 20** | 10.2 |
| Madrid | 21* | 11.6 | Lisbon | 12 | 10.0 |
| Catalonia (Barcelona) | 16 | 11.3 | Connecticut | 11 | 11.1 |
| Rest of UK | 16 | 10.8 | Algarve | 6 | 10.6 |
| Lisbon | 9 | 11.5 | Rest of UK | 4 | 9.6 |
| Belfast | 9 | 11.5 | Belfast | 4 | 10.6 |
| SW Wales | 5 | 11.1 | Reykjavik | 2 | 9.6 |
| **LONDON** | **REFERENCE** | | SW Wales | 2 | 10.7 |
| Lazio (Rome) | -5 | 11.5 | **LONDON** | **REFERENCE** | |
| Attica | -8 | 11.1 | Lazio (Rome) | -10 | 10.2 |
| Algarve | -9 | 11.5 | Attica | -14 | 9.9 |
| Florida | -12 | 12.0 | Florida | -16 | 10.2 |
| SE Wales | -14 | 10.8 | SE Wales | -18* | 10.1 |
| Belgrade | -17 | 12.6 | Mexico State | -25** | 11.3 |
| Dubai | -20* | 10.5 | Dubai | -30** | 7.6 |
| Port-of-Spain | -48** | 11.0 | Belgrade | -31** | 11.2 |
| Abu Dhabi | -58** | 11.6 | Port-of-Spain | -37** | 9.9 |
| Mexico State | -58** | 12.3 | Buenos Aires | -51** | 10.8 |
| Buenos Aires | -61** | 12.6 | Sao Paulo | -52** | 10.6 |
| Sao Paulo | -82** | 10.8 | Rio de Janeiro | -60** | 11.3 |
| Rio de Janeiro | -90** | 12.3 | Abu Dhabi | -63** | 9.0 |

**Notes**: Authors' calculations using the pooled PISA 2009 and 2012 datasets. * and ** indicates difference statistically significant at the 10 and 5 percent levels respectively. Final student and replicate weights applied. 'Conditional' estimates where gender, socio-economic status and immigrant status have been controlled.

**Table 6. London PISA scores in sub-domains**

**A. Mathematics**

| | London | Rest of UK | OECD average |
|---|---|---|---|
| **Content** | | | |
| Change and relationships | 470 (15) | 500 (3) | 493 (0.6) |
| Quantity | 473 (18) | 497 (3) | 495 (0.5) |
| Space and Shape | 456 (13) | 478 (3) | 490 (0.5) |
| Uncertainty and data | 474 (11) | 506 (3) | 493 (0.5) |
| **Process** | | | |
| Employ | 473 (13) | 494 (3) | 493 (0.5) |
| Formulate | 457 (15) | 493 (3) | 492 (0.5) |
| Interpret | 475 (17) | 505 (3) | 497 (0.5) |

**B. Reading**

| | London | Rest of UK | OECD average |
|---|---|---|---|
| **Aspect categories** | | | |
| Access and retrieve | 487 (14) | 492 (4) | 495 (0.5) |
| Integrate and interpret | 492 (12) | 490 (2) | 493 (0.5) |
| Reflect and evaluate | 503 (13) | 503 (2) | 494 (0.5) |
| **Text formats** | | | |
| Continuous | 489 (13) | 492 (2) | 494 (0.5) |
| Non-continuous | 508 (11) | 505 (2) | 493 (0.5) |

**Notes**: Authors' calculations using the PISA public use dataset. Mathematics (reading) estimates produced using PISA 2012 (2009) dataset only. OECD average taken from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/299658/programme-for-international-student-assessment-pisa-2012-national-report-for-england.pdf and https://www.nfer.ac.uk/publications/NPDZ01/NPDZ01.pdf

**Table 7. London's position in the PISA problem solving rankings**

| Country rankings | | | City rankings | | |
|---|---|---|---|---|---|
| **Country** | **Mean** | | **City / State** | **Mean** | |
| Singapore | 562 | ** | Singapore | 562 | ** |
| South Korea | 561 | ** | Macau | 540 | ** |
| Japan | 552 | ** | Hong Kong | 540 | ** |
| Macedonia | 540 | ** | Lombardia (Milan) | 539 | ** |
| Hong Kong | 540 | ** | Shanghai | 536 | ** |
| Shanghai | 536 | ** | British Columbia | 535 | ** |
| Chinese Taipei | 534 | ** | Western Australia | 528 | * |
| Canada | 526 | - | Ontario | 528 | - |
| Australia | 523 | - | New South Wales | 525 | - |
| Finland | 523 | - | Quebec | 525 | - |
| Rest of UK | 519 | - | Victoria | 523 | - |
| Estonia | 515 | - | Helsinki | 521 | - |
| France | 511 | - | Madrid | 507 | - |
| Netherlands | 511 | - | LONDON | 505 | - |
| Czech Republic | 509 | - | Lazio (Rome) | 501 | - |
| Germany | 509 | - | Lisbon | 500 | - |
| United States | 508 | - | Catalonia (Barcelona) | 488 | - |
| Belgium | 508 | - | Algarve | 487 | - |
| Italy | 507 | - | Dubai | 457 | ** |
| Austria | 506 | - | São Paulo | 443 | ** |
| LONDON | 505 | - | Rio de Janeiro | 443 | ** |
| Norway | 503 | - | Abu Dhabi | 391 | ** |
| Ireland | 498 | - | | | |
| Denmark | 497 | - | | | |
| Portugal | 494 | - | | | |
| Sweden | 491 | - | | | |
| Russia | 489 | - | | | |
| Slovak Republic | 483 | - | | | |
| Poland | 481 | * | | | |
| Spain | 479 | * | | | |
| Slovenia | 476 | ** | | | |
| Serbia | 473 | ** | | | |
| Croatia | 466 | ** | | | |
| Hungary | 459 | ** | | | |
| Turkey | 454 | ** | | | |
| Israel | 454 | ** | | | |
| Chile | 448 | ** | | | |
| Brazil | 434 | ** | | | |
| Malaysia | 422 | ** | | | |
| UAE | 411 | ** | | | |
| Montenegro | 407 | ** | | | |
| Uruguay | 403 | ** | | | |
| Bulgaria | 402 | ** | | | |
| Columbia | 399 | ** | | | |

**Notes**: Authors' calculations using the PISA 2012 dataset. * and ** indicates difference from London statistically significant at the 10 and 5 percent levels respectively. Final student and replicate weights applied.

## Table 8. London's children's 'non-cognitive' skills

| Work ethic | | | Perseverance | | | Attributions to failure | | |
|---|---|---|---|---|---|---|---|---|
| City/state | Mean | | City/state | Mean | | City/state | Mean | |
| Helsinki | -0.50 | ** | Catalonia (Barcelona) | -0.39 | ** | Shanghai | -0.39 | * |
| Riga | -0.40 | ** | Lombardia (Milan) | -0.29 | ** | Singapore | -0.39 | * |
| Buenos Aires | -0.32 | ** | Attica | -0.24 | ** | Massachusetts | -0.36 | - |
| New South Wales | -0.21 | ** | Reykjavik | -0.19 | ** | Reykjavik | -0.33 | - |
| Attica | -0.20 | ** | SW Wales | -0.17 | * | LONDON | -0.30 | - |
| Western Australia | -0.19 | ** | Helsinki | -0.16 | * | Hong Kong | -0.30 | - |
| Lombardia (Milan) | -0.19 | ** | SE Wales | -0.16 | - | Connecticut | -0.29 | - |
| Hong Kong | -0.19 | ** | Québec | -0.15 | - | Florida | -0.23 | - |
| Catalonia (Barcelona) | -0.14 | * | Western Australia | -0.09 | - | Mexico State | -0.20 | - |
| Lisbon | -0.13 | * | São Paulo | -0.08 | - | Ontario | -0.18 | ** |
| Macau | -0.12 | * | Victoria | -0.07 | - | British Columbia | -0.18 | ** |
| Victoria | -0.11 | * | Hong Kong | -0.06 | - | SE Wales | -0.16 | ** |
| Algarve | -0.10 | - | Buenos Aires | -0.05 | - | New South Wales | -0.15 | ** |
| Madrid | -0.08 | - | New South Wales | -0.05 | - | Belfast | -0.15 | * |
| Ontario | -0.07 | - | Macau | -0.03 | - | Western Australia | -0.15 | ** |
| Lazio (Rome) | -0.06 | - | Belfast | -0.03 | - | Victoria | -0.14 | ** |
| São Paulo | -0.04 | - | LONDON | -0.01 | - | SW Wales | -0.13 | ** |
| British Columbia | -0.03 | - | Lazio (Rome) | 0.00 | - | Helsinki | -0.05 | ** |
| SW Wales | -0.02 | - | Madrid | 0.01 | - | Dubai | -0.04 | ** |
| Québec | -0.01 | - | Shanghai | 0.06 | - | Macau | -0.03 | ** |
| Rio de Janeiro | 0.06 | - | Rio de Janeiro | 0.07 | - | São Paulo | 0.09 | ** |
| LONDON | 0.07 | - | British Columbia | 0.10 | - | Québec | 0.14 | ** |
| SE Wales | 0.08 | - | Riga | 0.11 | - | Abu Dhabi | 0.16 | ** |
| Mexico State | 0.10 | - | Singapore | 0.11 | - | Lombardia (Milan) | 0.19 | ** |
| Florida | 0.11 | - | Ontario | 0.13 | - | Lazio (Rome) | 0.21 | ** |
| Shanghai | 0.15 | - | Algarve | 0.14 | - | Riga | 0.21 | ** |
| Singapore | 0.18 | - | Mexico State | 0.16 | * | Catalonia (Barcelona) | 0.22 | ** |
| Massachusetts | 0.21 | - | Massachusetts | 0.17 | ** | Rio de Janeiro | 0.22 | ** |
| Connecticut | 0.22 | - | Lisbon | 0.19 | ** | Madrid | 0.31 | ** |
| Belfast | 0.24 | - | Florida | 0.20 | ** | Algarve | 0.32 | ** |
| Reykjavik | 0.24 | - | Abu Dhabi | 0.22 | ** | Buenos Aires | 0.35 | ** |
| Dubai | 0.39 | ** | Dubai | 0.24 | ** | Lisbon | 0.35 | ** |
| Abu Dhabi | 0.56 | ** | Connecticut | 0.26 | ** | Attica | 0.39 | ** |

**Notes**: Authors' calculations using the PISA 2012 dataset. * and ** indicates statistical significant difference from London at the 10 and 5 percent levels respectively. Final student and replicate weights applied.

**Table 9. OLS regression model estimates**

| | M1 | | M2 | | M3 | | M4 | |
|---|---|---|---|---|---|---|---|---|
| | **Beta** | **SE** | **Beta** | **SE** | **Beta** | **SE** | **Beta** | **SE** |
| **Location (Ref: Rest of England)** | | | | | | | | |
| London | -18.5* | 11.3 | -22.3** | 7.2 | -11.2 | 7.4 | -10.8* | 6.6 |
| **SES (Ref: Most advantaged 20%)** | | | | | | | | |
| Second quintile | - | - | - | - | -2.8 | 2.2 | -2.2 | 2.1 |
| Third quintile | - | - | - | - | -9.6** | 2.6 | -8.4** | 2.5 |
| Fourth quintile | - | - | - | - | -13.7** | 3.3 | -11.8** | 3.1 |
| Most disadvantaged 20% | - | - | - | - | -19.2** | 3.3 | -16.3** | 3.1 |
| **Ethnicity (Ref: White)** | | | | | | | | |
| Other | - | - | - | - | -18.8** | 7.6 | -10.7 | 7.7 |
| Asian | - | - | - | - | -29.6** | 3.8 | -21.8** | 3.6 |
| Black | - | - | - | - | -26.2** | 5.6 | -18.1** | 5.5 |
| Mixed | - | - | - | - | -2.9 | 5.1 | -1 | 4.9 |
| Unclassified | - | - | - | - | -7.3 | 7.5 | -2.8 | 7.6 |
| **Additional controls** | | | | | | | | |
| GCSE Maths score | - | - | √ | √ | √ | √ | √ | √ |
| GCSE capped points score | - | - | √ | √ | √ | √ | √ | √ |
| Gender | - | - | - | - | √ | √ | √ | √ |
| Key Stage 2 points scores | - | - | - | - | - | - | √ | √ |
| R-Squared | 0.01 | | 0.58 | | 0.61 | | 0.63 | |
| Number of observations | 7,311 | | 7,310 | | 7,310 | | 7,310 | |

**Notes**: Authors' calculations using the PISA-NPD 2009 and 2012 datasets. All estimates refer to state school children only (figures may therefore differ slightly compared to previous tables). * and ** indicate parameter estimate significantly different from zero at the 10 percent and 5 percent levels respectively. 'SES' refers to socio-economic status.

## Appendix A. Results for PISA mathematics test scores (2009, 2012 and pooled)

| 2009 | | | 2012 | | | Pooled | | |
|---|---|---|---|---|---|---|---|---|
| **Country** | **Mean** | | **Country** | **Mean** | | **Country** | **Mean** | |
| Shanghai | 600 | ** | Shanghai | 613 | ** | Shanghai | 606 | ** |
| Singapore | 562 | ** | Singapore | 573 | ** | Singapore | 568 | ** |
| Hong Kong | 555 | ** | Hong Kong | 561 | ** | Hong Kong | 558 | ** |
| South Korea | 546 | ** | Chinese Taipei | 560 | ** | Chinese Taipei | 551 | ** |
| Chinese Taipei | 543 | ** | South Korea | 554 | ** | South Korea | 550 | ** |
| Finland | 541 | ** | Macedonia | 538 | ** | Liechtenstein | 536 | ** |
| Liechtenstein | 536 | ** | Japan | 536 | ** | Japan | 533 | ** |
| Switzerland | 534 | ** | Liechtenstein | 535 | ** | Switzerland | 532 | ** |
| Japan | 529 | ** | Switzerland | 531 | ** | Macedonia | 531 | ** |
| Canada | 527 | ** | Netherlands | 523 | ** | Finland | 530 | ** |
| Netherlands | 526 | ** | Estonia | 521 | ** | Netherlands | 524 | ** |
| Macedonia | 525 | ** | Finland | 519 | ** | Canada | 523 | ** |
| New Zealand | 519 | ** | Canada | 518 | ** | Estonia | 516 | ** |
| Belgium | 515 | ** | Poland | 518 | ** | Belgium | 515 | ** |
| Australia | 514 | ** | Belgium | 515 | ** | Germany | 513 | ** |
| Germany | 513 | * | Germany | 514 | ** | Viet Nam | 511 | ** |
| Estonia | 512 | * | Viet Nam | 511 | ** | New Zealand | 510 | ** |
| Iceland | 507 | - | Austria | 506 | ** | Australia | 509 | ** |
| Denmark | 503 | - | Australia | 504 | ** | Poland | 505 | ** |
| Slovenia | 501 | - | Ireland | 501 | ** | Denmark | 502 | ** |
| Norway | 498 | - | Slovenia | 501 | ** | Slovenia | 501 | ** |
| France | 497 | - | Denmark | 500 | ** | Austria | 501 | ** |
| Slovak Republic | 497 | - | New Zealand | 500 | ** | Iceland | 500 | ** |
| Austria | 496 | - | Czech Republic | 499 | * | France | 496 | - |
| Poland | 495 | - | Rest of UK | 497 | * | Czech Republic | 495 | - |
| Sweden | 494 | - | France | 495 | - | Rest of UK | 495 | - |
| Rest of UK | 493 | - | Iceland | 493 | - | Ireland | 494 | - |
| Czech Republic | 493 | - | Latvia | 491 | - | Norway | 494 | - |
| Hungary | 490 | - | Luxembourg | 490 | - | Slovak Republic | 490 | - |
| Luxembourg | 489 | - | Norway | 489 | - | Luxembourg | 489 | - |
| LONDON | 489 | - | Portugal | 487 | - | Portugal | 487 | - |
| United States | 487 | - | Italy | 485 | - | Sweden | 487 | - |
| Ireland | 487 | - | Spain | 484 | - | Latvia | 485 | - |
| Portugal | 487 | - | Perm (Russia) | 484 | - | United States | 484 | - |
| Spain | 483 | - | Russia | 482 | - | Italy | 484 | - |
| Italy | 483 | - | Slovak Republic | 482 | - | Hungary | 484 | - |
| Latvia | 482 | - | United States | 481 | - | Spain | 484 | - |
| Lithuania | 477 | - | Lithuania | 479 | - | Perm (Russia) | 484 | - |
| Russia | 468 | - | Sweden | 478 | - | LONDON | 479 | - |
| Greece | 466 | * | Hungary | 477 | - | Lithuania | 478 | - |
| Malta | 463 | ** | Croatia | 471 | - | Russia | 475 | - |
| Croatia | 460 | ** | LONDON | 470 | - | Croatia | 466 | - |
| Israel | 447 | ** | Israel | 466 | - | Malta | 463 | - |
| Turkey | 445 | ** | Greece | 453 | - | Greece | 459 | * |
| Serbia | 442 | ** | Serbia | 449 | - | Israel | 457 | ** |
| Azerbaijan | 431 | ** | Turkey | 448 | - | Turkey | 447 | ** |
| Bulgaria | 428 | ** | Romania | 445 | - | Serbia | 446 | ** |
| Romania | 427 | ** | Bulgaria | 439 | ** | Romania | 436 | ** |
| Uruguay | 427 | ** | UAE | 434 | ** | Bulgaria | 433 | ** |
| UAE | 421 | ** | Kazakhstan | 432 | ** | Azerbaijan | 431 | ** |

## Appendix B. Results for PISA reading test scores (2009, 2012 and pooled)

| 2009 | | | 2012 | | | Pooled | | |
|---|---|---|---|---|---|---|---|---|
| **Country** | **Mean** | | **Country** | **Mean** | | **Country** | **Mean** | |
| Shanghai | 556 | ** | Shanghai | 570 | ** | Shanghai | 562 | ** |
| South Korea | 539 | ** | Hong Kong | 545 | ** | Hong Kong | 539 | ** |
| Finland | 536 | ** | Singapore | 542 | ** | South Korea | 538 | ** |
| Hong Kong | 533 | ** | Japan | 538 | ** | Singapore | 534 | ** |
| Singapore | 526 | ** | South Korea | 536 | ** | Finland | 530 | ** |
| Canada | 524 | ** | Finland | 524 | ** | Japan | 529 | ** |
| New Zealand | 521 | ** | Ireland | 523 | ** | Canada | 524 | ** |
| Japan | 520 | * | Canada | 523 | ** | New Zealand | 517 | ** |
| Australia | 515 | - | Chinese Taipei | 523 | ** | Australia | 513 | ** |
| Netherlands | 508 | - | Poland | 518 | ** | Netherlands | 510 | ** |
| Belgium | 506 | - | Estonia | 516 | ** | Ireland | 510 | ** |
| Norway | 503 | - | Liechtenstein | 516 | ** | Chinese Taipei | 509 | ** |
| Estonia | 501 | - | New Zealand | 512 | ** | Poland | 509 | ** |
| Switzerland | 501 | - | Australia | 512 | ** | Viet Nam | 508 | ** |
| Poland | 500 | - | Netherlands | 511 | ** | Estonia | 508 | ** |
| Iceland | 500 | - | Switzerland | 509 | ** | Belgium | 507 | ** |
| United States | 500 | - | Macedonia | 509 | ** | Liechtenstein | 507 | ** |
| Liechtenstein | 499 | - | Belgium | 509 | ** | Switzerland | 505 | ** |
| Sweden | 497 | - | Viet Nam | 508 | ** | Norway | 504 | * |
| Germany | 497 | - | Germany | 508 | ** | Germany | 502 | * |
| Ireland | 496 | - | France | 505 | * | France | 501 | - |
| France | 496 | - | Norway | 504 | * | United States | 499 | - |
| Chinese Taipei | 495 | - | Rest of UK | 503 | * | Rest of UK | 499 | - |
| Denmark | 495 | - | United States | 498 | - | Macedonia | 497 | - |
| LONDON | 495 | - | Denmark | 496 | - | Denmark | 496 | - |
| Hungary | 494 | - | Czech Republic | 493 | - | Iceland | 492 | - |
| Rest of UK | 494 | - | Italy | 490 | - | Hungary | 492 | - |
| Portugal | 489 | - | Austria | 490 | - | Sweden | 491 | - |
| Macedonia | 487 | - | Latvia | 489 | - | Portugal | 489 | - |
| Italy | 486 | - | Hungary | 488 | - | Italy | 488 | - |
| Latvia | 484 | - | Spain | 488 | - | Latvia | 486 | - |
| Slovenia | 483 | - | Luxembourg | 488 | - | Spain | 484 | - |
| Greece | 483 | - | Portugal | 488 | - | Czech Republic | 484 | - |
| Spain | 481 | - | Israel | 486 | - | LONDON | 483 | - |
| Czech Republic | 478 | - | Croatia | 485 | - | Perm (Russia) | 482 | - |
| Slovak Republic | 477 | - | Sweden | 483 | - | Slovenia | 482 | - |
| Croatia | 476 | - | Iceland | 483 | - | Luxembourg | 480 | - |
| Israel | 474 | - | Perm (Russia) | 482 | - | Croatia | 480 | - |
| Luxembourg | 472 | * | Slovenia | 481 | - | Israel | 480 | - |
| Austria | 470 | * | Lithuania | 477 | - | Greece | 480 | - |
| Lithuania | 468 | ** | Greece | 477 | - | Austria | 480 | - |
| Turkey | 464 | ** | Turkey | 475 | - | Lithuania | 472 | - |
| Russia | 459 | ** | Russia | 475 | - | Slovak Republic | 471 | - |
| Chile | 449 | ** | LONDON | 472 | - | Turkey | 470 | - |
| Costa Rica | 443 | ** | Slovak Republic | 463 | - | Russia | 467 | - |
| Malta | 442 | ** | Serbia | 446 | - | Chile | 446 | ** |
| Serbia | 442 | ** | UAE | 442 | * | Serbia | 444 | ** |
| UAE | 431 | ** | Chile | 441 | * | Malta | 442 | ** |
| Bulgaria | 429 | ** | Thailand | 441 | * | Costa Rica | 442 | ** |
| Uruguay | 426 | ** | Costa Rica | 441 | * | UAE | 437 | ** |

## Appendix C. Results for PISA science test scores

| 2009 | | | 2012 | | | Pooled | | |
|---|---|---|---|---|---|---|---|---|
| **Country** | **Mean** | | **Country** | **Mean** | | **Country** | **Mean** | |
| Shanghai | 575 | ** | Shanghai | 580 | ** | Shanghai | 577 | ** |
| Finland | 554 | ** | Hong Kong | 555 | ** | Hong Kong | 552 | ** |
| Hong Kong | 549 | ** | Singapore | 551 | ** | Finland | 550 | ** |
| Singapore | 542 | ** | Japan | 547 | ** | Singapore | 547 | ** |
| Japan | 539 | ** | Finland | 545 | ** | Japan | 543 | ** |
| South Korea | 538 | ** | Estonia | 541 | ** | South Korea | 538 | ** |
| New Zealand | 532 | ** | South Korea | 538 | ** | Estonia | 534 | ** |
| Canada | 529 | ** | Viet Nam | 528 | ** | Viet Nam | 528 | ** |
| Estonia | 528 | * | Poland | 526 | ** | Canada | 527 | ** |
| Australia | 527 | * | Canada | 525 | ** | Australia | 524 | ** |
| Netherlands | 522 | - | Liechtenstein | 525 | ** | New Zealand | 524 | ** |
| Chinese Taipei | 520 | - | Germany | 524 | ** | Germany | 522 | ** |
| Germany | 520 | - | Chinese Taipei | 523 | ** | Liechtenstein | 522 | ** |
| Liechtenstein | 520 | - | Netherlands | 522 | ** | Netherlands | 522 | ** |
| Switzerland | 517 | - | Ireland | 522 | ** | Chinese Taipei | 522 | ** |
| Rest of UK | 515 | - | Australia | 521 | ** | Poland | 516 | * |
| Slovenia | 512 | - | Macedonia | 521 | ** | Rest of UK | 516 | * |
| Macedonia | 511 | - | Rest of UK | 518 | * | Switzerland | 516 | * |
| Poland | 508 | - | New Zealand | 516 | * | Macedonia | 516 | * |
| Ireland | 508 | - | Switzerland | 515 | * | Ireland | 515 | * |
| Belgium | 507 | - | Slovenia | 514 | * | Slovenia | 513 | - |
| LONDON | 506 | - | Czech Republic | 508 | - | Belgium | 506 | - |
| Hungary | 503 | - | Austria | 506 | - | Czech Republic | 504 | - |
| United States | 502 | - | Belgium | 505 | - | Austria | 500 | - |
| Czech Republic | 500 | - | Latvia | 502 | - | United States | 500 | - |
| Norway | 500 | - | France | 499 | - | Denmark | 499 | - |
| Denmark | 499 | - | Denmark | 498 | - | Hungary | 499 | - |
| France | 498 | - | United States | 497 | - | France | 499 | - |
| Iceland | 496 | - | Spain | 496 | - | Latvia | 497 | - |
| Sweden | 495 | - | Lithuania | 496 | - | Norway | 497 | - |
| Austria | 494 | - | Norway | 495 | - | LONDON | 497 | - |
| Latvia | 494 | - | Hungary | 494 | - | Lithuania | 493 | - |
| Portugal | 493 | - | Italy | 494 | - | Spain | 492 | - |
| Lithuania | 491 | - | Croatia | 491 | - | Italy | 491 | - |
| Slovak Republic | 490 | - | Luxembourg | 491 | - | Portugal | 491 | - |
| Italy | 489 | - | Portugal | 489 | - | Sweden | 490 | - |
| Spain | 488 | - | LONDON | 488 | - | Croatia | 489 | - |
| Croatia | 486 | - | Russia | 486 | - | Luxembourg | 488 | - |
| Luxembourg | 484 | * | Sweden | 485 | - | Iceland | 487 | - |
| Russia | 478 | ** | Perm (Russia) | 480 | - | Russia | 482 | - |
| Greece | 470 | ** | Iceland | 478 | - | Slovak Republic | 482 | - |
| Malta | 461 | ** | Slovak Republic | 471 | - | Perm (Russia) | 480 | - |
| Israel | 455 | ** | Israel | 470 | - | Greece | 468 | ** |
| Turkey | 454 | ** | Greece | 467 | - | Israel | 463 | ** |
| Chile | 447 | ** | Turkey | 463 | - | Malta | 461 | ** |
| Serbia | 443 | ** | UAE | 448 | ** | Turkey | 459 | ** |
| Bulgaria | 439 | ** | Bulgaria | 446 | ** | Chile | 446 | ** |
| UAE | 438 | ** | Chile | 445 | ** | Serbia | 444 | ** |
| Costa Rica | 430 | ** | Serbia | 445 | ** | UAE | 443 | ** |
| Romania | 428 | ** | Thailand | 444 | ** | Bulgaria | 443 | ** |

## Appendix D. London's position in the pooled PISA 2009 and 2012 PISA mathematics rankings: before and conditioning upon demographic characteristics

| Unconditional | | | Conditional | | |
|---|---|---|---|---|---|
| **Country** | **Difference** | **SE** | **Country** | **Difference** | **SE** |
| Shanghai | 126** | 10.5 | Shanghai | 143** | 8.8 |
| Singapore | 88** | 10.9 | Singapore | 105** | 8.9 |
| Hong Kong | 78** | 10.6 | Viet Nam | 102** | 9.1 |
| Chinese Taipei | 72** | 10.7 | Hong Kong | 101** | 9.2 |
| South Korea | 70** | 10.7 | Chinese Taipei | 90** | 8.8 |
| Liechtenstein | 56** | 11.9 | Macau-China | 87** | 7.3 |
| Japan | 53** | 11.2 | South Korea | 69** | 9.7 |
| Switzerland | 53** | 10.6 | Liechtenstein | 52** | 9.6 |
| Macau-China | 52** | 10.6 | Japan | 51** | 10.2 |
| Finland | 50** | 10.6 | Switzerland | 50** | 8.4 |
| Netherlands | 45** | 11.0 | Netherlands | 36** | 9.1 |
| Canada | 43** | 10.6 | Poland | 35** | 9.0 |
| Estonia | 36** | 10.3 | Finland | 34** | 9.5 |
| Belgium | 36** | 10.6 | New Zealand | 31** | 9.1 |
| Germany | 35** | 10.9 | Belgium | 31** | 8.5 |
| Viet Nam | 31** | 11.4 | Germany | 29** | 8.6 |
| New Zealand | 31** | 10.9 | Canada | 29** | 8.3 |
| Australia | 30** | 10.6 | Estonia | 27** | 9.1 |
| Poland | 26** | 10.6 | Slovenia | 24** | 8.8 |
| Denmark | 22** | 10.8 | Portugal | 23** | 9.1 |
| Slovenia | 22** | 10.6 | Australia | 21** | 8.4 |
| Austria | 21** | 10.8 | Slovak Republic | 21** | 9.4 |
| Iceland | 21** | 10.7 | Austria | 19** | 8.5 |
| France | 17 | 10.7 | Czech Republic | 17** | 8.5 |
| Rest of UK | 16 | 10.8 | France | 16 | 9.4 |
| Czech Republic | 16 | 10.6 | Spain | 14 | 8.7 |
| Ireland | 15 | 10.7 | Turkey | 11 | 10.6 |
| Norway | 14 | 10.6 | Luxemburg | 10 | 8.3 |
| Slovak Republic | 10 | 11.0 | Latvia | 10 | 9.3 |
| Luxemburg | 10 | 10.7 | Ireland | 8 | 9.4 |
| Sweden | 8 | 10.4 | Denmark | 8 | 8.6 |
| Portugal | 7 | 10.8 | Russia | 6 | 9.2 |
| Latvia | 6 | 10.4 | Italy | 6 | 9.6 |
| USA | 5 | 11.0 | Rest of UK | 4 | 9.6 |
| Italy | 4 | 10.7 | USA | 4 | 9.0 |
| Hungary | 4 | 10.7 | Hungary | 3 | 9.6 |
| Spain | 4 | 10.8 | Sweden | 2 | 8.6 |
| **LONDON** | **REFERENCE** | | **LONDON** | **REFERENCE** | |
| Lithuania | -2 | 11.1 | Lithuania | -2 | 10.0 |
| Russia | -5 | 11.0 | Norway | -4 | 9.1 |
| Croatia | -14 | 10.9 | Thailand | -4 | 9.0 |
| Malta | -14 | 10.6 | Iceland | -8 | 9.7 |
| Greece | -20* | 10.7 | Croatia | -12 | 9.6 |
| Israel | -21* | 11.2 | Malta | -16* | 9.7 |
| Turkey | -33** | 10.7 | Israel | -20** | 9.8 |
| Serbia | -34** | 10.8 | Greece | -24** | 9.4 |
| Romania | -44** | 11.0 | Azerbaijan | -25** | 8.6 |

**Notes**: Authors' calculations using the pooled PISA 2009 and 2012 datasets. * and ** indicates difference statistically significant at the 10 and 5 percent levels respectively. Final student and replicate weights applied. 'Conditional' estimates where gender, socio-economic status and immigrant status have been controlled.

**Appendix E. Comparison of pupil demographic characteristics in London to the rest of England (based upon PISA sample)**

| | Rest of England | London |
|---|---|---|
| **Socio-economic status** | | |
| % most advantaged 20 percent | 20 | 15 |
| % Second quintile | 20 | 17 |
| % Third quintile | 19 | 21 |
| % Fourth quintile | 19 | 21 |
| % least advantaged 20 percent | 19 | 21 |
| **Ethnicity** | | |
| White | 88 | 50 |
| Other | 1 | 5 |
| Asian | 6 | 14 |
| Black | 2 | 22 |
| Mixed | 3 | 6 |
| Unclassified | 1 | 3 |

## Appendix F. Average PISA test scores by gender (pooled 2009 and 2012 data)

a. Mathematics

| Boys | | | Girls | | |
|---|---|---|---|---|---|
| **Country** | **Mean** | | **Country** | **Mean** | |
| Shanghai | 607 | ** | Shanghai | 605 | ** |
| Singapore | 568 | ** | Singapore | 567 | ** |
| Hong Kong | 565 | ** | Hong Kong | 550 | ** |
| South Korea | 555 | ** | Chinese Taipei | 549 | ** |
| Chinese Taipei | 554 | ** | South Korea | 544 | ** |
| Liechtenstein | 547 | ** | Finland | 530 | ** |
| Switzerland | 541 | ** | Macedonia | 528 | ** |
| Japan | 539 | ** | Japan | 526 | ** |
| Macedonia | 535 | ** | Switzerland | 524 | ** |
| Netherlands | 531 | ** | Liechtenstein | 523 | ** |
| Finland | 530 | ** | Netherlands | 518 | ** |
| Canada | 528 | ** | Canada | 517 | ** |
| Belgium | 523 | ** | Estonia | 513 | ** |
| Germany | 520 | * | Viet Nam | 507 | ** |
| Estonia | 520 | * | Belgium | 507 | ** |
| Viet Nam | 517 | - | Germany | 506 | ** |
| New Zealand | 515 | - | New Zealand | 504 | ** |
| Australia | 515 | - | Australia | 504 | ** |
| Austria | 511 | - | Poland | 503 | ** |
| Denmark | 509 | - | Iceland | 501 | ** |
| Poland | 507 | - | Slovenia | 500 | ** |
| Rest of UK | 502 | - | Denmark | 494 | ** |
| Slovenia | 502 | - | Norway | 492 | ** |
| France | 502 | - | Czech Republic | 491 | ** |
| Luxembourg | 500 | - | Austria | 490 | ** |
| Ireland | 500 | - | France | 490 | ** |
| Iceland | 499 | - | Ireland | 489 | ** |
| Czech Republic | 499 | - | Sweden | 488 | ** |
| Norway | 495 | - | Rest of UK | 488 | ** |
| LONDON | 495 | - | Slovak Republic | 487 | ** |
| Portugal | 493 | - | Latvia | 486 | ** |
| Spain | 493 | - | Portugal | 481 | * |
| Slovak Republic | 493 | - | Perm (Russia) | 480 | - |
| Italy | 492 | - | Lithuania | 479 | - |
| United States | 490 | - | Hungary | 479 | - |
| Hungary | 490 | - | Luxembourg | 478 | - |
| Perm (Russia) | 487 | - | United States | 478 | - |
| Sweden | 486 | - | Italy | 476 | - |
| Latvia | 485 | - | Spain | 475 | - |
| Lithuania | 476 | - | Russia | 474 | - |
| Russia | 475 | - | Malta | 470 | - |
| Croatia | 471 | * | LONDON | 462 | - |
| Greece | 465 | ** | Croatia | 460 | - |
| Israel | 462 | ** | Greece | 454 | - |
| Malta | 455 | ** | Israel | 452 | - |
| Turkey | 451 | ** | Turkey | 442 | - |
| Serbia | 451 | ** | Serbia | 440 | * |
| Romania | 437 | ** | Bulgaria | 435 | ** |
| Azerbaijan | 435 | ** | Romania | 434 | ** |
| Chile | 433 | ** | UAE | 431 | ** |

## b. Reading

| Boys | | | Girls | | |
|---|---|---|---|---|---|
| **Country** | **Mean** | | **Country** | **Mean** | |
| Shanghai | 546 | ** | Shanghai | 578 | ** |
| Hong Kong | 525 | ** | Finland | 560 | ** |
| South Korea | 524 | ** | Hong Kong | 554 | ** |
| Singapore | 518 | ** | South Korea | 553 | ** |
| Japan | 514 | ** | Singapore | 550 | ** |
| Canada | 506 | * | Japan | 545 | ** |
| Finland | 501 | - | Canada | 541 | ** |
| Netherlands | 497 | - | New Zealand | 537 | ** |
| New Zealand | 497 | - | Poland | 532 | ** |
| Australia | 496 | - | Australia | 531 | ** |
| Liechtenstein | 493 | - | Estonia | 531 | ** |
| Ireland | 493 | - | Norway | 528 | ** |
| Belgium | 493 | - | Ireland | 527 | ** |
| Viet Nam | 492 | - | Chinese Taipei | 527 | ** |
| Chinese Taipei | 491 | - | Germany | 524 | ** |
| Estonia | 486 | - | Switzerland | 524 | ** |
| Switzerland | 486 | - | Netherlands | 523 | ** |
| Poland | 485 | - | Viet Nam | 523 | ** |
| United States | 485 | - | Belgium | 522 | ** |
| Rest of UK | 485 | - | Liechtenstein | 522 | ** |
| Germany | 482 | - | France | 521 | ** |
| Norway | 481 | - | Iceland | 516 | ** |
| Denmark | 481 | - | Sweden | 515 | ** |
| Macedonia | 480 | - | Macedonia | 515 | ** |
| France | 479 | - | United States | 513 | ** |
| LONDON | 478 | - | Rest of UK | 512 | ** |
| Hungary | 472 | - | Latvia | 511 | ** |
| Spain | 470 | - | Slovenia | 511 | ** |
| Portugal | 469 | - | Hungary | 511 | ** |
| Iceland | 468 | - | Denmark | 510 | ** |
| Italy | 467 | - | Italy | 510 | * |
| Sweden | 467 | - | Czech Republic | 508 | * |
| Perm (Russia) | 465 | - | Portugal | 508 | * |
| Luxembourg | 463 | - | Croatia | 506 | - |
| Czech Republic | 463 | - | Greece | 504 | - |
| Latvia | 461 | - | Perm (Russia) | 501 | - |
| Austria | 460 | - | Lithuania | 501 | - |
| Israel | 458 | - | Israel | 501 | - |
| Croatia | 456 | - | Spain | 499 | - |
| Slovenia | 455 | - | Austria | 499 | - |
| Greece | 455 | - | Luxembourg | 498 | - |
| Turkey | 448 | * | Slovak Republic | 495 | - |
| Slovak Republic | 448 | * | Turkey | 493 | - |
| Russia | 446 | ** | Russia | 488 | - |
| Lithuania | 444 | ** | LONDON | 488 | - |
| Chile | 434 | ** | Malta | 478 | - |
| Costa Rica | 431 | ** | Bulgaria | 466 | * |
| Serbia | 423 | ** | Serbia | 465 | ** |
| Miranda-Venezuela | 412 | ** | UAE | 465 | ** |
| Mexico | 412 | ** | Chile | 457 | ** |

c. Science

| Boys | | | Girls | | |
|---|---|---|---|---|---|
| **Country** | **Mean** | | **Country** | **Mean** | |
| Shanghai | 578 | ** | Shanghai | 576 | ** |
| Hong Kong | 554 | ** | Finland | 558 | ** |
| Singapore | 546 | ** | Hong Kong | 549 | ** |
| Japan | 543 | ** | Singapore | 547 | ** |
| Finland | 542 | ** | Japan | 543 | ** |
| South Korea | 538 | ** | South Korea | 538 | ** |
| Estonia | 533 | * | Estonia | 535 | ** |
| Liechtenstein | 530 | - | Viet Nam | 528 | ** |
| Viet Nam | 529 | - | Canada | 525 | ** |
| Canada | 529 | - | New Zealand | 524 | ** |
| Australia | 525 | - | Australia | 523 | ** |
| Netherlands | 524 | - | Chinese Taipei | 522 | ** |
| New Zealand | 524 | - | Germany | 521 | ** |
| Germany | 523 | - | Netherlands | 520 | ** |
| Chinese Taipei | 522 | - | Slovenia | 519 | ** |
| Rest of UK | 521 | - | Poland | 519 | ** |
| Switzerland | 519 | - | Macedonia | 517 | ** |
| Ireland | 515 | - | Ireland | 515 | ** |
| Macedonia | 515 | - | Liechtenstein | 513 | ** |
| Poland | 514 | - | Switzerland | 512 | ** |
| LONDON | 509 | - | Rest of UK | 512 | ** |
| Belgium | 508 | - | Czech Republic | 505 | ** |
| Slovenia | 507 | - | Belgium | 503 | ** |
| Denmark | 504 | - | Latvia | 502 | ** |
| Austria | 504 | - | Lithuania | 502 | ** |
| Czech Republic | 503 | - | Norway | 499 | ** |
| United States | 502 | - | France | 498 | ** |
| Hungary | 500 | - | Hungary | 498 | ** |
| France | 499 | - | United States | 497 | ** |
| Spain | 496 | - | Austria | 496 | ** |
| Norway | 495 | - | Denmark | 493 | ** |
| Luxembourg | 493 | - | Sweden | 493 | * |
| Latvia | 492 | - | Portugal | 492 | - |
| Italy | 491 | - | Croatia | 492 | - |
| Portugal | 490 | - | Italy | 491 | - |
| Sweden | 488 | - | Spain | 489 | - |
| Iceland | 487 | - | Iceland | 487 | - |
| Croatia | 486 | - | Russia | 484 | - |
| Lithuania | 485 | * | LONDON | 484 | - |
| Slovak Republic | 483 | * | Luxembourg | 482 | - |
| Perm (Russia) | 481 | * | Slovak Republic | 481 | - |
| Russia | 480 | ** | Perm (Russia) | 479 | - |
| Greece | 463 | ** | Malta | 478 | - |
| Israel | 462 | ** | Greece | 474 | - |
| Turkey | 453 | ** | Turkey | 465 | - |
| Chile | 450 | ** | Israel | 463 | - |
| Malta | 444 | ** | UAE | 458 | * |
| Serbia | 442 | ** | Bulgaria | 453 | ** |
| Costa Rica | 438 | ** | Serbia | 445 | ** |
| Bulgaria | 433 | ** | Chile | 442 | ** |

**Notes**: All estimates based upon the pooled PISA 2009 and 2012 datasets.