SOLUTION TO SUBJECT COMPARABLE PROBLEMS IN PARALLEL EXAMINATIONS: COMMON CURRENCY INDEX (CCI) METHOD

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Abstract - The public examination system in countries like UK and Australia are constantly suffering from the problem of compatibility, between different examinations in the same subject and also different subject combinations set by different boards of examination, especially in GCE A- Level examinations. In any examination students are allowed to select fixed number of subjects for their examination. In order to select students by ranking the student performances who offered different sets of subjects suffer subject comparable problems because some subjects are easy relative to the other subjects and inadvertently some students will get unfair advantage over selection for higher education or for employment. This paper explains, how to apply CCI method to select students from two parallel examinations using a simple data set. It is concluded that the top most students in the combinations are selected by this method.

Keywords - Public Examinations, CCI method, Comparable Problems, Parallel, combination of subjects.

I. INTRODUCTION

Goldstein and Cresswell(1996) have studied the problem of between subject compatibility and examined the assumptions behind attempts to achieve comparability and explore the educational implications of some statistical procedures advocated in UK. Public examination system in countries like UK and Australia are constantly suffering from the problem of comparability in the same and also different subjects for university admission. Specially, at the university admission, the comparability problems appear between different examination subjects set by different boards. Further, it refers to the view of Holland and Rubin (1992) where the basic aim of equating test scores is to find mathematical transformation which changes scores on test A to scores on the scales of test B. However, in the case of examinations from different boards or in different subjects the author is of the view that normal equating procedures cannot be applied since the two populations of two examinations are distinct. They are different in number of ways, but most importantly they differ in their curricula, learning experiences and it immediately poses a definitional problem of examination standards. Under these circumstancesuni-dimensionality is considered as an assumption: that each syllabus and associated examination develops and assess the same underline attributes. Accordingly, Goldstein and Cresswell indicate that "in a strict sense, such an assumption is almost certainly false". Further, Ofqual (2015) also discusses many methods for subject comparability, but it shows that this problem still exists severely. Newton (1995) pointed out in his work that the public examinations in different subjects are not comparable and the statistical techniques that have been used for comparison of subject marks were not appropriate even to approximate validity. Newton (2005) claims that for the last fifty years, researchers had identified that the methods used for subject comparability in public examination systems are not entirely correct. In the light of the studies carried out by Goldstein and Cresswell (1996), Newton(2005), Wijesekara and Yatapana (2001), AL-Bayatti (2000), Common Currency Index Method has been developed by considering the combination marks (i.e. average mark of subjects of a candidate. In order to eliminate the undesirable effects in within combination and between combination competitions in an examination,all the combinationmarks of candidatesare convertedinto one type of combination marks. Then the same method, CCI method again applies to convert all the combination marks in different examinations into one type of combination marksby eliminating the undesirableeffects in different examinations. This method is a simple, easily understandable and transparent method.

II. METHODS AND MATERIALS

2.1 Application of CCI method to select students from parallel examinations

For easy explanation, the procedure includes two phases.
Phase I: conversion of subject combination marks of candidates who offered different subject combinations of an examination into one type of combination marks.

Phase II: After application of Part I for each examination, Conversion of subject combination marks of candidates in two or more parallel examinations into one type of combination marks and rank.
In phase I, there exists two types of competitions. (i) Within Combination (WC) Competition and (ii)

Between Combination (BC) Competition. In order to select the best set of students out of all the candidates who sat the same examination, both the abovecompetitionshave to be evaluated correctly. The development of the CCI method is testedmathematically and alsostatistically using different shapes of simulated data sets (Yatapana, Sooriyaarachchi, 2006). The study of phase I and the application of CCI method with a simple dataset is explained in detail and the simulated data have been descriptively analyzed andpublished in thefollowing research paper.
http://www.iaea.info/documents/paper_226e234744.pdf.

In phase I, all the combination marks are converted to the lowest combination effect type marks (i.e. Adjusted marks) like different currencies converted to one type of currency.

In phase II, in order to select the best set of students out of different examinations (e.g. same examination conducted by differentExamination boards), Phase I has to be implemented to each of examinations separately. i.e. students' performances in each examination have been converted to one type of combination marks in the examination. As an example, they are converted to the lowest combination effect type marks. Again the competition among the students in different examinations can be considered as between combination competitors in different examinations. Hence, CCI method has to be utilized again, to convert all the combination marks in each examination in terms of its' lowest combination effect type marks in to the Lowest of theLowest Combination Effectof the Examinations (LLCEE)type marks. Now, all the combination marks have been converted to one type similar to theone type of currency.By ranking those final adjusted marks,the best set of student can be selected out of anysubset of the combinationsin an examination(s) out of all the students in all the examinations.

2.2 Mathematical Explanation of application of the CCI Method to select students fromdifferent Combination of Subjects in two or moreexaminations.

First, the combination marks of each student are calculated for each of the examinations. Here, the students who have achieved minimum qualifications to pass the examination are considered for the selection and all of them are considered as Between Combination competitors. Let X_{ijk} be the k^{th} student's combination mark of the j^{th} combination in the i^{th} examination (i.eaverage of the subject marks offered by the k^{th} student in the j^{th} combination at the i^{th} examination). Where, i=1..,m, j=1..,$l_i$for $\forall i$, k=1,2,3,..$n_{ij}$for $\forall i,j$. Consider the simple example, the ranking of the combination marks of two examinations using the data set given in Table 1, where, m=2, j=1,…l_1, & j=1,…l_2, where l_1=4, l_2=4 and n_{11}=6, n_{12}=3, n_{13}=5, n_{14}=4, n_{21}=6, n_{22}=4, n_{23}=5 and n_{24}=3 , arbitrary values.

Now, apply Phase I. i.e. Convert all the combination marks into the lowest combination effect type marks separately for each examination. Let, Y_{ijk}be the combination mark of the k^{th} student of the j^{th} combination in the i^{th} examination in terms of the lowest combination effect type marks. Here, i=1..,m, j=1..,l_i , $\forall i$, k=1,2,3,..$n_{ij,}\forall i,j$ and let the lowest combination effects of the m examinations be, Υ_1, Υ_2, …, Υ_m respectively. Then let, Υ= min {Υ_1, Υ_2 ….,Υ_m} (Where Υ is the LLCEE).

$\underline{Z_{ijk}} = \underline{Y_{ijk}}$* $\Upsilon/\ \Upsilon_k$,i=1,2,..,m, j= 1,2,…l_i, $\forall i$ k=1,2,…,$n_{ij,}\forall ij$. Z_{ijk} are in same type of marks (Like same type of currency), The best set of students can be selected out of the students in all m examinations according to the ranks of Z_{ijk}. For the data in Table 1, by applying Phase 1, $\underline{Y_{ijk}}$,$\forall ijk$were calculated. And then, applied phase II, Combination marks in two examinations were converted to a same type of combination marks, i.e. combination 3 of examination 1 type marks using the values given in Table 1 and the Zijk,$\forall ijk$values were ranked for selection of students from two different examinations.

Table 1 : Examination Effects, Combination Effects and Indices needed for CCI method calculations

Exam	Combination	1	2	3	4	
1	Combination effect	53.3	60.3	51.8	58.5	
	CCI Index	0.97	0.85	1	0.88	
	Examination Effect					51.8
	Examination Index					1
2	Combination effect	52.8	59.2	63.2	65.3	
	CCI Index	1	0.89	0.83	0.81	
	Examination Effect					52.9
	Examination Index					.968

According to results given in table 1 calculated from the sample data, the lowest combination effect of the Examination-1 is 51.8 associated with combination 3 which is the min {53.3, 60.3, 51.8, 58.5} and all the combination marks in the examination 1 are converted to combination 3 type marks.

Similarly, the lowest combination effect of the Examination 2 is 52.8 associated with combination 1, which is the min {52.8, 59.2, 63.2, 65.3} and all the combination marks of the examination 2 are converted to combination 1 type marks.

Next, the two types of combination marks in each examination were converted to the same lowest examination effect type marks, 51.8, which is the min, of {51.8, 52.9}. i.e Combination 3 of

examination-1 type marks and obtained Zijk,Vijkmarks.Then the marks ranked and are given in Table 2 as ($RCCI_{ijk}$), Vijk.

III. RESULTS AND DISCUSSION

Table 2: Data set of combination marks of students in two examinations

i	j	k	Xijk
1	1	1	55
1	1	2	62
1	1	3	66
1	1	4	42
1	1	5	47
1	1	6	48
1	2	1	54
1	2	2	65
1	2	3	62
1	3	1	75
1	3	2	57
1	3	3	64
1	3	4	35
1	3	5	28
1	4	1	68
1	4	2	57
1	4	3	49
1	4	4	60
2	1	1	45
2	1	2	55
2	1	3	63
2	1	4	37
2	1	5	74
2	1	6	43
2	2	1	65
2	2	2	76
2	2	3	46
2	2	4	50
2	3	1	45
2	3	2	76
2	3	3	67
2	3	4	70
2	3	5	58
2	4	1	80
2	4	2	50
2	4	3	66

Table 3 : Calculated values of Xijk, Yijk, ZIjk and final ranked combination marks (RCCijk) of two Examinations together using CCI Method

i	j	k	Xijk	Yijk	Zijk	RCCIijk
1	1	3	66	64.1058	64.1058	5
1	1	2	62	60.2206	60.2206	9
1	1	1	55	53.4215	53.4215	17
1	1	6	48	46.6224	46.6224	23
1	1	5	47	45.6511	45.6511	25
1	1	4	42	40.7946	40.7946	31
1	2	2	65	55.80663	55.809	15
1	2	3	62	53.23094	53.2332	19
1	2	1	54	46.36243	46.3644	24
1	3	1	75	75	75	1
1	3	3	64	64	64	6
1	3	2	57	57	57	13
1	3	4	35	35	35	35
1	3	5	28	28	28	36
1	4	1	68	60.214	60.214	10
1	4	4	60	53.13	53.13	20
1	4	2	57	50.4735	50.4735	22
1	4	3	49	43.3895	43.3895	28
2	1	5	74	74	74	2
2	1	3	63	63	63	8
2	1	2	55	55	55	16
2	1	1	45	45	45	26
2	1	6	43	43	43	29
2	1	4	37	37	37	34
2	2	2	76	67.7692	67.76891	3
2	2	1	65	57.9605	57.9605	12
2	2	4	50	44.585	44.585	27
2	2	3	46	41.0182	41.0182	30
2	3	2	76	63.53372	63.53372	7
2	3	4	70	58.5179	58.5179	11
2	3	3	67	56.00999	56.00999	14
2	3	5	58	48.48626	51.24863	21
2	3	1	45	37.61865	37.61865	33
2	4	1	80	64.696	64.6936	4
2	4	3	66	53.3742	53.37222	18
2	4	2	50	40.435	40.4335	32

It can be concluded by observing the results of the Table 3, that the final rankings, i.e. $RCCI_{ijk,}$Vijk values preserve the order of student's combination marks in each combination for the two examinations. (i.e. the order of $X_{ijk,}$Vijkvalues by each combination in all the combinations are same as the order of $RCCI_{ijk,}$Vijk values by each combination in the two examinations. This means, the order of students who sat for the same examination papers (i.e. same combination) preserves their average marks ranking order and this method can be extended up to any number of examinations to select students for any University course from any subset of combinations in any examination or out of differentparallel examinations without having discriminations.

Hence, it can be concluded that this method selects the top most combination marks in all the combinations,such as the students have sat for the same examination with the same combination of subjects.

CONCLUSION RECOMMENDATIONS

The CCI method preserves the combination wise ranking order eliminating the uncontrollable factors affecting the students' performance at competitive examination(s). This method is designed to eliminate the, "Within Combination" and"Between Combination"Competitors, uncontrollable factors affecting the examination(s) such as difficult levels of subject contents, difficult levels of examinations papers, mistakes and unclear parts appearing in an exam paper, examiner differences etc..

Since the application of the CCI method is similar to currency conversion and the conversion factors CCI indices are calculated by equating the combination averages in any parallel examination, this method is simple and understandable by any person with some level of knowledge. Further, it is transparent as students can be given their subject marks, final adjusted marks and CCI indices. This method does

not distort the students' original subject raw marks and hence, the method is reliable.

In order to improve the reliability of the competitive parallel examination(s) the subjects of the examinations should be designed to have similar standard subject contents with similar learning objectives and the papers also have to be designed to test the defined learning objectives of the subject. Further, the competitive examination papers have to be designed to differentiate the clever and weak students by including the questions in the examination papers to test learning objectives according to SOLO (The structure of observed learning outcomes) taxonomy, which is the model that describes levels of increasing complexity in student's understanding of subjects (Biggs J. B&Collis, K.F ,1982)

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