A study on the suitability of class XII board examination scores as a basis for national level admission to tertiary education

A report submitted by the Indian Statistical Institute

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In India, there are over 40 different boards at the 10+2 level, including the state boards as well as the central boards such as CBSE and ICSE. These examinations cover a number of subjects (a student usually registers for five to seven subjects), and are conducted over a number of days. This is in contrast with various national level admission tests such as the IIT-JEE and the AIEEE, which are generally of shorter duration, and rely mostly on objective type tests. The possibility of using the board scores as a basis for national level admission to various 'tertiary level' courses had been under consideration for the past few years. The Ministry of Human Resources Development had constituted a committee under the Chairmanship of Dr. T. Ramasamy, Secretary, Department of Science and Technology (DST), to develop a National Test Scheme that would possibly include some criterion based on board scores. The Secretary-DST, in turn, asked the Indian Statistical Institute (ISI) to look into the following questions.

(a) Do the aggregate scores from different boards exhibit sufficient stability over the years, so that these can be used as criteria for admissions with a reasonable degree of confidence?

(b) What is the best way of standardizing different board scores in order to make them comparable for the purpose of selection?

Recent data on scores obtained by students in a few boards were made available, in order to help ISI to arrive at answers to these question.

This report provides the answers from ISI, with reasons.

1   The data

The data consist of the list of aggregate scores obtained by the students of four boards in the years 2007 to 2010. The boards are: CBSE (5.0-6.3 lakh examinees), Tamil Nadu board (5.6-7.3 lakh examinees), West Bengal board (3.0-4.6 lakh examinees) and ICSE board (23-56 thousand examinees). Out of these, the CBSE scores in the year 2010 could not be used because the data were incomplete, and the West Bengal scores for the year 2010 were not used because a data formatting issue could not be resolved within the requisite time frame.

2   Assumptions needed for comparability of different board scores

The following assumptions would have to be made in order to make the aggregate scores of different boards comparable.

- Aggregate scores are expected to increase from less meritorious to more meritorious students in any particular subject

- Merit distribution is the same in all boards.

3   Stability of board scores

Under the above assumptions, the percentile ranks of students in different board examinations become directly comparable. It would be of interest to observe how the raw aggregate scores relate to the percentile ranks, and how these relationships vary from year to year as well as across different boards.

The number of subjects for aggregation varies from board to board, and sometimes even within a board. For the sake of standardization, the CBSE scores were aggregated over five subjects in all the cases, and the maximum score ranged from 492 (in 2008 and 2009) to 508 (in 2007). The Tamil Nadu board scores were aggregated over six subjects in all cases, and the maximum score ranged from 1188 (in 2010) to 1191 (in 2008). The West Bengal board scores were aggregated over the five compulsory subjects, and the total ranged from 459 (in 2007) to 475 (in 2008). The ICSE board permits students to take examinations in five, six or seven subjects, and the aggregate scores were turned into averages over the appropriate number of subjects. The maximum of this value ranged from 97.83 (in 2008) to 98 (in 2007 and 2009).

The following figure shows the plot of percentile rank against aggregate scores for all students on or above the 50th percentile mark. The aggregate score is expressed as a fraction of the maximum aggregate score obtained by a student in that examination. Each curve represents a particular board examination of a particular year. The curves corresponding to different boards are shown in different colours.

Percentile rank vs. aggregate score: cutoff 50 %
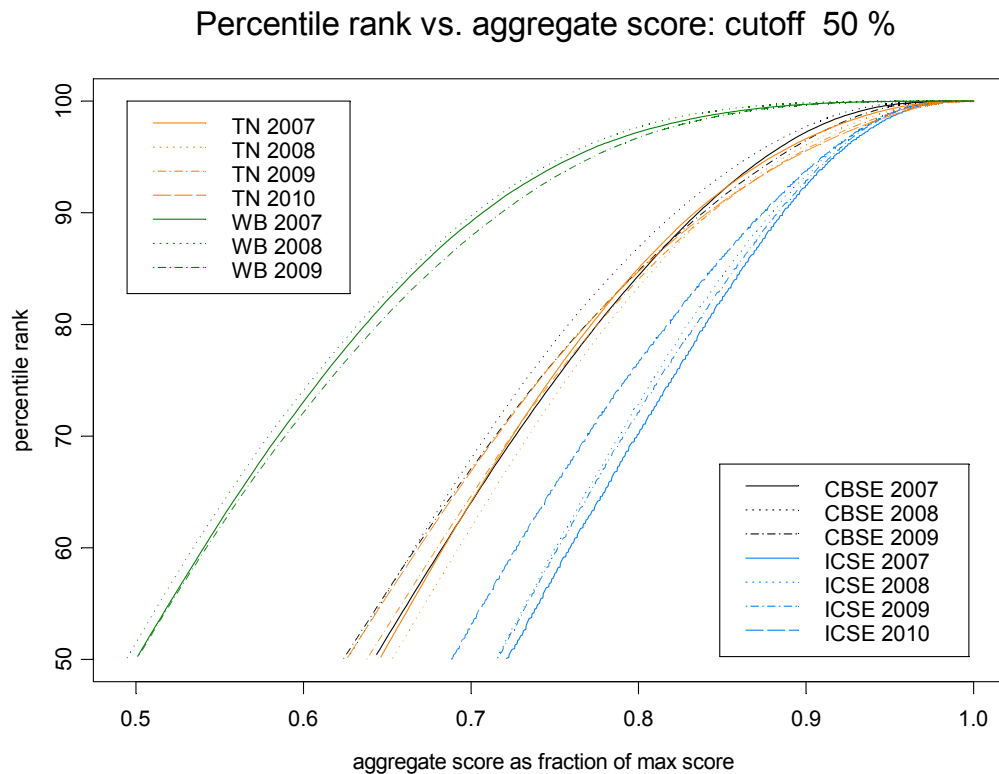
It is clear from the graph that the year-to-year variation in the aggregate scores is minimal, while there is substantial variation of aggregate scores from board to board. For example, a student at the 50th percentile of the ICSE board has an aggregate score

of about 70% of the maximum score, while the corresponding figure for the West Bengal board is around only 50%.

It would be interesting to find out whether the observed extent of board to board variation in aggregate score is primarily due to board to board variation in scores in non-science subjects. For this purpose, the curves were re-drawn by replacing the aggregate score with the average score in science subjects, namely, Physics, Chemistry, Mathematics and Biology (PCMB) in respect of those students who took the examination in at least three of these four subjects.

Percentile rank vs. aggregate score for PCMB: cutoff 50 %
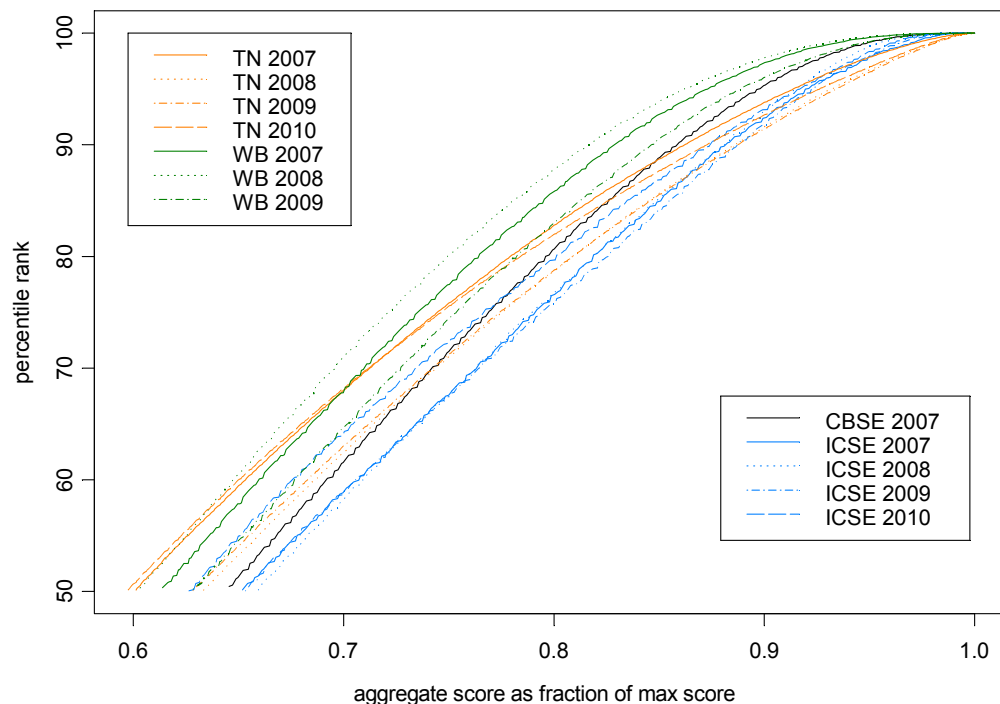
The graph shows relatively smaller variation from one board to another, suggesting that much of the board to board variation in aggregate scores can be attributed to scores in non-science subjects.

In any case, the stability of the aggregate scores of different boards over the years indicates stability of the examination processes that produce these scores.

4 Criterion for selection

Under the two assumptions mentioned in Section 2, the percentile ranks of the students computed from aggregate scores are comparable across different boards and years. Any monotone transformation of the percentile ranks is also appropriate for comparison, as long as the same transformation is used across different boards and years. Let us now consider a few such transformations.

Any of the curves in the first figure is a monotone function of the percentile rank. One can use any one of them, say CBSE 2007, as standard. If the same transformation of percentile ranks is used for other boards and years, then the resulting modified score

of any student of any board in any year can be regarded as the aggregate score, which could have been obtained by that student if he/she had appeared for the CBSE examinations in 2007. Thus, the transformed scores provide a common basis for comparison.

A feature of such a transformation is that, after this transformation, the scores are **not evenly distributed** throughout the available range of scores. In particular, when the scale of the CBSE 2007 aggregate score is used, less than 5% of the students have scores in the range of 90% to 100% of the maximum score. On the other hand, more than 10% of the students (spanning over the percentile range of 50 to 62) have scores squeezed in the narrow range of 65% to 70% of maximum score. This would lead to a loss of discriminating power in that percentile range, particularly if the board scores are used only as a component in a weighted selection criterion involving multiple components.

For maximal discrimination over the requisite range of percentile ranks, it is imperative that the scores have the uniform distribution over that range. This may be achieved if the percentile ranks themselves are used as scores. If there is a threshold percentile, say 75%, then the available range is maximally utilized by using the following linear transformation of the percentile rank:

$$\frac{Percentile\ rank\ of\ student - 75}{100 - 75} \times 100 .\qquad\qquad (1)$$

According to this scale, a student with percentile rank 75 receives the score 0, a student with percentile rank 90 receives 60, and the topper receives 100. Similar computations can be done for other choices of the threshold percentile.

5   Recommendations

(a) The above analysis regarding stability of board scores should be carried out for all the boards over a longer period of time.

(b) If the reported stability of the board scores is found to hold generally, then a transformed percentile rank with a suitable cut-off, as described in (1), may be used as a score representing performance in the board examination, for the purpose of admission to tertiary education.

(c) The different boards should be asked to indicate the percentile rank of each student in the mark sheet.

(d) In order to prepare a formal and reliable basis for selection at the tertiary level, educational institutions at that level, including the IITs, should be asked to provide to the HRD ministry a statement of marks obtained by each graduating student, together with the student's score in the admission test of that institution (if any), the board score at the class XII level and the name of the board.