The relationship between the Kumon maths programme and Key Stage 2 maths outcomes in England

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Executive Summary

This report analyses the relationship between the Kumon maths programme and Key Stage 2 (KS2) outcomes in 2019. We use the National Pupil Database linked with anonymous Kumon data to create two matched control groups.

Kumon is a large international provider of supplementary education, specialising in paid private tuition in maths and English. This tuition can be accessed from the age of two and up to GCSE and beyond, but in this research we consider only pupils in Year 6 completing their national curriculum assessments in 2019.

Characteristics of Kumon pupils

In comparing our sample of 310 Kumon pupils with all other pupils finishing KS2 in 2019, we find that Kumon pupils:

- Have higher prior attainment at Key Stage 1: A third of Kumon pupils are among the highest performing fifth of pupils nationally at KS1 in English and maths.
- Attend higher performing schools: More than half of Kumon pupils attend schools that are in the top 30 per cent for their pupils achieving the expected standard in reading, writing and maths.
- Are less likely to have identified special educational needs or disabilities: seven per cent of Kumon pupils have any identified special needs compared with 17 per cent nationally.
- Are less likely to be eligible for free school meals and are more likely to live in affluent areas: five per cent of Kumon pupils are FSM eligible compared with 16 per cent nationally.

All these characteristics are associated with higher maths attainment at KS2.

In addition, Kumon pupils in our sample are much less likely to have English recorded as their first language (51 per cent compared with 79 per cent nationally) and are much less likely to be White in comparison with the national population (41 per cent compared with 74 per cent nationally). The next largest Kumon group is the Asian ethnic group, with 27 per cent belonging to this group compared with 11 per cent of non-Kumon pupils.

Looking at their characteristics alone we would expect Kumon pupil attainment to be higher than average even without access to tutoring. There is therefore a strong case for applying matching methods to compare Kumon pupils with a group who are more similar to them. A caveat to this method is that while we know that our comparison group has not participated in Kumon, we cannot know whether they have participated in other tutoring programmes.

Attainment of Kumon pupils

We compare Kumon pupil attainment with other pupils before and after creating a matched comparison group. We find that:

- When compared with all pupils *before matching*, Kumon participants who have accessed the programme for at least three months achieve, on average, 5.27 additional points in KS2 maths scaled scores. However this should not be considered a valid comparison given the substantial differences in characteristics between Kumon pupils and all pupils nationally.

- Based on our best estimate *after matching*, Kumon pupil attainment in KS2 maths scaled scores is on average 1.80 points higher than their similar non-Kumon peers. Kumon pupils average about 110 points compared with 108 for their similar non-Kumon peers.
- The difference between Kumon and non-Kumon pupils' outcomes *after matching* is equivalent to 6.8 months of additional progress.

Ultimately this study finds that Kumon pupils who have accessed the programme for at least three months achieve about two points higher in KS2 maths scaled scores than similar non-Kumon pupils.

To put this in context, findings from the wider literature are mixed when it comes to estimating the impact of private tuition programmes that are not randomly assigned or targeted. These mixed findings are due in part to the differences in design and duration of tuition programmes analysed, but also largely to the difficulties of controlling for the characteristics that influence both access to tuition and attainment.

Through our matching method we have controlled as far as possible for these intervening factors, but nevertheless there remain unobserved variables such as parental engagement and other factors relating to the home-learning environment. This means that the additional attainment we find may be attributable to Kumon, but may also be partly attributable to these other factors.

Judging from their matched comparison group, it is likely that this sample of Kumon pupils would have achieved well without accessing Kumon tutoring. It is not known what benefit is conferred by this two point 'bonus' for pupils who would likely have higher than average maths attainment anyway. Future research could consider how this affects pupil performance in entry into selective schools, transition into KS3 and whether differences in attainment are sustained up to GCSE.

Introduction

This report analyses the relationship between the Kumon maths tuition programme and Key Stage 2 (KS2) outcomes. We use the National Pupil Database linked with anonymous Kumon data detailing the cohort completing their national curriculum assessments in 2019. Coarsened exact matching is used to create two control groups matched on a number of meaningful variables.

Kumon is a large international provider of supplementary education, specialising in tuition in maths and English. The company is well established in England with over 550 centres in England and over 40,000 students enrolled in English or maths courses.[1]

Private tuition comes in highly varied formats and is typically difficult to evaluate without access to rich pupil-level data. There is a growing need for government, schools and parents to consider evidence on which forms of intervention can raise attainment or facilitate catch-up – particularly those that can be delivered outside the classroom in light of the covid-19 pandemic.

Equally important is to understand the challenges that private tuition can pose to equitable education, in that unequal access can lead to further social stratification.[2] While there is evidence that access to private tuition in England is uneven in terms of a number of social characteristics, it is not established that this does in fact widen the attainment gap by a substantial margin: it may be that pupils who access tutoring would attain highly anyway. These unknown effects have been a concern both prior to and during the covid-19 pandemic.[3]

It is therefore important to understand the role that Kumon plays in influencing outcomes at KS2 and its potential to raise attainment for those who access it.

Description of Kumon programme

As outlined on their website, the Kumon method of tuition aims to provide an individualised course of study for the pupil. A Kumon pupil is initially assessed by an instructor to determine their starting level. The instruction then consists of worksheets completed independently by the pupil under the observation of an instructor. The aim is for the pupil to develop independent learning skills, and so the role of the instructor is to offer support and guidance to enable pupils to solve problems themselves.

The pupil works through topics and levels at their own pace, depending on their grasp of the subject. The worksheets do not follow a school curriculum, and the website states that they are designed to be complementary to curricula across the world. Instruction takes place in Kumon centres twice a week, in addition to daily home study using the same worksheets. Pupils can start Kumon study from

[1] Figures supplied by Kumon June 2020.
[2] John Jerrim, 'Extra Time: Private Tuition and out-of-School Study, New International Evidence' (The Sutton Trust, September 2017).
[3] Rebecca Montacute, 'Social Moblity and Covid-19: Implications of the Covid-19 Crisis for Educational Inequality' (The Sutton Trust, April 2020); Mark Bray, 'The Shadow Education System: Private Tutoring and Its Implications for Planners', *Economics of Education Review* 20, no. 6 (December 2001): 608–9; Mark Bray, Unesco, and International Institute for Educational Planning, *Confronting the Shadow Education System: What Government Policies for What Private Tutoring?* (Paris: United Nations Educational, Scientific and Cultural Organization : International Institute for Educational Planning, 2009).

the age of two. They are registered by their parents and the Kumon website states that the cost of tuition is on average £60 a month.

Kumon encourages parents of pupils to ensure that they provide encouragement and a quiet place to study. However, the parent is not required to provide any instruction themselves, meaning that the parents' confidence in their own maths knowledge is taken out of the home-learning equation.[4]

Evidence on the impact of tutoring

Private tuition is broadly considered to be a promising intervention for raising attainment, particularly for those in need of additional help and for disadvantaged pupils.[5,6] It appears widely assumed among parents that tutoring is a worthwhile investment, and it is a central tenet of the government plan to facilitate catch-up on learning loss caused by the covid-19 pandemic. There is indeed evidence that one-to-one and small group tutoring can be effective: an EEF summary of the evidence estimates that it can add approximately five months' progress on average.[7]

On the evidence available it appears safe to say that tutoring *can* be effective, but it depends on the quality of tutoring and who accesses it.[8] There remains fairly limited understanding of the elements of effective tutoring. Tutoring in England can range from a university student improvising a session for an hour a week to trained and experienced tutors delivering a planned sequence of work multiple times a week. The work may be designed to complement the school curriculum, prepare for a specific exam, and may or may not be associated with the pupil's school. Considering the elements at play in the present study, Kumon is fairly distinct in format compared with other types of tutoring. Indeed, it was explicitly excluded from a study of private tuition on the grounds that its students are not taught by a tutor (which is arguable).[9] As would be the case with a study of any specific design of tutoring programme, this study should be regarded as a test of 'Kumon' versus 'absence of Kumon', rather than a test of private tuition in the broad sense.

The question of access is also an important one when considering evidence of impact. It is important to consider that much of the studies comprising England's existing evidence base for national tutoring programmes, for example Every Child Counts, Action Tutoring or Tutor Trust, are randomised and/or targeted towards disadvantaged pupils or low achievers.[10,11,12] By contrast, the Kumon programme is neither randomly assigned nor targeted at specific types of pupils in terms of

[4] 'The Kumon Method', Kumon, accessed 20th July 2020, https://www.kumon.co.uk/about/our-method/
[5] Andrea J. Hickey and Robert J. Flynn, 'Effects of the TutorBright Tutoring Programme on the Reading and Mathematics Skills of Children in Foster Care: A Randomised Controlled Trial', *Oxford Review of Education* 45, no. 4 (4 July 2019): 519–37, https://doi.org/10.1080/03054985.2019.1607724.
[6] Jens Dietrichson et al., 'Academic Interventions for Elementary and Middle School Students With Low Socioeconomic Status: A Systematic Review and Meta-Analysis', *Review of Educational Research* 87, no. 2 (1 April 2017): 243–82, https://doi.org/10.3102/0034654316687036.
[7] 'One to One Tuition', Teaching and Learning Toolkit (Education Endowment Foundation, August 2018).
[8] Katie Rushforth, 'The Quality and Effectiveness of One-to-One Private Tuition in England' (Institute of Education, University of London, 2011).
[9] Katie Rushforth, 'The Quality and Effectiveness of One-to-One Private Tuition in England' (Institute of Education, University of London, 2011).
[10] Carole Torgerson, 'Every Child Counts: The Independent Evaluation Technical Report', March 2011.
[11] Paolo Lucchino, 'Action Tutoring's Small-Group Tuition Programme: An Impact Evaluation Using Statistical Comparison Groups' (National Institute of Economic and Social Research, March 2016).
[12] Carole Torgerson, 'Tutor Trust: Affordable Primary Tuition: Evaluation Report and Executive Summary' (Education Endowment Foundation, November 2018).

their prior attainment or their disadvantage. It will be important in the present study to control for characteristics of Kumon pupils that would influence both their access to it and their KS2 attainment.

Some existing studies are able to control for characteristics of pupils where tutoring is neither randomly assigned nor targeted – these characteristics include gender, special educational needs, ethnicity, parental engagement, socio-economic status, prior attainment, and duration of tuition. In a study estimating the overall impact of private tuition on attainment in Sri Lanka, it is found that, when attainment is observed over a five-month period, tutoring has no detectable effect after controlling for prior attainment.[13] A PhD study completed in 2011 using pupil-level data on participation in private tuition in England between 2003 and 2005 controlled for a range of factors including parental engagement. It concluded that there is some evidence of a small positive impact on attainment when the pupil has undertaken an extended period of tutoring in maths, particularly when this tuition is explicitly intended as exam preparation.[14] Ultimately more evidence is required on the impact of additional tuition on attainment when the intervention is not randomly assigned, as in the present example of Kumon.

Data

This analysis uses the rich data held within the National Pupil Database (NPD) linked with anonymous data provided by Kumon to identify their pupils.

Kumon sought consent from parents and carers for their child to be anonymously identified within the NPD. Approximately 4,500 households were contacted by email. To be included in the final sample for the analysis we stipulated that all pupils must have participated in the programme for a minimum of three months and that they had to have participated in the programme at any point between the September and February of their final year of KS2 (September 2018 to February 2019). The number of Kumon pupils fitting these criteria was around 4,200, representing about 85 per cent of the total. More than 50 per cent have participated for more than a year, and just under a quarter for more than three years (see Figure A in Technical Appendix).

The final number of consents received after applying our selection criteria for 3+ months' participation was 357, representing eight per cent of the total Kumon population contacted.

Data linking was carried out by the Department for Education, first using full matching on full name and postcode and then fuzzy matching on names only. This resulted in 310 pupils successfully matched to a KS2 record in the NPD, representing about seven percent of the total population contacted. Deidentified data covering all pupils who reached the end of KS2 in 2019 was then supplied to EPI with an added Kumon flag variable.

The extract of the KS2 NPD provides detailed data on the educational outcomes and characteristics of all pupils finishing KS2 in state-funded schools in England in 2019. This includes maths attainment at KS2; prior attainment at both KS1 (generally age seven) and Foundation Stage (generally age five); and various pupil characteristics including ethnicity, eligibility for free school meals, first language, income deprivation of home postcode and special educational needs.

[13] Rachel Cole, 'Estimating the Impact of Private Tutoring on Academic Performance: Primary Students in Sri Lanka', *Education Economics* 25, no. 2 (4 March 2017): 142–57.
[14] Rushforth, 'The Quality and Effectiveness of One-to-One Private Tuition in England'.

The outcome variable used in this study is KS2 maths scaled scores. This is a variable included within the NPD and is derived from raw marks which are totalled from three separate mathematics assessment papers and converted to scaled scores to enable comparison between years. It is a continuous variable ranging from 80 to 120. In school accountability terms, a pupil is considered to have achieved the expected standard if they score 100 or more on this scale. We considered using raw marks from the arithmetic paper, as it was considered by Kumon that this more closely matches the skills developed within the Kumon programme. However, there are far more missing data points on the arithmetic paper variable in the NPD, and the two variables are strongly correlated meaning we would be likely to have similar results with either variable.

Method

This analysis uses coarsened exact matching (CEM) to identify a valid control group and employs simple linear regression to analyse the relationship between participation in the Kumon programme and maths attainment at KS2. A matched comparison group is required because it is likely that our sample of Kumon pupils is substantially different in profile from the general Year 6 population. This is because access to Kumon tuition is not randomly assigned. Access is mainly determined by pupils' parents or carers who may be motivated by various factors, for example the importance they set by academic attainment in general; concern about a child's low achievement; encouraging a child's interest and ability in maths; or additional training for selective secondary school entrance exams such as the 11 Plus or independent school entrance exams. In addition, access is also dependent on parents' means to pay – whether through income or access to childcare vouchers and pupil premium payment which according to their website many Kumon instructors accept.[15]

More importantly, many characteristics that may make a pupil more likely to access Kumon tutoring, like higher socio-economic status, are also likely to impact on our KS2 maths outcome variable. It is therefore necessary to control for variables that influence both a pupil's access to the treatment (Kumon) and their maths attainment. Put another way, we must consider the counterfactual of what these pupils' assessment outcomes would have been regardless of access to Kumon tutoring.

There are a number of matching methods commonly in use in this type of quasi-experimental analysis. We opt for coarsened exact matching (CEM) for a number of reasons: Firstly, with a fairly small treatment group of just under 300 (after accounting for missing data) and a very large potential control group (600,000+) we can be reasonably confident of obtaining exact matches with very few treatment cases unmatched; secondly, many of our control variables are binary, leaving a minority of continuous control variables in need of further 'coarsening', thus minimising the number of potentially arbitrary decisions we introduce into our analysis; finally we find that our data is insufficient to confidently predict treatment, meaning that using the perhaps better-known matching method of propensity score matching would likely introduce more model-dependency into the analysis rather than reduce it.[16]

In our final analysis we use two alternative specifications for our matched comparison group, as well as multiple specifications for our linear regression, to demonstrate the extent to which we have

[15] 'Questions from parents', Kumon, accessed 22nd July 2020, https://www.kumon.co.uk/frequently-asked-questions/parents/

[16] Stefano M. Iacus, Gary King, and Giuseppe Porro, 'Causal Inference without Balance Checking: Coarsened Exact Matching', *Political Analysis* 20, no. 1 (2012): 1–24.

successfully reduced model dependency. We limit our potential comparison group to pupils who do not live within reasonable travel distance of a Kumon centre, and therefore who had no reasonable way of accessing this tutoring. Our reasoning is that we are aiming to find pupils who are as similar as possible to Kumon pupils: if a pupil could have accessed Kumon but did not then we must assume there is some difference between them and the pupil that did.

An important limitation of this method is that it assumes that we are able to match pupils on all of the variables that influence access to treatment and outcome. There remain, however, a number of unobserved variables that may matter greatly in determining both access to Kumon and maths attainment. A particular concern is that we cannot observe parental engagement. Recalling that our identified treatment group are those whose parents actively gave their consent, it is reasonable to assume that parental engagement may be particularly high in our sample in comparison with the Kumon pupil population as a whole. Furthermore, a study of private tuition in England cited above found that pupils whose parents returned a questionnaire as part of the study were more likely to have higher achievement than those whose parents did not, regardless of whether they were participating in private tuition.[17] It follows that higher parental engagement in our Kumon sample may inflate estimates of their attainment in ways we cannot control for in the rest of our analysis. It is possible that our result will be an overestimate of the Kumon effect and more of a reflection of the effect of parental engagement on this group. Equally we cannot observe whether our comparison group has accessed any other form of tuition, so there is also a risk of underestimating the Kumon effect. Indeed, given that our matched group will have similar characteristics to our Kumon group it is quite likely that our matched group has indeed accessed other forms of tutoring. We therefore do not consider this analysis to demonstrate causal effect because we cannot observe all meaningful variables which may impact the results in different directions.

The report is structured as follows. In the next section we explore how the characteristics of our sample of Kumon pupils compare with those of all other KS2 pupils. We also compare the KS2 maths attainment of Kumon pupils with all other KS2 pupils, to demonstrate how the results would appear if we did not use a matched sample. We then move on to our matching process. This involves first using a logistic regression to understand which factors are the strongest predictors of participating in Kumon. The results of this stage of analysis inform our decisions on which characteristics are most important to match on when creating our comparison group. We then report on a series of matching iterations using CEM, arriving at two alternative specifications. Having created our two comparison groups we then repeat the attainment comparisons carried out in the previous section to re-estimate the difference between Kumon and non-Kumon pupil attainment after matching. Finally we convert our results to a more 'real world' metric to estimate the number of months of additional progress a Kumon pupil makes in comparison with their non-Kumon peer.

[17] Rushforth, 'The Quality and Effectiveness of One-to-One Private Tuition in England'. p.82.

Comparison with all pupils nationally

In this section we compare the profile of our sample of Kumon pupils with all other state-school pupils taking their KS2 assessments in 2019. This allows us to consider how Kumon pupils differ from the national population as a group and how this affects estimates of the programme's impact.

Pupil characteristics

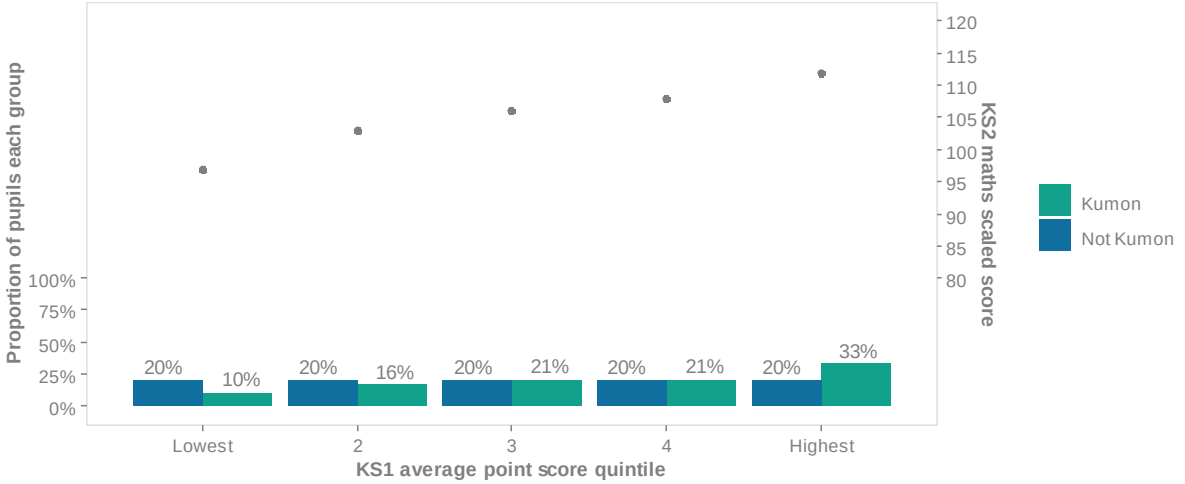
Pupil prior attainment

Pupil prior attainment is a key predictor of later school attainment. The measure used here is pupil average point score at KS1, split into quintiles. This is a measure of pupil attainment which weights English and maths equally at KS1. We opt for an aggregate measure of prior attainment as this gives a stronger correlation with KS2 attainment compared with solely using maths prior attainment.

We find that, as illustrated in Figure 1, Kumon pupils are more likely to be in the top 20 per cent for prior attainment, and less likely to be in the bottom 40 per cent, with fairly even distribution in the middling quintiles. Based solely on their prior attainment, we would expect that Kumon pupils as a group would have higher than average KS2 outcomes regardless of tutoring accessed, as the plot shows that those with higher attainment at KS1 tend to also have higher attainment at KS2.

It is likely that some of these Kumon pupils will already have been accessing Kumon tutoring at the time of their KS1 assessment, and so it is possible that their prior attainment is already bolstered by this supplementary education. A measure of prior attainment that may be less influenced by Kumon training is at the Foundation Stage (age five). However, too many Kumon pupils are missing Foundation Stage data (see pupil's first language for further discussion) so it is difficult to assess their prior attainment separate from any past Kumon training they might have received. This study should therefore be interpreted as evaluating value added by Kumon training between KS1 and KS2.

Figure 1: Prior attainment – proportion of pupils in each group and median KS2 maths score of all pupils



Performance of school attended

A vital factor to control for in this analysis is the performance of pupils' schools. The quality of teaching accessed by pupils in this study, particularly in maths, is likely to impact on their final KS2 maths attainment potentially over and above any tutoring accessed. Our measure of school attainment is the percentage of pupils achieving the expected standard in reading, writing and maths at KS2 in 2019. We considered the danger of circularity insofar as the school attainment measure is calculated partly using our outcome measure. However, we concluded that Kumon pupils are insufficiently clustered within schools to be able to influence the measure of their school's overall attainment. School attainment was calculated using individual pupil records and then split into deciles.

Figure 2 shows that Kumon pupils are more clustered in the top five deciles for school attainment. Given that higher performing schools are logically associated with higher maths outcomes on average, we might expect Kumon pupils as a group to have higher maths outcomes simply by dint of attending these schools. It should be noted that the difference between median KS2 maths score in the lowest and highest school attainment deciles is only between eight points, from 101 to 109. This indicates that there is only small variation in KS2 maths scores (which are on a scale between 80 and 120). This is informative for how we might interpret the size of effect if any is detected in our analysis.

Region and urban/rural classification of pupil home neighbourhood

We also considered whether Kumon pupils are clustered in different regions of England or in different rural or urban area types. These characteristics are visualised in figures I and J in the Technical Appendix.

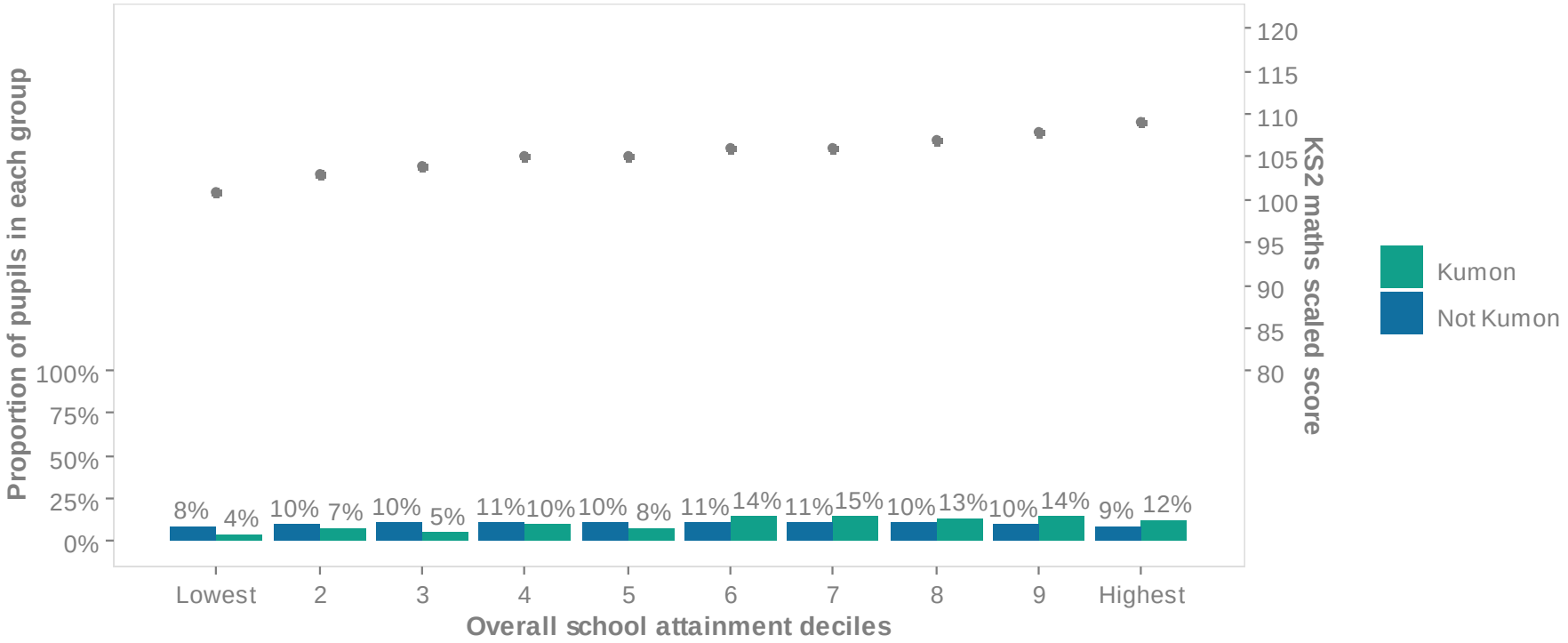
We find that Kumon pupils are more likely to attend school in London and the South East compared with other pupils. Whereas a 'London effect' is observed in other measures of attainment, for instance at GCSE, there is little variation observed on our KS2 maths outcome.[18] Kumon pupils are more disproportionately represented in the South East than in London and there is not a straightforward interpretation of how this would impact on attainment. What is more, region generally tends to explain only a small proportion of variation in educational outcomes.

Equally we do not observe clear differences between the rural/urban area types of Kumon and other pupils' home neighbourhoods. Furthermore there is no clear difference between these area types in terms of median KS2 maths outcomes.

It is preferable to restrict our list of variables to only those that are likely to influence a pupil's participation in Kumon and/or their KS2 maths attainment. Including region would split Kumon pupils into too small a group once we have factored in all other variables and there appears to be little evidence of its impact on attainment. We therefore drop this variable from the rest of the analysis. Rural/urban area has only three levels, and so it does no harm to keep it in the analysis as a proxy for major cities like London.

[18] Alex Macdougall and Ruth Lupton, 'The "London Effect": Literature Review', (Inclusive Growth Analysis Unit, University of Manchester, April 2018).

Figure 2: School performance – proportion of pupils in each group and median KS2 maths score of all pupils



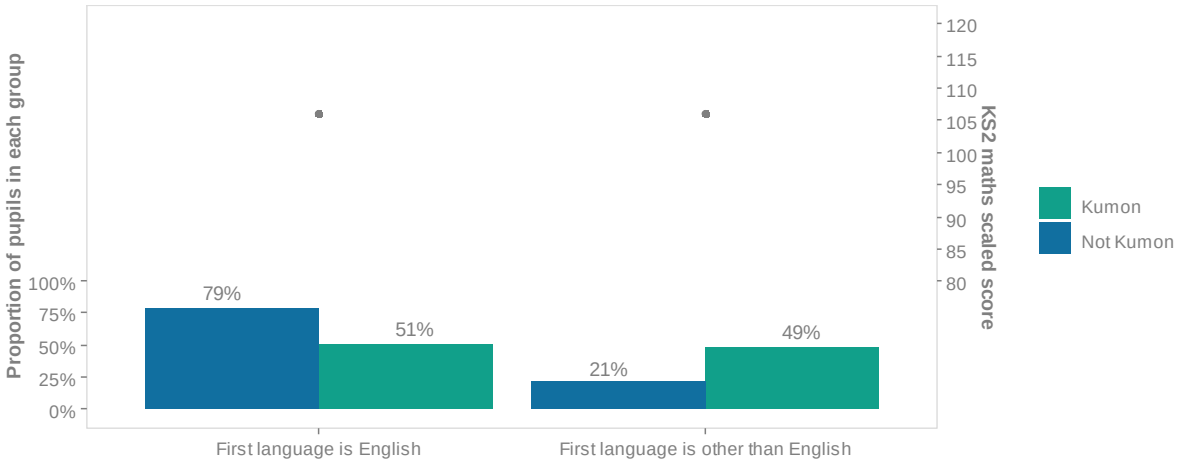
Pupil's first language

First language is expressed as a binary between English as a first language and English as an additional language (EAL). We did not have access in this analysis to data on which specific languages pupils speak.

As illustrated in Figure 3, Kumon pupils are far less likely to speak English as a first language in comparison with other pupils. Fifty-one per cent of Kumon pupils speak English as a first language compared with 79 per cent of non-Kumon pupils. It seems likely that many Kumon pupils in our sample are of migrant background, based on the number with English as an additional language who are also missing Foundation Stage data, indicating that they did not enter the state-school system in England until after this stage.

Overall, there is no difference in median maths attainment at KS2 between pupils who do and do not speak English as a first language. The median score for both groups is 106.[19] We therefore would not expect first language, identified in this way, to strongly influence Kumon pupils' outcomes. Nevertheless, the clear difference between Kumon pupils and the rest of the population on this metric means it will be important to match on when selecting our comparison group.

Figure 3: Pupil's first language – proportion of pupils in each group and median KS2 maths score of all pupils



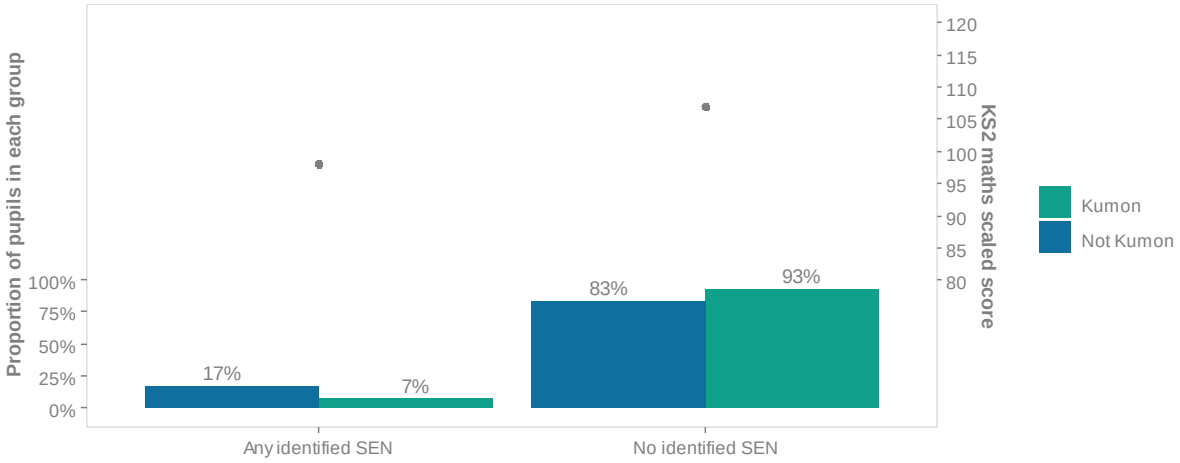
Special educational needs and disability

Special educational need and disability (SEND) is a binary measure in this study. We differentiate between pupils with no identified special educational needs or disability and those with any identified needs (whether they are receiving SEN support or have an EHC plan or statement). More fine-grained categories were not possible due to low numbers in the Kumon sample. Kumon pupils are 10 percentage points less likely to have any identified special educational needs or disability

[19] It is recognised that pupils identified as speaking English as an additional language is a fairly broad grouping, and difference in attainment is likely to vary depending on how recently the pupil has arrived in the state-school system. However the relatively small number of Kumon pupils means we are unable to consider this level of detail.

(Figure 4).[20] This would tend to suggest that we would expect them as a group to have higher KS2 attainment.

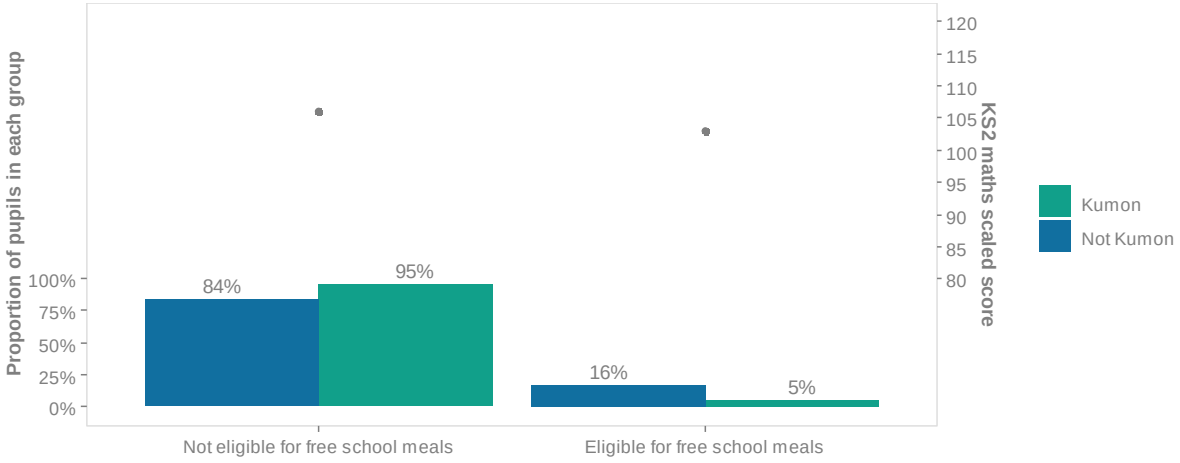
Figure 4: Special educational needs or disability – proportion of pupils in each group and median KS2 maths score of all pupils



Pupil disadvantage – eligibility for free school meals and home neighbourhood deprivation

Kumon pupils are also less likely to be eligible for free school meals (FSM) compared with non-Kumon pupils. Five per cent (15 Kumon pupils) are eligible for free school meals, compared with 16 per cent of non-Kumon pupils. FSM eligible pupils have lower maths attainment as a group (103 median scaled score) compared with non-eligible pupils (106). Therefore this is another characteristic that indicates Kumon pupils would be expected to have higher than average KS2 attainment regardless of the tutoring they have accessed.

Figure 5: Eligibility for free school meals – proportion of pupils in each group and median KS2 score of all pupils

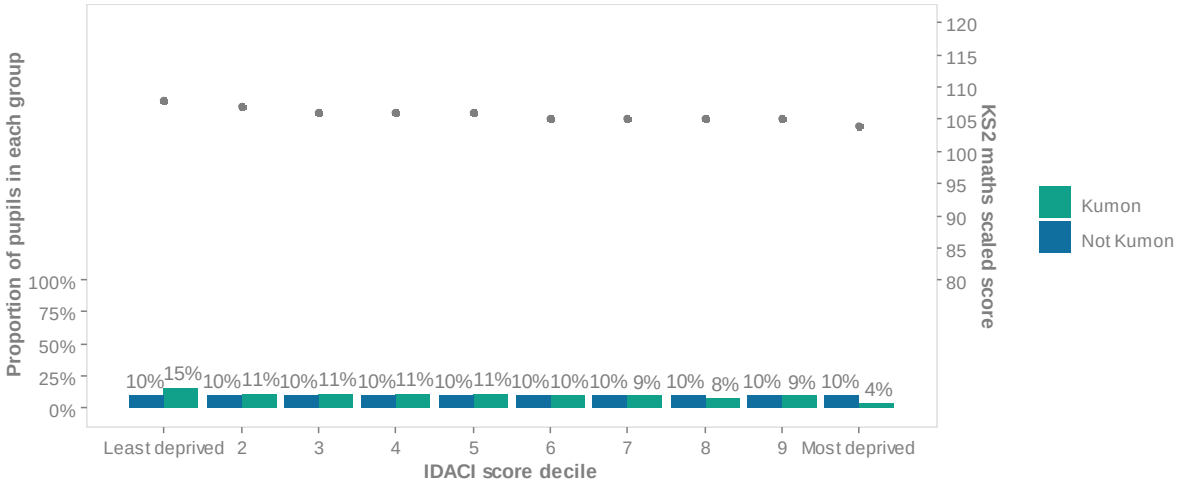


[20] This analysis includes pupils in state-funded mainstream schools only. Therefore pupils with special educational needs who attend special schools and other non-mainstream settings are not included.

We also considered the socio-economic deprivation of the pupil's home neighbourhood. This is expressed in this study as the IDACI score decile of their home LSOA.[21]

Kumon pupils are more likely to live in the least deprived 10 per cent of neighbourhoods and less likely to live in the most deprived 10 per cent of neighbourhoods (Figure 6). They are otherwise fairly equally represented in the deciles in between. The floating points on the figure demonstrate an inverse relationship between KS2 maths scores and neighbourhood deprivation – the higher the deprivation the lower the maths score. However, as with school attainment decile, there is only a handful of points' difference between the least and most deprived deciles. The median KS2 maths score in the least deprived neighbourhoods is 108, compared with 104 in the most deprived neighbourhoods. This is an indication of how we should interpret any Kumon-effect detected: if the difference between the most and least deprived neighbourhoods is only four points then we should expect any Kumon-effect to be no bigger than a few points on the scale, but those few points would nonetheless be indicative of large differences in educational outcomes.

Figure 6: Deprivation of pupil's home LSOA (IDACI score decile) – proportion of pupils in each group and median KS2 maths score of all pupils



Pupil ethnic group

Owing to relatively small numbers, we explored pupil ethnicity using broad groups as produced by the Office for National Statistics (ONS). There were too few pupils in the Chinese and Unclassified categories, and so these ethnicities are included under 'any other ethnic group'.[22]

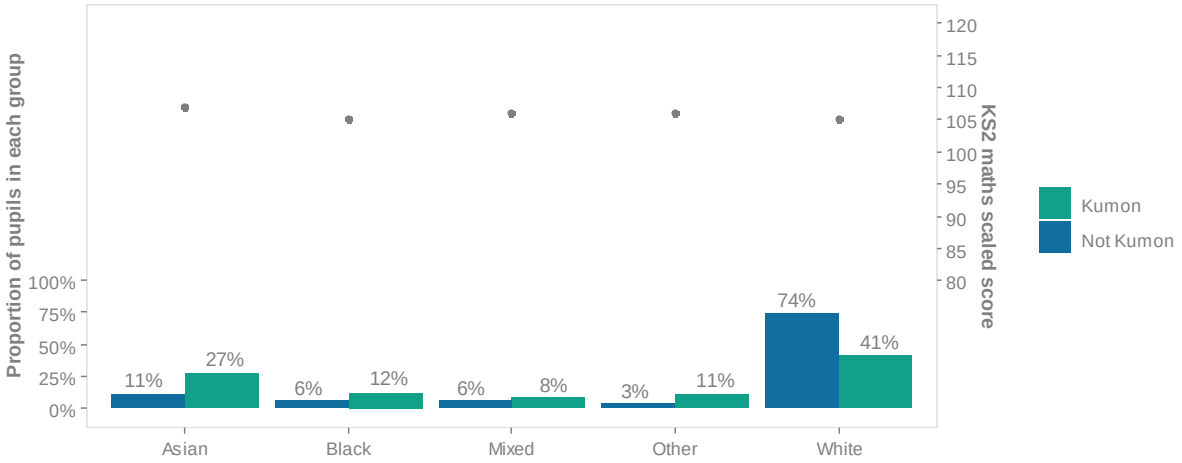
As with pupil first language, there is a striking difference between Kumon and non-Kumon pupils in terms of the distribution of ethnic groups (Figure 7). Forty-one per cent of Kumon pupils are part of the White ethnic group, compared with 74 per cent of non-Kumon pupils. The next largest Kumon

[21] The Income Deprivation Affecting Children Index (IDACI) is part of the Indices of Multiple Deprivation (IMD). It is an area-based measure defined at the level of Lower Super Output Area (LSOA) and was last calculated for 2015. It takes the form of a score between 0 and 1, which can be interpreted as the proportion of families in LSOA, with children aged under 16, which are income deprived. The higher the score, the more deprived the neighbourhood. LSOAs are small geographic areas comprising between 400 and 1,200 households. There are around 33,000 LSOAs in England.

[22] Note that maths attainment tends to be high among Chinese pupils.

group is the Asian ethnic group, with 27 per cent belonging to this group compared with 11 per cent of non-Kumon pupils. Kumon pupils are also more likely to belong to Black, Mixed and Other ethnic groups. In considering these groups' relationship with KS2 maths outcomes, there again seems to be little difference between the groups in terms of higher or lower median attainment. We therefore make no assumption as to how belonging to these groups will affect outcomes for Kumon pupils, but given large differences in the ethnic composition of the Kumon sample it will be important to match on ethnicity when selecting our comparison group.

Figure 7: Pupil ethnic group – proportion of pupils in each group and median KS2 maths score of all pupils



Summary of pupil characteristics

In comparison with all other pupils, Kumon pupils in our sample tend to have higher prior attainment; to attend higher performing schools; to be less likely to have any identified special educational needs or disability; to be less likely to be eligible for free school meals; and to live in more affluent areas. All these characteristics are associated with higher attainment at KS2.

We do not find evidence of within-group differences. Where we might have found equally large groups of pupils with particularly high or particularly low prior attainment being entered to Kumon for different reasons, we find instead that it is mainly pupils with high prior attainment who participate in the programme. It does not appear based on this sample that Kumon is used as a remedial form of tutoring for pupils with lower than average attainment.

In addition, Kumon pupils in our sample are much less likely to have English recorded as their first language and are much less likely to be White in comparison with the national population. There does not appear to be substantial differences in attainment between different language or ethnic groups on our particular attainment measure, but it appears that pupils in these groups are much more likely than others to access Kumon tutoring.[23]

Finally, Kumon pupils are proportionally overrepresented in some regions of the country, particularly London, and are slightly more likely to live in urban areas than the national average. However, the imbalance is moderate and these characteristics are not strongly tied to KS2 maths attainment.

[23] For a discussion of the interaction between first language, ethnicity and educational outcomes see J Hutchinson, 'Educational Outcomes of Children with English as an Additional Language', (Education Policy Institute, 2018).

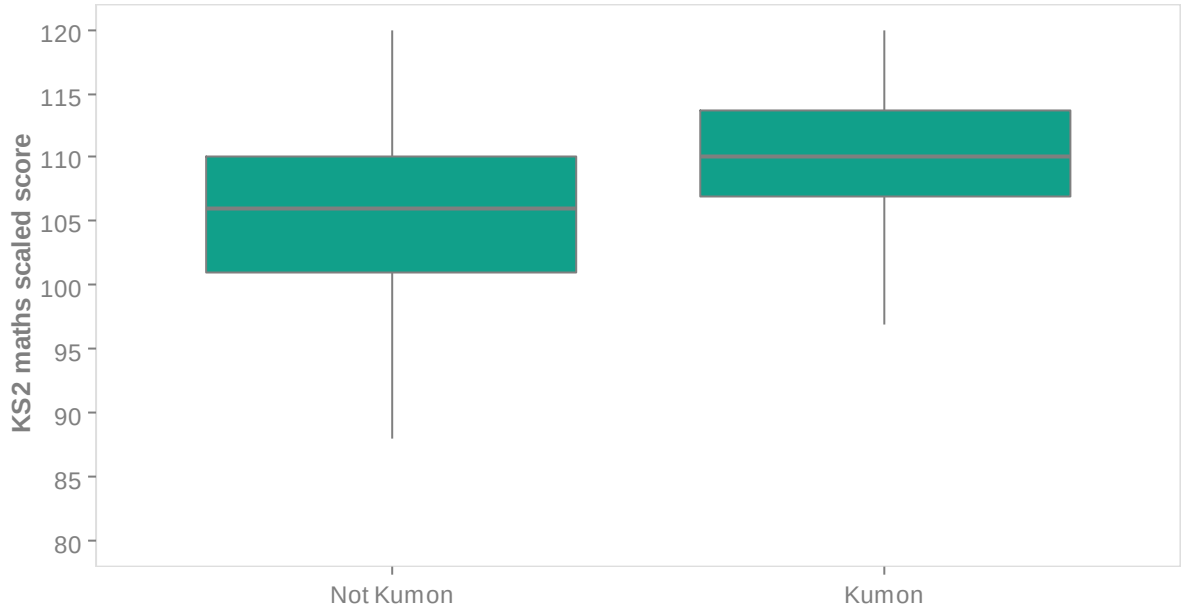
Taken together – looking at their characteristics alone we can see that Kumon pupils as a group are quite different to the national population. Owing to their characteristics we might expect their attainment to be higher than average even without access to tutoring. There is therefore a strong case for applying matching methods to compare Kumon pupils with a group who are more similar to them.

Pupil attainment

This section compares Kumon pupils with all other pupils in terms of maths attainment at KS2. We do this to estimate how the impact of Kumon would appear without matching. These measures will be repeated following matching.

First, a simple visualisation using boxplots demonstrates that, as a group, Kumon pupils have higher KS2 maths attainment than other pupils (before matching). Kumon pupils have a median KS2 maths outcome of 110 compared with 106 for all pupils. The lower quartile of the Kumon group is above the median of the non-Kumon pupils, at 107.

Figure 8: Boxplots comparing KS2 maths outcomes of unmatched pupils



Secondly, a simple linear regression provides an estimate that participating in Kumon tutoring adds on average 5.27 points to a pupil's KS2 maths scaled score. The 95 per cent confidence interval for this estimate is between 4.40 and 6.13.[24]

Figure 9: Linear regression, Kumon participation on KS2 maths scaled scores, all pupils before matching

Term	95% confidence interval - lower	Estimate	95% confidence interval – upper	Standard error	Statistic	P-value
(Intercept)	104.71	104.73	104.75	0.01	10718.56	0.000
Kumon flag	4.40	5.27	6.13	0.44	11.95	0.000

N = 310 Kumon pupils and 630,775 non-Kumon pupils

Without using matching, it would appear that Kumon pupils have substantially higher attainment on average than other pupils. However, as we have seen from this section there are large meaningful differences between our sample of Kumon pupils and other pupils. The nature of these differences indicates that Kumon pupils are likely to have higher than average KS2 attainment regardless of the tutoring they have accessed. It is therefore necessary to select a more viable comparison group, as we do in the next section.

[24] In simple terms, we can be 95 per cent confident that a 95 per cent confidence interval contains the true value we are trying to estimate. In other words, if we were to repeat this study by sampling the same population 100 times and produced a 95 per cent confidence interval each time, we would expect 95 of these confidence intervals to contain the true value.

Comparison with matched group

Identifying characteristics to match on

To select a viable comparison group, it is important to understand which characteristics are most important in influencing a pupil's participation in Kumon. We use logistic regression to gain a more detailed understanding of this. This type of regression estimates the impact of a given set of variables on the likelihood of an event occurring. In this case our event is that a pupil participates in the Kumon programme, and the set of explanatory variables is the suite of characteristics explored in the previous section.

We also introduce two additional variables. The first addition is a binary variable for whether the pupil has Foundation Stage Profile (FSP) data or not. This is used as an interaction variable with the EAL variable as a proxy for how long the pupil has been in the England state-school system. The second addition is another binary variable identifying whether a pupil lives within reasonable travel distance of a grammar school. Our reasoning for including this variable is that a pupil may be more likely to be registered with Kumon if they are preparing for their 11 plus entrance exam to selective grammar schools. Grammar schools are unevenly distributed across England and so living within proximity of one may increase a pupil's likelihood of participating in Kumon. The method for deriving this variable is set out in the Technical Appendix.

Various specifications of the logistic regression were used, first using all variables and then using different combinations of variables to achieve a model that best fit the data (Figure 10). The output for the model using all variables is reported in the Technical Appendix.

Figure 10: Logistic regression predicting Kumon participation, best fit for data

Term	Estimate	Standard error	Statistic	P-value
(Intercept)	-8.06	0.31	-25.80	0.000
Any identified SEND	-0.35	0.24	-1.49	0.135
KS1 average point score quintile	0.16	0.05	3.33	0.001
School performance decile	0.05	0.02	2.26	0.024
Eligibility for FSM	-0.98	0.27	-3.63	0.000
IDACI score decile	-0.13	0.02	-5.40	0.000
Pupil speaks English as an additional language (EAL)	0.65	0.16	4.13	0.000
Pupil home LSOA is Urban Conurbation (ref = Rural)	-0.04	0.23	-0.18	0.859
Pupil home LSOA is Urban Town/City (ref = Rural)	0.30	0.21	1.42	0.155
Pupil ethnic group is Asian (ref = White)	1.16	0.19	6.27	0.000
Pupil ethnic group is Black (ref = White)	1.53	0.21	7.13	0.000
Pupil ethnic group is Mixed (ref = White)	0.89	0.23	3.91	0.000
Pupil is of any other ethnic group (ref = White)	1.74	0.23	7.70	0.000
Pupil lives within travel distance of a grammar school	-0.28	0.13	-2.22	0.027

N = 292 Kumon pupils and 426,209 non-Kumon pupils who live within travel distance of a Kumon centre

The resulting findings from this exercise are that higher KS1 prior attainment, speaking English as an additional language and being of any ethnic group other than White have a significant positive impact on a pupil's likelihood of participating in Kumon. The pupil's school performance decile also has a significant positive effect, however the effect size is smaller.

Pupils are significantly less likely to participate in Kumon if they are eligible for free school meals or live in neighbourhoods in the higher IDACI deprivation deciles. It also appears that having any identified SEND means a pupil is less likely to participate in Kumon, however these results are less certain possibly owing to low numbers in the data.

Another variable found to have a significant negative impact on a pupil's likelihood of participating in Kumon is living within travel distance of a grammar school. This is the opposite effect to what we expected prior to analysis. It may be that this grammar school flag is acting as a proxy for some other unobserved variable, for example a network of alternative tutoring options that are greater developed in areas with selective local authorities than in non-selective local authorities. An alternative explanation may be that parents may not deem Kumon suitable as direct preparation for the 11 plus and seek out more targeted tutoring instead. Lacking a clear explanation for this finding we do not use this variable to match on when selecting our comparison group.

The rural/urban classification of the pupil's neighbourhood appears to have no effect on a pupil's likelihood of participating in Kumon. Equally it was found that the FSP/EAL interaction variable did not aid our model in predicting Kumon participation.

Conducting coarsened exact matching to create comparison groups

Having gained a stronger understanding of which variables most strongly predict Kumon participation, we proceed to the selection of our matched comparison groups. It should be recalled at this point that we are only able to match on observable variables, and that it is likely that there remain important unobserved variables that affect both a pupil's likelihood of participating in Kumon and their KS2 maths attainment. Parental engagement, pupil motivation and access to other types of tutoring are examples of such variables that cannot be accounted for in this analysis.

We restrict our pool of potential comparison pupils to those who did not *and could not* access Kumon tutoring. Our reason for this is that if a pupil could have accessed Kumon tutoring but did not then by definition they must be different from those that did in some way that we cannot necessarily observe in the data. We therefore focus on those without access by identifying pupils who live outside of reasonable travel distance of a Kumon centre. The method for defining reasonable travel distance is set out in the Technical Appendix.

Figure 11 summarises the outcome of the matching process. We use coarsened exact matching (CEM) to select two alternative matched comparison groups. This method works by specifying the pupil characteristics we wish to match on, and software is used to identify (for each Kumon pupil) any non-Kumon pupils with the same characteristics. A trade-off of this method is that, the more variables specified to match on, the greater the likelihood that not all treatment (Kumon) pupils will have perfect matches. We therefore create two alternative matched comparison groups with the first optimising the greatest number of variables used (matched group 1), and the second optimising the greatest number of Kumon pupils matched (matched group 2). Both these groups are used to

compare outcomes between Kumon and non-Kumon pupils, and in doing so we will be able to judge if either of the matched groups appear more reliable.

The first group ('matched group 1') matches on all variables except for proximity to grammar school, the rural/urban classification of the pupil's neighbourhood and the FSP data flag. This matches 20,570 pupils to 263 Kumon pupils, with 29 Kumon pupils unmatched.

The second group ('matched group 2') aims to match on the maximum number of Kumon pupils. To achieve this, we drop the overall school performance variable from the matching specification, producing 91,782 pupils matched to 290 Kumon pupils and leaving two Kumon pupils unmatched.

It would have been possible to achieve a fully matched sample, however this would have required dropping the SEND variable from the matching specification, and given the importance of SEND for explaining attainment this was not thought desirable for the analysis.

The CEM method employs weights to achieve a similar distribution of characteristics in the matched group compared to the treatment (Kumon) group. The summary set out in Figure 11 demonstrates that, after weighting, both matched groups have achieved parity in means across all variables. The exception to this is the balance of overall performance of schools attended between control and treatment groups in matched group 2. This is because this group was not matched on this variable, and we take steps to control for this variable in other ways in the subsequent analysis.

Figure 11: Summary of matched comparison group characteristics

	Weighted means			
	Matched group 1		Matched group 2	
	Control 1	Treatment (Kumon) 1	Control 2	Treatment (Kumon) 2
% EAL	44.1%	44.1%	45.9%	45.9%
% eligible for free school meals	3.8%	3.8%	5.2%	5.2%
% with any identified SEND	6.1%	6.1%	6.9%	6.9%
% Asian	29.3%	29.3%	28.3%	28.3%
% Black	10.3%	10.3%	12.8%	12.8%
% Mixed ethnicity	6.8%	6.8%	8.3%	8.3%
% White	44.5%	44.5%	40.3%	40.3%
% any other ethnic group	9.1%	9.1%	10.3%	10.3%
IDACI decile	4.7	4.7	4.8	4.8
KS1 prior attainment quintile	3.5	3.5	3.5	3.5
School performance decile	6.3	6.3	5.3 *not matched on	6.4 *not matched on
All – after accounting for missing data	174,283	292	174,283	292
Matched	**20,570**	**263**	**91,782**	**290**
Unmatched	153,713	29	82,501	2

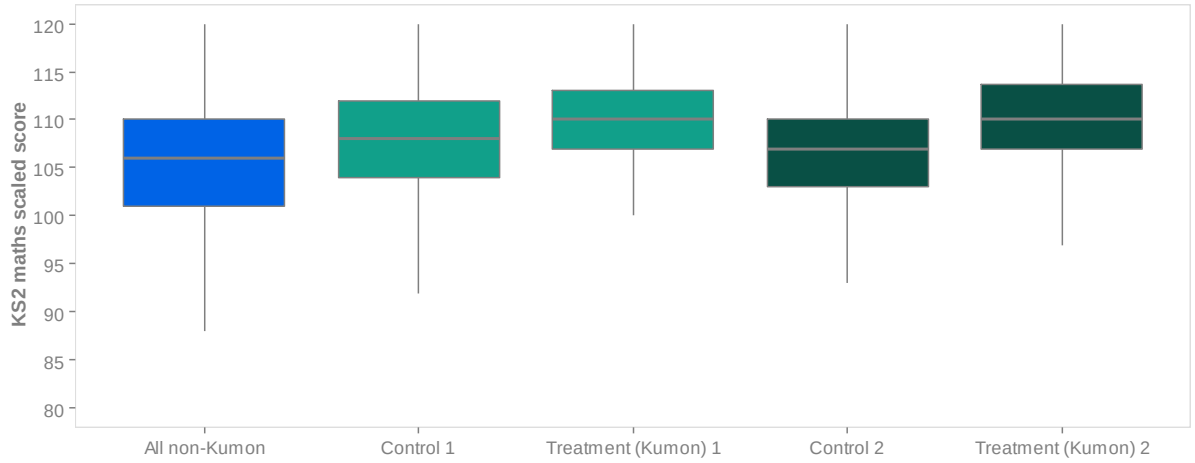
Pupil attainment – comparing matched groups

This section now repeats the analysis from the previous section to compare outcomes between Kumon and non-Kumon pupils.

The boxplots in Figure 12 summarise the KS2 outcomes of all unmatched non-Kumon pupils, depicted alongside summaries for the control and treatment pupils in each matched comparison group.

We find that matched control groups are much closer to Kumon groups in their distribution of outcomes than all unmatched non-Kumon pupils, but that Kumon pupils still appear to have slightly higher attainment as a group than the control groups. The median outcome for Kumon pupils in both matched groups is 110 points, despite there being 27 fewer Kumon pupils in matched group 1 than in matched group 2. This suggests we are not artificially altering the outcomes of the Kumon group by using different matching specifications. The median outcome for control pupils in matched group 1 is 108, and for matched group 2 this figure is 107.

Figure 12: Boxplots comparing KS2 maths outcomes of matched group pupils



Taken together, we find that after controlling for meaningful observable characteristics the difference between Kumon and non-Kumon groups is reduced but a difference appears to remain. The remaining difference in medians is 2-3 points depending on the matched group. At this point however we would treat the results for control group 2 with caution given that this group does not take into account the overall performance of schools attended.

Next we use a series of linear regressions to get a more accurate estimate of the size of this difference. Five matched regression models are created and summarised in this section. They are reported in full in the Technical Appendix. Note that this amounts to six models in total, with the first being the unmatched linear regression presented in the previous section (Figure 9).

The rationale behind our series of linear regression models is as follows:

- We first regress the KS2 maths outcome on the Kumon participation variable using each matched comparison group (this creates model 2 and model 3). This gives an estimate of the difference between the Kumon and non-Kumon groups without controlling for anything else, and is the same as comparing the means of the two groups.

- Next we take matched group 2 and control for both Kumon participation and overall school performance (this creates model 4). We do this because overall performance of pupils' schools was the variable we sacrificed in order to maximise the number of Kumon pupils in matched group 2, and so it must be controlled for in regression post-matching.
- Finally, we regress KS2 maths outcomes on all variables discussed in this paper, using each matched comparison group (model 5 and model 6). This gives an estimate of the difference between the Kumon and non-Kumon groups controlling for all other meaningful variables that could be accounted for in this analysis.

An additional purpose of employing more than one comparison group as well as different specifications of linear regression (or in other words controlling for different variables) is that it indicates how sensitive our analysis is to the decisions we have made in our specifications. If we have successfully reduced model-dependency then our results should be more or less similar in each instance, indicating how confident we can be to have identified an accurate estimate of the effect.

Results in KS2 maths scaled scores

Figure 13 visualises the estimated effects of Kumon participation in each of the six models. The estimates are given in 95 per cent confidence intervals and represent the average number of points' difference on a pupil's KS2 maths scaled score when they participate in Kumon tutoring. [25] Note that this analysis does not prove causality, as there remain potentially important unobserved variables.

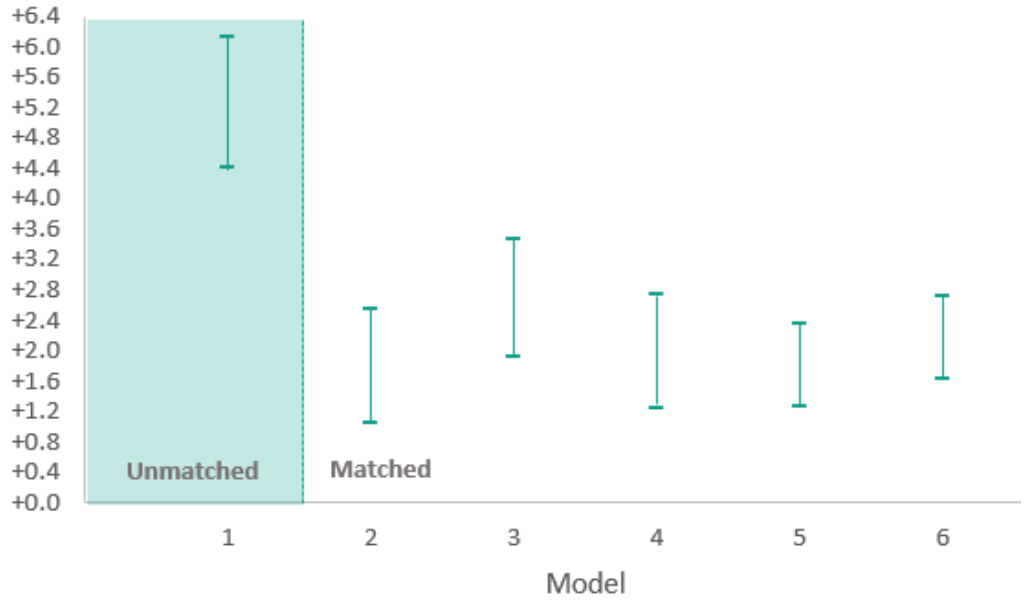
It can be observed that there is a clear difference between the unmatched and matched estimates, demonstrating the benefits of using matched comparison groups to account for differences in pupil characteristics.

We find that estimates of the effect associated with Kumon participation converge around two additional points when comparing matched groups. The estimates are fairly consistent from model to model, suggesting that the output is not strongly dependent on either our matching or our regression specifications. The exception is model 3 which gives a higher estimate of 2.69. However, when we add a control for overall school performance this reduces the estimate to 1.99 (model 4). This demonstrates the importance of controlling for overall school performance and suggests that **matched group 1 may be a more reliable control group for estimating the effect of Kumon.**

Overall, we find that our best conservative estimate of the difference in attainment between Kumon and similar non-Kumon pupils is an additional 1.80 points in terms of KS2 maths scaled scores, with a margin of error of +/-0.54 after controlling for other variables.

[25] In simple terms, we can be 95 per cent confident that a 95 per cent confidence interval contains the true value we are trying to estimate. In other words, if we were to repeat this study by sampling the same population 100 times and produced a 95 per cent confidence interval each time, we would expect 95 of these confidence intervals to contain the true value.

Figure 13: Ninety-five per cent confidence interval estimates of impact of Kumon programme on KS2 maths scale scores



Model	Description of model:	Estimated additional points	Lower - 95% confidence interval	Upper - 95% confidence interval	n Kumon pupils
1	Comparison of the attainment of Kumon pupils with all pupils nationally	**5.27**	4.4	6.13	310
2	Comparison of the attainment of Kumon pupils with a set of pupils with similar characteristics and similar school level performance	**1.80**	1.04	2.56	263
3	Comparison of the attainment of Kumon pupils with a set of pupils with similar characteristics but not necessarily similar school level performance	**2.69**	1.92	3.47	290
4	Comparison of the attainment of Kumon pupils with a set of pupils with similar characteristics but not necessarily similar school level performance, controlling for school level performance in a regression analysis	**1.99**	1.24	2.74	290
5	Comparison of the attainment of Kumon pupils with a set of pupils with similar characteristics and similar school level performance, with a full set of controls in a regression analysis	**1.80**	1.26	2.34	263
6	Comparison of the attainment of Kumon pupils with a set of pupils with similar characteristics but not necessarily similar school level performance, with a full set of controls in a regression analysis (including school level performance).	**2.17**	1.63	2.71	290

Results in additional months' progress

Finally, we use matched group 1 to estimate the additional months' progress that Kumon pupils make in comparison with the matched control group in terms of KS2 maths outcomes. This is done by finding the difference in mean percentile rank between the two groups, and then adjusting to translate the gap into months. Detail of the method can be found in our previously published annual reports.[26]

We estimate this gap to be 6.8 months. That is to say, we estimate that as a group the pupils in our Kumon sample made 6.8 months' additional progress in maths in comparison with non-Kumon pupils who have similar observable characteristics.

EPI has published a number of previous reports examining gaps in months' progress between disadvantaged and non-disadvantaged pupils, and these reports provide a useful benchmark for interpreting the size of the gap found in this study.[27] Note however that these previous studies consider gaps in combined scores across reading, writing and maths and are not strictly comparable with the findings in the present study which considers maths only. Our findings relating to Kumon pupils and their KS2 maths outcomes can best be compared with the subject-level disadvantage gaps which will be published for the first time in 2020.[28]

[26] Jo Hutchinson et al., 'Education in England: Annual Report 2019' (Education Policy Institute, July 2019).
[27] Jo Hutchinson et al., 'Education in England: Annual Report 2019' (Education Policy Institute, July 2019); Jo Hutchinson et al., 'Education in England: Annual Report 2018' (London: Education Policy Institute, 25 July 2018).
[28] Jo Hutchinson et al., 'Education in England: Annual Report 2020' (Education Policy Institute, forthcoming 2020).

Conclusion

When compared with all pupils, Kumon participants who have accessed the programme for at least three months have on average 5.27 additional points in KS2 maths scaled scores. However, there are substantial differences in characteristics between Kumon pupils and others, hence why we use a matched comparison group. After matching, a difference of about 1.80 additional points remains. This is equivalent to 6.8 months of additional progress in comparison with similar pupils.

This analysis used two alternative comparison groups in addition to multiple regression specifications. Results were consistent across models, suggesting that we have successfully reduced model-dependence. This should not however be treated as causal analysis. There remain important unobserved variables such as parental engagement, pupil motivation, and access to other forms of tutoring which could not be accounted for in this paper. Furthermore, the sampling method may have introduced bias as pupils with more engaged parents may have been more likely to have their consents given.

With these caveats in mind, this analysis does find evidence that pupils participating in Kumon tutoring have about two points higher maths attainment than similar pupils who have not accessed Kumon.

This effect is observed on a group whose maths attainment is already higher than average. In other words, judging from their matched comparison group it is likely that this sample of Kumon pupils would have achieved well without accessing Kumon tutoring. While government, schools or parents may view any increased attainment as valuable, it is not known what benefit is conferred by this additional attainment. It may or may not be that these pupils are more likely to pass entry exams to selective schools, or to be more confident transitioning into KS3 maths, and the attainment gap may or may not be sustained up to GCSE. Future research could add to a clearer understanding of the sustained differences in outcomes between pupils who do and do not access Kumon.

Numbers were too small in our Kumon sample to examine the impact of Kumon on participants with low prior attainment, who are eligible for FSM, or who live in more deprived areas. It cannot be concluded from this study what impact Kumon would have on those who are most likely to be targeted for catch-up learning in the recovery from the covid-19 pandemic.

Technical Appendix

Figure A: Length of time on Kumon programme for Kumon pupils finishing KS2

Months	Number of students	%
<=3	638	13.06%
4-6	802	16.41%
6-12	572	11.70%
13-24	1005	20.56%
25-36	693	14.18%
37+	1177	24.08%

Source: Provided by Kumon, 27th Feb 2020

Identifying LSOAs that are within a reasonable travel distance to a grammar school

Reasonable distance was taken from EPI's published report on Grammar Schools and Social Mobility (p.18).[29] This report used the Key Stage 4 National Pupil Database to calculate the maximum distance travelled to school by 90 per cent of grammar school pupils, split by rural or urban area type of the pupil's home LSOA.

Straight-line distance in miles was calculated between the population-weighted centroids (using eastings and northings) of each LSOA in England and each LSOA that had a grammar school open as at June 2020. For each LSOA, if the closest grammar LSOA is within the reasonable travel distance for that area type, a pupil living in that LSOA is considered to have reasonable access to a grammar school.

Identifying LSOAs that are within a reasonable travel distance to a Kumon centre

Kumon provided EPI with a list of open Kumon centres (as at 2020) linked to their LSOA codes. For each Kumon pupil in our sample we were able to identify their closest Kumon centre from this list (in terms of straight-line distance). Working on the assumption that each Kumon pupil will attend their closest Kumon centre, we calculated the maximum distance travelled to the Kumon centre by 90 per cent of Kumon pupils, split by rural or urban area type of the pupil's home LSOA.

Figure B: Reasonable travel distance to Kumon centres

Urban/rural area type	Reasonable distance to travel to Kumon centre, miles	n pupils
Rural - Hamlet/Village/Town	8.0	29
Urban - Town/City	3.3	143
Urban – Conurbation	2.5	141

The same method as for grammar schools was then used to identify LSOAs that are within a reasonable travel distance to a Kumon centre.

[29] Jon Andrews, Jo Hutchinson, and Rebecca Johnes, 'Grammar Schools and Social Mobility' (Education Policy Institute, September 2016).

Logistic regression predicting Kumon participation, all variables

Figure C: Logistic regression predicting Kumon participation, all variables

Variable	Estimated additional points	Standard error	Statistic	P value
(Intercept)	-7.47	0.54	-13.84	0.000
Any identified SEND	-0.34	0.24	-1.45	0.146
KS1 average point score quintile	0.17	0.05	3.49	0.000
School attainment decile	0.05	0.02	2.28	0.023
Eligibility for FSM	-0.98	0.27	-3.63	0.000
IDACI score decile	-0.13	0.02	-5.35	0.000
Pupil speaks English as an additional language (EAL)	0.37	0.53	0.69	0.491
Pupil has Foundation Stage Profile data	-0.64	0.46	-1.40	0.161
Pupil home LSOA is Urban Conurbation (ref = Rural)	-0.04	0.23	-0.16	0.870
Pupil home LSOA is Urban Town/City (ref = Rural)	0.30	0.21	1.43	0.154
Pupil ethnic group is Asian (ref = White)	1.16	0.19	6.27	0.000
Pupil ethnic group is Black (ref = White)	1.51	0.21	7.06	0.000
Pupil ethnic group is Mixed (ref = White)	0.88	0.23	3.87	0.000
Pupil is of any other ethnic group (ref = White)	1.72	0.23	7.63	0.000
Pupil lives within travel distance of a grammar school	-0.28	0.13	-2.22	0.026
EAL and FSP interaction	0.27	0.54	0.50	0.618

N = 292 Kumon pupils and 426,209 non-Kumon pupils who live within travel distance of a Kumon centre

Linear regression outputs, matched models 2-6

Figure D: Model 2: Matched Group 1, Kumon flag only

Variable	Lower estimate (95% confidence interval)	Estimated additional points	Upper estimate (95% confidence interval)	Standard error	Statistic	P value
(Intercept)	108.01	108.10	108.18	0.04	2485.76	0.000
Kumon flag	1.04	1.80	2.56	0.39	4.65	0.000

N = 263 Kumon pupils and 20,570 non-Kumon pupils

Figure E: Model 3: Matched Group 2, Kumon flag only

Variable	Lower estimate (95% confidence interval)	Estimated additional points	Upper estimate (95% confidence interval)	Standard error	Statistic	P value
(Intercept)	107.27	107.31	107.35	0.02	4837.15	0.000
Kumon flag	1.92	2.69	3.47	0.40	6.82	0.000

N = 290 Kumon pupils and 91,782 non-Kumon pupils

Figure F: Model 4: Matched Group 2, Kumon flag and school attainment

Variable	Lower estimate (95% confidence interval)	Estimated additional points	Upper estimate (95% confidence interval)	Standard error	Statistic	P value
(Intercept)	103.94	104.04	104.13	0.05	2230.07	0.000
Kumon flag	1.24	1.99	2.74	0.38	5.21	0.000
School attainment decile	0.61	0.62	0.64	0.01	79.03	0.000

N = 290 Kumon pupils and 91,782 non-Kumon pupils

Figure G: Model 5: Matched Group 1, controlling for all variables

Variable	Lower estimate (95% confidence interval)	Estimated additional points	Upper estimate (95% confidence interval)	Standard error	Statistic	P value
(Intercept)	94.27	94.57	94.86	0.15	627.48	0.000
Kumon flag	1.26	1.80	2.34	0.28	6.51	0.000
Any identified SEND	-4.38	-4.11	-3.83	0.14	-29.29	0.000
KS1 average point score quintile	2.74	2.79	2.84	0.02	111.88	0.000
School attainment decile	0.40	0.42	0.45	0.01	33.86	0.000
Eligibility for FSM	-0.03	0.30	0.63	0.17	1.77	0.077
IDACI score decile	0.01	0.04	0.07	0.01	3.11	0.002
Pupil speaks English as an additional language (EAL)	0.73	0.88	1.03	0.08	11.50	0.000
Pupil ethnic group is Asian (ref = White)	0.98	1.14	1.31	0.09	13.39	0.000
Pupil is of any other ethnic group (ref = White)	2.58	2.83	3.08	0.13	22.35	0.000
Pupil ethnic group is Black (ref = White)	0.48	0.71	0.93	0.11	6.18	0.000
Pupil ethnic group is Mixed (ref = White)	0.68	0.93	1.18	0.13	7.26	0.000
Pupil lives within travel distance of a grammar school	-0.14	-0.02	0.11	0.06	-0.29	0.768

N = 263 Kumon pupils and 20,570 non-Kumon pupils

Figure H: Model 6: Matched group 2, controlling for all variables

Variable	Lower estimate (95% confidence interval)	Estimated additional points	Upper estimate (95% confidence interval)	Standard error	Statistic	P value
(Intercept)	93.80	93.93	94.06	0.07	1408.08	0.000
Kumon flag	1.63	2.17	2.71	0.28	7.89	0.000
Any identified SEND	-4.30	-4.17	-4.04	0.07	-63.00	0.000
KS1 average point score quintile	2.86	2.88	2.91	0.01	233.69	0.000
School attainment decile	0.47	0.48	0.49	0.01	82.23	0.000
Eligibility for FSM	-1.70	-1.56	-1.41	0.07	-21.28	0.000
IDACI score decile	0.04	0.05	0.06	0.01	7.84	0.000
Pupil speaks English as an additional language (EAL)	1.01	1.08	1.15	0.04	29.48	0.000
Pupil ethnic group is Asian (ref = White)	0.89	0.97	1.06	0.04	22.56	0.000
Pupil is of any other ethnic group (ref = White)	1.43	1.55	1.67	0.06	26.19	0.000
Pupil ethnic group is Black (ref = White)	-0.06	0.05	0.15	0.05	0.86	0.388
Pupil ethnic group is Mixed (ref = White)	0.24	0.35	0.47	0.06	5.89	0.000
Pupil lives within travel distance of a grammar school	-0.18	-0.12	-0.06	0.03	-3.76	0.000

N = 290 Kumon pupils and 91,782 non-Kumon pupils

Figure I: Region of school attended – proportion of pupils in each group and median KS2 maths score of all pupils

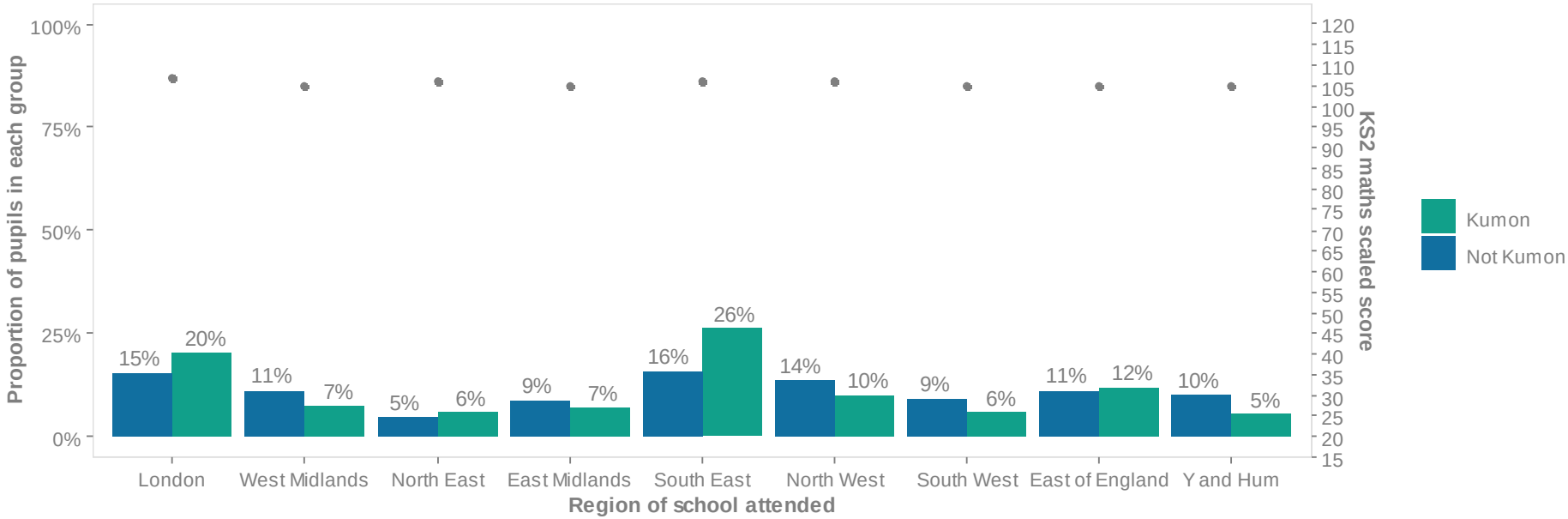


Figure J: Rural/Urban classification of pupil's home LSOA – proportion of pupils in each group and median KS2 maths score of all pupils