

Benchmarking London in the PISA rankings

John Jerrim

Gill Wyness

UCL Institute of Education

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<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.

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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 internationally¹.’* 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 analysis².

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 England³. 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 obtain 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 possible⁵. Our population of interest therefore refers to 15 year olds who were attending a London school in either 2009 or 2012⁶. 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 Combining 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-domains⁷, 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 39th in the mathematics rankings (confidence interval ranging between 24th and 45th 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 24th 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 Shanghai⁸.

<< 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 34th out of the 76 economies included in these PISA rankings, this wide confidence interval means England's capital city could fall anywhere between Germany (21st) and Chile (45th). 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 about 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), Asian¹² (-30 points) and Other (-26 points) ethnic groups¹³. 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.

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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.