Key Performance Measure 1: Assessment of uncertainty

1. Key Performance Measure 1 (KPM 1) measures the proportion of students at higher education providers where student outcomes indicators are below the minimum numerical thresholds we have set (based on 95 per cent statistical confidence level).

2. KPM 1 is subject to potential volatility that can affect year-on-year comparisons. If a provider's performance is close to the numerical threshold, random statistical variation may mean that its indicator value moves above or below the threshold in different years. In some years we may have 95 per cent statistical confidence that its indicator value is below our numerical threshold and in other years we may not. This might mean that a provider is included in the KPM 1 data in some years and not in others, even where there is not a material change in its performance. This can lead to year-on-year variations, which may be more marked if large providers are included in only some of the years shown in KPM 1.

3. This short paper explains our approach to calculating and assessing statistical uncertainty.

Methodology in assessing uncertainty

4. The approach used is to introduce natural variation into the student outcomes seen in the provision being assessed in KPM1. This is based on the continuation, completion and progression outcomes for each mode, level and cohort combination within each provider (unit). This natural variation can be assessed using statistical simulation.

Example

Using the completion outcome, we may have a unit where 18 out of 30 entrants successfully completed their studies. This means that this unit's completion indicator value is 60% where the associated minimum numerical threshold is 75%. The statistical confidence that 60% is below 75% based on 30 entrants is 96.6%, therefore the 30 entrants in this unit have experienced provision below the numerical threshold and contribute to the KPM 1 indicator.

This indicator value of 60% is prone to year-on-year natural variation. It is unlikely that all 30 entrants might have completed under the same broad conditions due to natural variation, however there is a non-zero probability that one more entrant might have completed. In this case the completion rate increases to 63%, with associated statistical confidence of being below the numerical threshold of 92.6% meaning that, in this simulated scenario, the unit does not contribute to the KPM 1 indicator. Conversely one more entrant may not complete meaning the 30 entrants remain contributing to the KPM 1 indicator.

Results of inclusion of natural variation

5. Table 1 shows the impact the inclusion of this natural variation has on KPM 1 for different modes, levels and cohorts. The likely natural variation in the KPM 1 indicator is captured by the range between the lower and upper confidence limits (these are based on 95% confidence interval).

Table 1 Derived confidence internals using a natural variation approach

Outcome	Year of time series	Cohort description	KPM1 (%) published	Lower confidence limit (%)	Upper confidence limit (%)
Continuation	Year1	2016-17 (FT and APPR) / 2015-16 (PT)	7.9	7.9	8.5
Continuation	Year2	2017-18 (FT and APPR) / 2016-17 (PT)	3.4	3.5	7.0
Continuation	Year3	2018-19 (FT and APPR) / 2017-18 (PT)	4.4	4.3	4.9
Continuation	Year4	2019-20 (FT and APPR) / 2018-19 (PT)	5.2	4.9	5.6
Continuation	Year5	2020-21 (FT and APPR) / 2019-20 (PT)	4.7	4.7	5.7
Completion	Year1	2013-14 (FT and APPR) / 2011-12 (PT)	9.4	8.2	9.9
Completion	Year2	2014-15 (FT and APPR) / 2012-13 (PT)	7.0	7.0	7.8
Completion	Year3	2015-16 (FT and APPR) / 2013-14 (PT)	6.5	6.5	7.1
Completion	Year4	2016-17 (FT and APPR) / 2014-15 (PT)	6.7	6.5	7.1
Completion	Year5	2017-18 (FT and APPR) / 2015-16 (PT)	7.0	6.9	7.3
Progression	Year1	2017-18	0.7	0.9	1.6
Progression	Year2	2018-19	1.4	1.5	2.6
Progression	Year3	2019-20	1.6	1.7	2.5
Progression	Year4	2020-21	1.0	1.1	1.9

Violin plots

6. A violin plot is used to describe the distribution of numeric data using density curves. The black line on the plot shows the true observed value of the KPM. The red dashed line shows the modelled version of the KPM.[1]

[1] The plots show a small difference between the true observed value of the KPM and the modelled version of the KPM for the progression indicator. This is due to the modelling calculations requiring the used of rounded numerators and denominators.

Figure 1: Distribution of variation of data for KPM1: Continuation outcomes

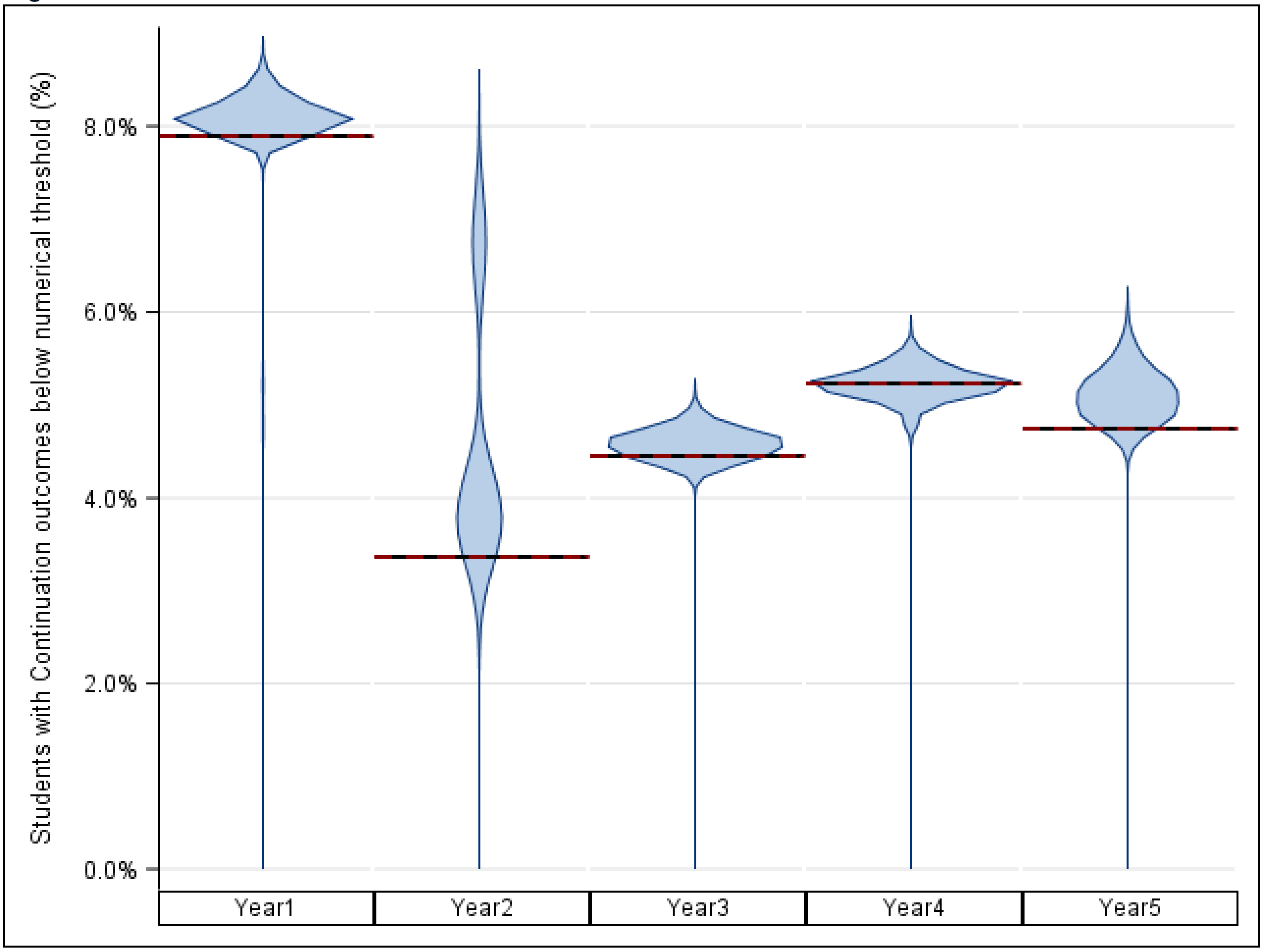


Figure 2: Distribution of variation of data for KPM1: Completion outcomes

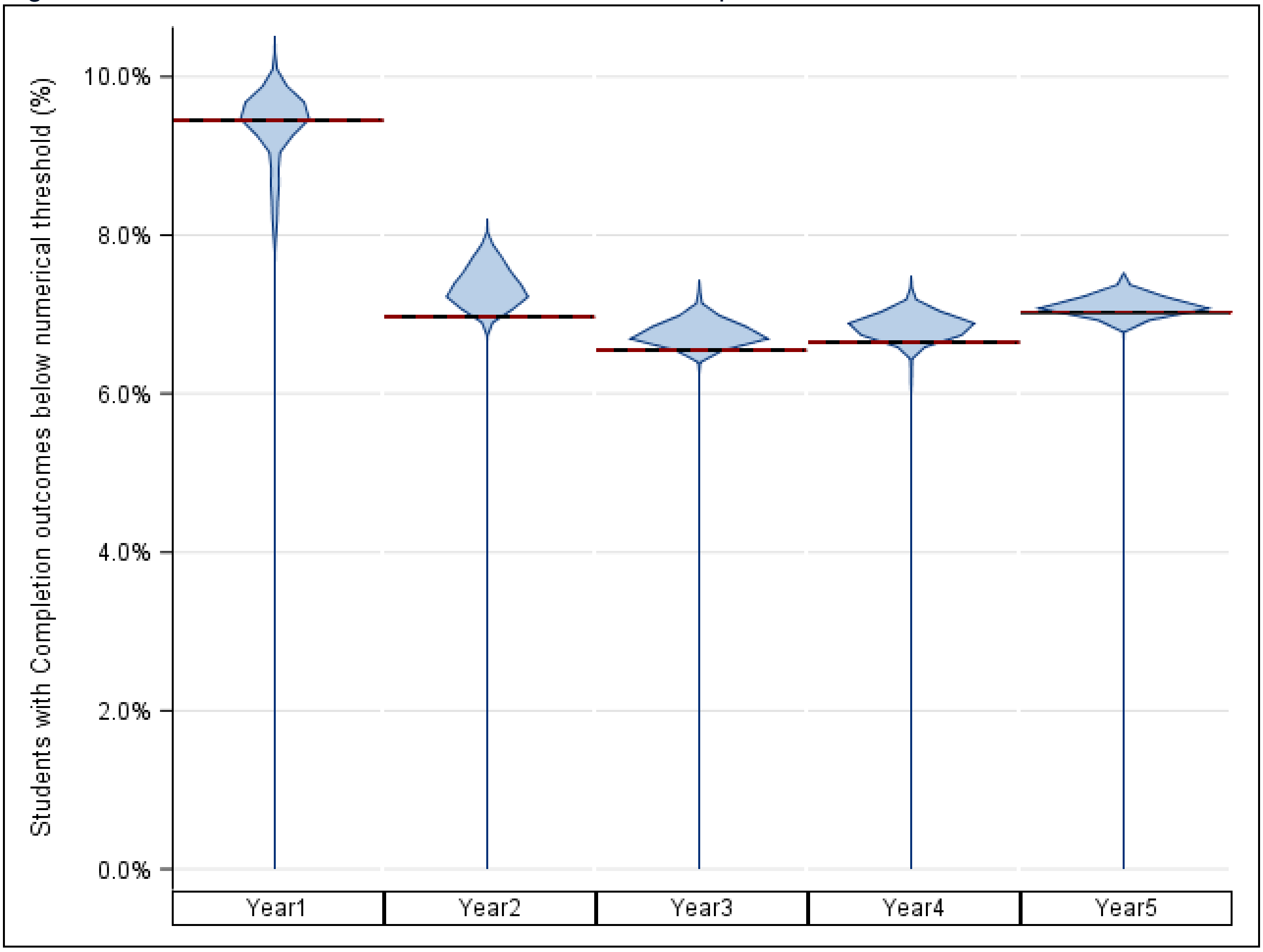
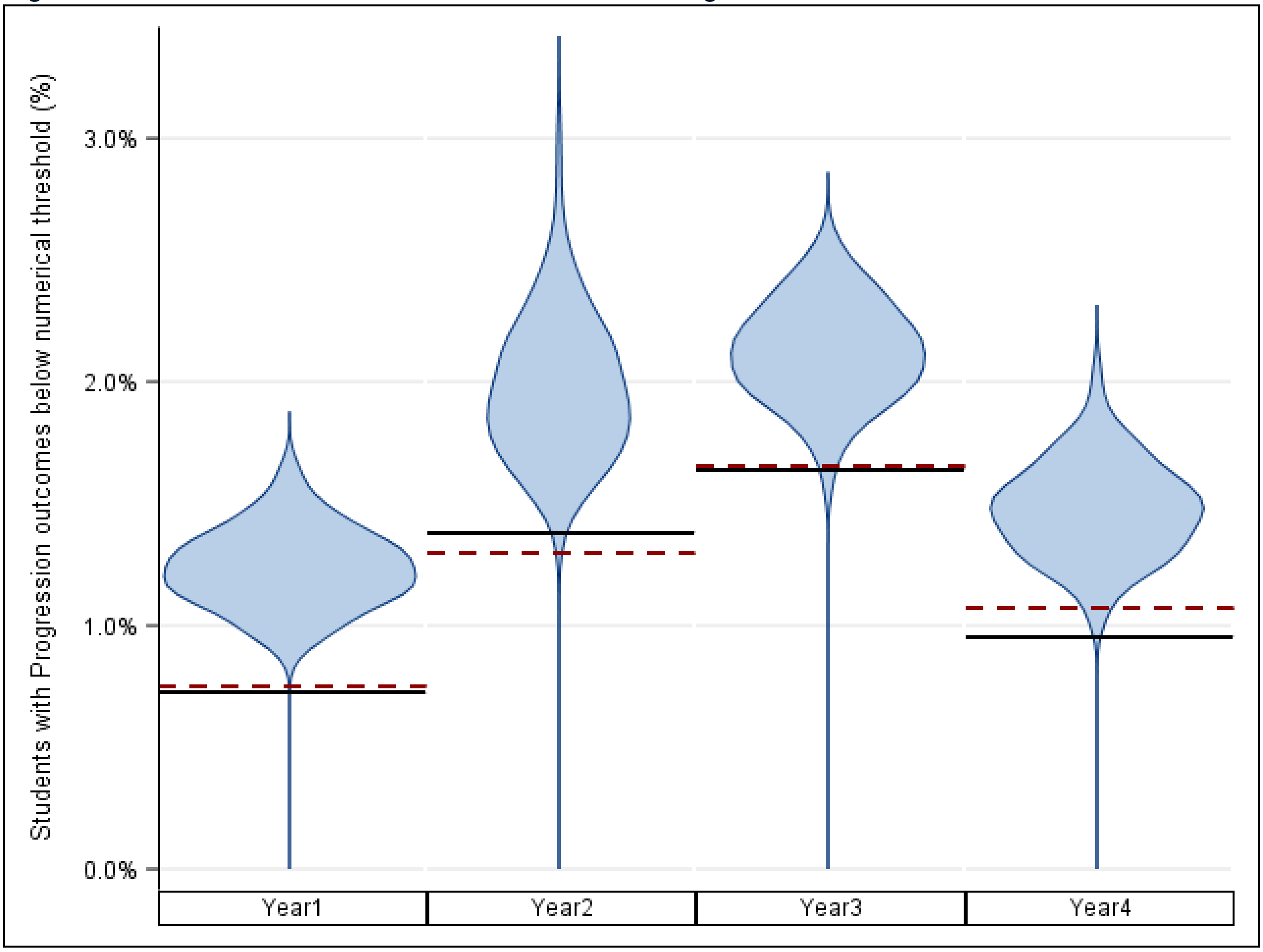


Figure 3: Distribution of variation of data for KPM1: Progression outcomes



What does the data show?

7. The KPM values are restricted to a value between 0 and 1. As they are near to 0, we see that the observed value of the KPM is at the lower end of the lower confidence limit.

Further information

8. Typically for this type of observed outcome, you would create a binomial proportion confidence interval, where the probability of success and the number of trials is given by the observed indicator value and the number of students informing the indicator respectively (the denominator).

9. The confidence intervals which we have constructed are created using the Jeffreys interval[2]. We have used the Jeffreys interval method because it has been shown to perform well in a wide range of circumstances, including where the denominator is small, or the observed proportion is close to 0 per cent or 100 per cent.[3] The Jeffreys interval is calculated using the Jeffreys prior[4] for the binomial proportion, p, given n trials. Confidence intervals are calculated from the posterior distribution for p which is a Beta distribution with parameters ($n\text{p}$ + 0.5, n −

[2] Jeffreys, Harold (1946). An invariant form for the prior probability in estimation problems. Proc. Royal Society, London. A186453–461. http://doi.org/10.1098/rspa.1946.0056.
[3] Brown et al (2001). Interval estimation for a binomial proportion Statistical Science. Vol. 16, No. 2, pages 101-133. http://dx.doi.org/10.1214/ss/1009213286.
[4] Although the Jeffreys interval has a Bayesian derivation it can also be justified from a frequentist perspective. See Brown et al (2001) – details in footnote 2.

np + 0.5). In our case, p is the observed proportion and n is the denominator for the indicator in question.

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