

Forecasting the Impact of the Mode of use of the UKCAT on Dental School Entrant Demographics

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October 2013

Executive Summary

The results of previous analyses suggest that the manner in which the UKCAT is used in the admissions process may influence the demographic characteristics of dental entrants. Consequently we use these findings in order to develop forecasts of what may happen to the demographics of the dental workforce if universities were to change their usage style of the test. Our findings suggest that if consortium dental schools currently using a 'factor' approach to the UKCAT scores switched to a 'threshold' approach then this may result in an appreciable increase in the proportion of ex-state school students admitted to 'standard entry' dental courses, roughly in the order of 10%. There is some evidence in medicine (though not dentistry) to suggest that the level of the threshold selected will also play a role in dictating the impact of adopting this usage style. It should be noted that this forecast assumes that the link between the demographics and the style of UKCAT usage are largely causal. The forecast also assumes that no other significant secular trends or 'shocks' will intervene (for instance the impact of education, societal or economic influences) and observed recent trends are likely to continue.

Full Report

Background

In order to estimate the potential impact of the UKCAT usage style on the demographics of UK dental graduates we first looked at where the mode of test usage is associated with a significant difference in the demographics of dental school entrants. In order for us to be reasonably confident that these differences are going to translate into long term trends they should be *consistent* across cohorts, especially over the most recent waves of intake. It is important to note that these findings reported only pertain to mainstream dental courses, not graduate entry, pre-dental entry courses or other 'widening access' schemes. Such entrants were excluded in order to reduce the risk of bias (which would be compounded due to the relatively high rates of missing sociodemographic data in entrants to these courses).

To recap, there are three main ways that dental schools in the consortium use the UKCAT;

Borderline: UKCAT score used in borderline cases, as a tie-breaker, or (more rarely) as a “rescue” mechanism to offer interviews to candidates whose applications would otherwise rate poorly—that is, weak use of the test or few candidates affected

Factor: UKCAT used as a factor in deciding to interview or offer, or both (moderate use of the test). In practice this means around 10-18% of the decision to offer an interview or place at dental school was based on UKCAT scores. My previous report to the UKCAT Board highlighted that, as expected, a greater weighting factor makes acceptance generally more difficult but favours higher scoring candidates applying to medical school (there were insufficient data to model these effects in dental applications).

Threshold: A threshold score used to decide whether to offer an interview (relatively strong use of test). My previous report to the UKCAT Board highlighted that, as expected, higher thresholds makes acceptance generally more difficult but favour higher scoring candidates applying to medical school (there were insufficient data to model these effects in dental applications). This style appears to be the only one that mitigates against the natural disadvantage experienced by a number of Widening Participation (WP) groups during the admissions process. Moreover, as highlighted in my previous report, admissions outcomes to ‘threshold’ universities are surprisingly predictable; given the basic demographic and educational characteristics of a candidate we can correctly predict the outcome of a single application event in around 75% of cases. Thus, endogenous factors (variables incapable of being modelled, such as what colour tie you wore at interview) are likely to play a relatively minor role in the selection process.

Unlike in medicine, there has been no tendency towards a stronger use of the UKCAT as a component of the admissions process amongst consortium dental schools, with usage trends being rather static (Table 1). It is not possible to comment on trends in the *weight* placed on the UKCAT due to a lack of detailed information provided by consortia dental schools.

Year of entry	‘Borderline’	‘Factor’	‘Threshold’
2007	N=2	N=1	N=4
2008	N=1	N=3	N=4
2009	N=1	N=3	N=4
2010	N=2	N=4	N=4
2011*	N=3	N=2	N=3

Table 1. Dental school UKCAT usage styles, 2007 to 2011.

*use style unreported in two cases

For the purposes of this study we defined an entrant as one where an unconditional offer has been made firm (including a changed course offer [UCAS code UCCF] in some rare cases). We then look at which dental schools have

significantly different proportions of entrants. Defining entrants in this way there should be a unique relationship between a candidate and a university. Thus, we checked for duplicates. A small number of these were identified. Duplicates appeared to be accepting more than one 'UF' offer at same university.

In order to build up a picture of which differences between university types are consistent enough to support plausible forecasts we managed, checked and cleaned data for cohort that entered dental school from 2007 to 2011 (inclusive). Thus, we were able to use a simple logistic regression to test whether the sociodemographic status of an entrant (as defined here) could be predicted by the category of university they were accepted to ('borderline'/'factor'/'threshold'). In effect, the category of university was treated as a factor variable, having three levels. Consequently the 'baseline' category of university had to be switched at least once (e.g. from 'borderline' to 'factor') in order to evaluate all the possible comparison pairings (e.g. 'borderline' vs 'factor'). The findings from this exploration are depicted in Table 2. For simplicity only the significance of the inter-group difference are shown. Unlike previous model building process (where 'true model nesting' had to be ensured) listwise deletion was not used to deal with missing data (i.e. deletion of observation where any values were missing). Thus, as long as the dependent (outcome) variable was not missing the data was analysed using this simple logistic regression approach in order to maximise the information available. It should also be noted that for dental entrants 'low A level attainment' was defined as obtaining less than three A grades at A level. This was because (at least until the last couple of years when grade inflation started to impact more profoundly) this represented the bottom quartile of entrants (25%) and also because the standard offer for entry to dental schools is usually three As or equivalent at A level. Trends are easily visualised in Table 3.

2007 entrants			
	borderline vs factor	borderline vs threshold	factor vs threshold
Male	Ns	ns	ns
Non-White	Ns	ns	ns
EASL-not avail	NA	NA	NA
>20 years	Ns	ns	ns
stateschool	.1	.09	ns
Low A levels	<.001	.04	<.001
2008 entrants			
	borderline vs factor	borderline vs threshold	factor vs threshold
Male	Ns	ns	ns
Non-White	.07	.005	.1
EASL-not avail	Ns	ns	ns
>20 years	Ns	.07	<.001
stateschool	.009	ns	<.001
Low A levels	<.001	.04	<.001
2009 entrants			
	borderline vs factor	borderline vs threshold	factor vs threshold
Male	Ns	ns	ns
Non-White	.08	.005	.1
EASL	Ns	ns	ns
>20 years	Ns	.07	.001
stateschool	.008	ns	<.001
Low A levels	Ns	ns	ns
2010 entrants			
	borderline vs factor	borderline vs threshold	factor vs threshold
Male	Ns	ns	.002
Non-White	Ns	ns	ns
EASL	Ns	ns	ns
>20 years	Ns	ns	ns
stateschool	Ns	ns	.002
Low A levels	Ns	ns	ns
2011 entrants			
	borderline vs factor	borderline vs threshold	factor vs threshold
Male	Ns	ns	ns
Non-White	.002	ns	.001
EASL	Ns	ns	ns
>20 years	.008	.03	ns
stateschool	Ns	ns	.007
Low A levels*	.002	.03	ns

Table 2. P values derived from a simple logistic regression with the sociodemographic characteristics of dental school entrants as the outcome variable. This highlights where significant inter-group differences exist for the period evaluated. Only those of borderline ($p \leq .1$) or statistical significance ($p < .05$) are shown.

Males	borderline vs factor	borderline vs threshold	factor vs threshold
2007			
2008			
2009			
2010			✓
2011			
Non-White	borderline vs factor	borderline vs threshold	factor vs threshold
2007			
2008	.07	✓	.1
2009	.08	✓	.1
2010			
2011	✓		✓
EASL	borderline vs factor	borderline vs threshold	factor vs threshold
2007	NA	NA	NA
2008			
2009			
2010			
2011			
Older (>20 years at application)	borderline vs factor	borderline vs threshold	factor vs threshold
2007			
2008		.07	✓
2009		.07	✓
2010			
2011	✓	✓	
School type	borderline vs factor	borderline vs threshold	factor vs threshold
2007	.1	.09	
2008	✓		✓
2009	✓		✓
2010			✓
2011			✓
Low A levels (less than AAA)	borderline vs factor	borderline vs threshold	factor vs threshold
2007			
2008	✓	✓	✓
2009			
2010			
2011	✓	✓	

Table 3. 'Consistency' matrices. Ticks indicate where a significant inter-group difference exists for the sociodemographic characteristics of dental school entrants. P values for trends of borderline significance are shown (in this case $p < .1$ but $> .05$). Note: English as a second language (EASL) was not available for 2007.

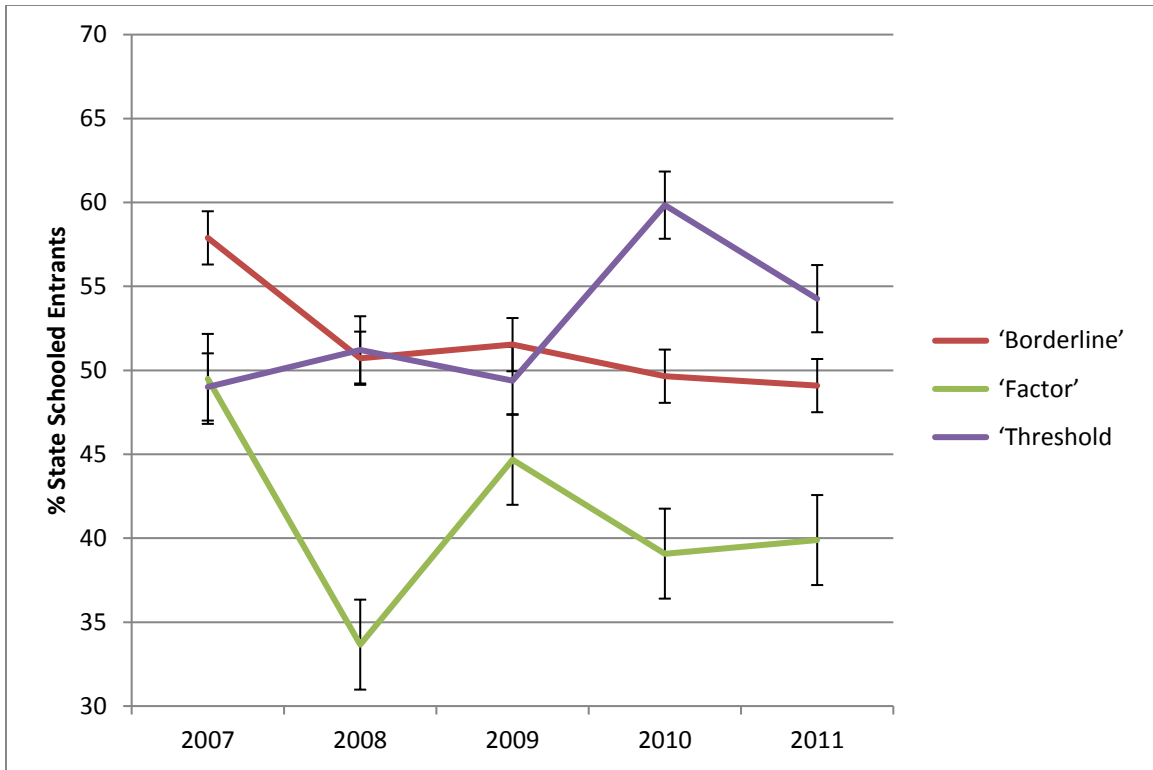


Figure 1: Trends for proportion of dental entrants who report being state schooled for each type of dental school (according to UKCAT usage style). Standard error bars are shown for the data points in each series.

As can be seen from Figure 1, there are rather stable (and significant) differences in the proportion of state schooled candidates that are admitted to universities using the UKCAT as a factor in the admissions process compared to the other two types of university. Assuming no underlying trend we can say that, on average 'factor' universities admit around 10% state schooled entrants compared to the other two types of dental schools. This observed difference was most marked for 'threshold' vs 'factor' universities in 2011 entrants.

How certain can we feel about this estimate? It should be noted that the standard error (SE) bars on Figure 1 are generated by Microsoft Excel for each data point and represent the SE for each point within its series (in effect the SD divided by the square root of N [the number of dental schools in each group] for each series). There are other ways of generating SEs (and hence 95% confidence intervals) in this particular situation. For example, as either a simple SE of a proportion (this is the proportion of state schooled entrants multiplied by the proportion of private/grammar schooled entrants divided by total N and the square root taken). Another option would be to create a weighted SE for each group of dental schools so that the SE of larger schools would be given more importance than smaller ones. However, if we look at the simple SE for each group at the latest time point (2011 entrants) we will have a reasonably good idea how confident we can be in our forecast. In this case our standard error for

the threshold group is calculated as a proportion of .0389, equating to around 4%. Thus, we can be 95% confident that the proportion of males entering medical schools using the UKCAT as a threshold in 2012 was somewhere between 46% and 62%. We can repeat this for the 'factor' type of university; pooling the data for these two latter groups we derive a similar standard error of .0357- around 3.6%. Therefore we can be 95% confident that the proportion of state schooled entrants to this type of medical school in 2012 will lie roughly between 33 and 47%. It should be noted that these estimates ignore variation in proportions between dental schools in the same group, but at this point we are interested in forecasting *overall* effects on dental school demographics rather than individual university intakes, where there would be a greater degree of uncertainty. Assuming independence (i.e. no underlying connection between these two proportions) we could be 95% confident that, for the foreseeable future (should this trend remain) the difference between state schooled intake to a 'threshold' type university and the 'factor' type will be somewhere between 29 and 1% (in the latter case, if an extreme value for both is observed) but is actually likely to be nearer to the mean of 10%. Note that, given the much smaller numbers of both dental schools and entrants our standard error (and hence confidence intervals) are much wider than those we can derive for medical schools. Indeed, if we go back to a simple logistic regression the OR for being a state school entrant to a threshold dental school is 1.79, but the 95% confidence intervals are wide at 1.17 to 2.73.

However, if we look at figure 1 we can see that the proportions of state schooled entrants are relatively stable over the 2010 and 2011. It is therefore plausible to use an entirely different approach to 'classical' statistics to attempt to increase our precision in estimating the 'true effect' of university type. Thus, we will now use a Bayesian analysis in order to incorporate 'prior knowledge' of these proportions from 2010 entrants to inform our estimate of the difference between 'factor' and 'threshold dental schools' in this respect. An explanation of this approach is contained within the Appendix.

Using a Bayesian approach we use estimates from the analysis of the 2010 entrant data to inform the analysis of the data from the 2011 entrants. This method aims to reduce our uncertainty about the 'true' effect of being an entrant to a 'threshold', as opposed to a 'factor' university. Analysing the 2011 data in this way gives us an estimate of the probit coefficient for being a state schooled student from a 'threshold', rather than 'factor' dental school of .461 (credibility intervals** of .302 to .622). Approximating these coefficients to odds ratios gives the odds ratio of being a state school entrant to a threshold type of dental school as 2.19, with a 95% CI** of 1.67 to 2.88. These estimates are rather more precise than our conventional estimate of 1.79 (95% confidence intervals 1.17 to 2.73). Note, that these are Odds Ratios (ORs) not probabilities.

**Credibility, or credible intervals are the Bayesian equivalent of confidence intervals

Thus, we can say that we are roughly 95% certain that the odds of being a state school (as opposed to private or grammar school) are roughly double that for threshold as opposed to factor dental schools, but we are 95% certain the true difference lies between 67% and 288% extra. Translating these figures back into proportions may help our interpretation:

If around 170 entrants (with a school type reported) went to a threshold dental school we could expect just over half to be from a state school background i.e. a probability of around .59, or an odds of .59/.41, which is 1.44. If around 190 (with a school type reported) went to a 'factor' dental school we could expect just 40% to be from a state school background i.e. a probability of around .40, or an odds of .40/.60, which is .67. Therefore, crudely the odds ratio for being from state school if you enter a 'threshold' rather than 'factor' type dental school is 1.44/.67 or 2.15- roughly equal to our Bayesian point estimate for the OR, though larger than our estimate using conventional statistics. This is because we used the findings from the 2010 entrants, where the difference in the proportion of state schooled students was even larger between the types of dental schools, to inform our estimate. Thus we can say that we are fairly sure, all things being equal, that the odds of being an entrant from state school are roughly double if the university uses the UKCAT score as a threshold, rather than a factor for admission.

Translating these proportions into absolute numbers; should 'factor' dental schools use a threshold approach to the UKCAT then it could result in an average additional state schooled intake to consortium universities of around 18-25 individuals per year. Over five years this might equate to approximately 100 extra state schooled dentists. Naturally this assumes a causal relationship between the style of UKCAT usage and the proportion of state schooled entrants. However, given what we already know about the socio-demographics predicting test performance the link is plausible.

Of course these predictions only apply to mainstream courses and non-graduate entrants, although these individuals make up the vast majority of dental students. Moreover, due to the relatively small number of dental schools and the limited weights/thresholds utilised for the UKCAT it is not possible to comment further on whether these are associated with sociodemographics. However, looking at the medical school effects it is possible that the same effects apply to dental student intakes also, with a greater weighting/higher threshold making overall acceptance more challenging but favouring candidates with high UKCAT scores, and of course, the characteristics associated with these (e.g. male sex). However, due to a lack of information this cannot be formally explored or tested for dental schools.

Further Reflections

Compared to medical entrant data, dental data are less plentiful. Consequently this may have contributed to the observation of only one observable trend (i.e. due to a lack of study power). It must also be borne in mind that the sociodemographics of dental, as opposed to medical entrants differ in several important respects. For example, a higher proportion of non-white and female candidates apply to and enter dental schools compared to medical schools. This may also lead to differing findings between medicine and dentistry. Where cross-sectional data is relatively sparse but (informative) historical data exists Bayesian statistics may be helpful in improving the precision of our forecasts.

Conclusions

1. Consortium dental schools currently using a 'factor' approach to the UKCAT scores may wish to consider switching to a 'threshold' approach if they wish to address the under-representation of state schooled individuals. This may result in an appreciable increase in the proportion of ex-state school students admitted to 'standard entry' dental courses, roughly in the order of 10%. There is some evidence in medicine (though not dentistry) to suggest that the level of the threshold selected will also play a role in dictating the impact of adopting this usage style.
2. Two 'health warnings' should be noted.
 - a. These forecasts assume that the link between the demographics and the style of UKCAT usage are largely causal. Case studies of situations where an institution changed its usage style could support or refute this assumption.
 - b. These forecast assumes that no other significant secular trends or 'shocks' will intervene (for instance the impact of education, societal or economic influences) and observed recent trends are likely to continue.

Appendix

Use of a Bayesian approach to inform our prediction of the impact of test usage

The Bayesian approach is, of course, based on 'Bayes theorem'; a way of conditioning probabilities on previous observations or assumptions. For example, you are walking down a school corridor, having forgotten your glasses. You know that 60% of the students are boys. You see a pupil at the end of the corridor. If you guessed it was a girl you would have a 40% chance of getting it right. However, you also know that 50% of girls wear trousers and all the boys do. You can now make out that pupil is wearing long trousers! What is the probability that the student is a girl? We are now in the realms of *conditional* probability (i.e. what is the probability that the pupil is a girl *given* that they are wearing trousers). We can update our earlier 40:60 guess with this new information using Bayes theorem (below):

$$P(A|B) = \frac{P(B|A) P(A)}{P(B)}$$

We estimate the probability of event A occurring (in this case that the student is a girl) given that (shown by the '|' symbol) that B has already occurred (that they are wearing trousers). Note that P(B|A) means the probability that B has occurred given A (i.e. the probability that a trouser wearers are girls). Also note that the probability that any student in the school is wearing trousers is 0.8 (i.e P(B)) given the proportion of sexes and their uniform tendencies . We plug the figures in:

$$= \frac{0.5 \times 0.4}{0.8} = 0.25.$$

Thus, we now conclude it is very unlikely to be a girl (there is only a 25% chance of this). This estimate is likely to be more accurate than our original estimate of a 40% chance it is a girl.

The Bayesian approach is easily extended to cases with continuous probability distributions and we now use it here to attempt to improve our forecasting precision when dealing with relatively small numbers. At this point we move to using a probit, rather than a logistic regression, simply because this analysis can be conveniently implemented in the modelling software Mplus using a Bayesian estimation approach. However, we can approximate coefficients from a probit regression to those from a logistic regression by multiplying them by a scale

factor of 1.7. They can then be exponentiated in the usual way to obtain interpretable Odds Ratios.

The probit coefficients for 2010 are .518 (95% Credibility intervals** 0.314 to 0.724). This equates to a mean of .518 and an SD (δ^2) of around 0.102 (i.e. a variance (δ) of .0104) for the ‘distribution’ of this estimated coefficient, representing the ‘effect’ of university type. We can now feed this estimate into our analysis of the 2011 entrant data. This serves to reduce our uncertainty about the ‘true’ effect of being an entrant to a ‘threshold’, as opposed to a ‘factor’ university. We do this by telling our software that we assume that the true probit regression coefficient for the effect of entering a ‘threshold’ as opposed to a ‘factor’ dental school is normally distributed with a mean of .518 and a variance of .0104. In fact we can visualise this as the results of our first estimation (see Figure 2):

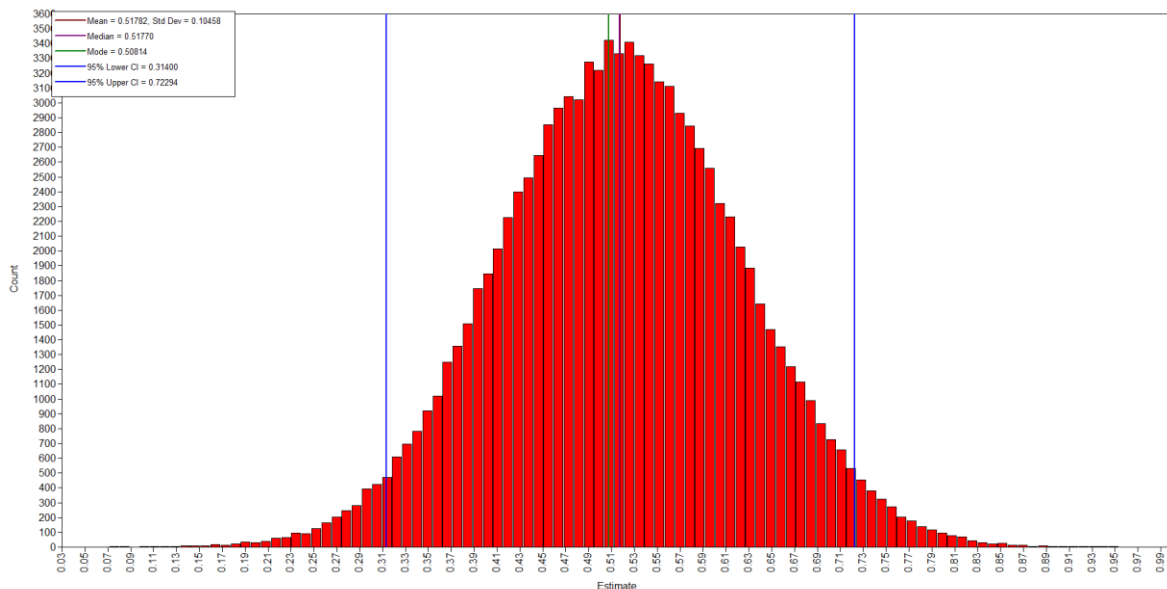


Figure 2. The ‘posterior distribution’ of our estimate of the probit regression coefficient for the effect of dental school type (‘threshold’ vs ‘factor’) on whether a 2010 entrant reports being from a state school background.

Analysing the 2011 data, informed by the 2010 results, gives us an estimate of the coefficient for .461, credibility intervals** of .302 to .622. Again, this can be visualised as a ‘posterior’ distribution of the estimate Figure 3). Note, it is slightly narrower than that seen in Figure 2.

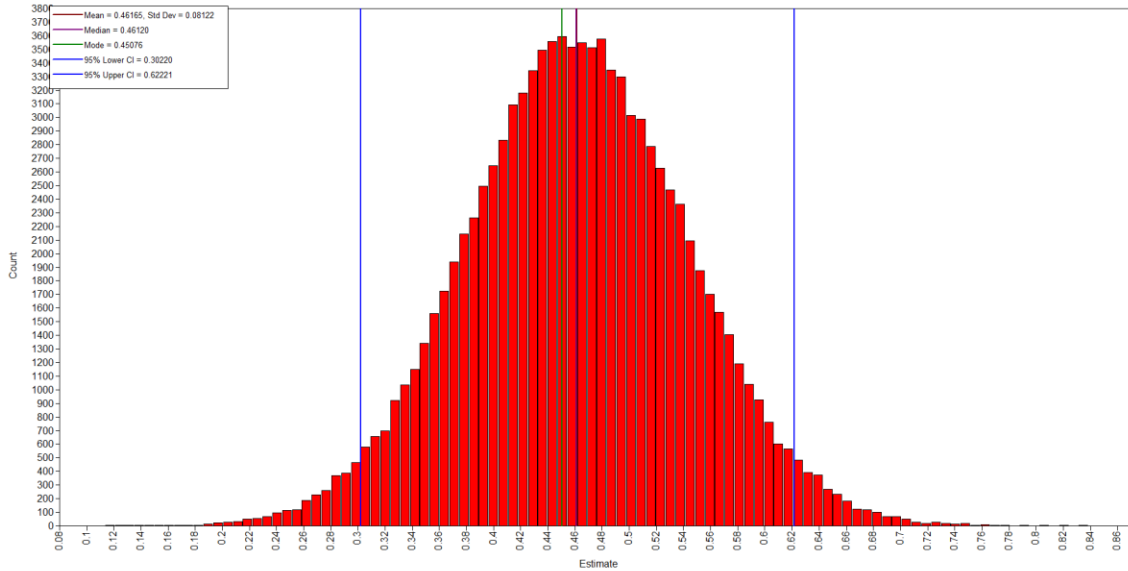


Figure 3. An updated 'posterior distribution' of our estimate of the probit regression coefficient for the effect of dental school type ('threshold' vs 'factor') on whether a 2011 entrant reports being from a state school background. The results from the 2010 cohort informed this estimate.

Approximating these coefficients to odds ratios gives the odds ratio of being a state school entrant to a threshold type of dental school as 2.19 , with a 95% CI** of 1.67 to 2.88). These estimates are rather more precise than our conventional estimate of 1.79 (95% confidence intervals 1.17 to 2.73). Note, that these are Odds Ratios (ORs) not probabilities. Thus, we can say that the we are roughly 95% certain that the odds of being a state school (as opposed to private or grammar school) are roughly double that for threshold as opposed to factor dental schools, but we are 95% certain the true difference lies between 67% and 288% extra.

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