A NEW METHOD TO SELECT GCE(A/L) STUDENTS TO UNIVERSITIES IN SRI LANKA : AN EASILY UNDERSTANDABLE SIMPLE APPROACH

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ABSTRACT

Though the ZScore (average of subject wise standardized values of raw marks) system is implemented for University admissions from General Certificate of Education (Advanced Level) examination, it is still a controversial issue in Sri Lanka. This article explains the application of a new selection method, Common Currency Index (CCI) Method. Several selection methods are compared mathematically and tested with simulated data using descriptive analysis. It is revealed that, performance of CCI method is better than other selection methods. Also CCI method can be used for any type of screening of human resources that passes through similar level competitive examinations. This method is simple, transparent and does not distort students' raw marks obtained at the examination. Raw mark is the unique mark of the student in a particular subject and cannot be treated as other measurements considered in statistics since a raw mark consists of non measurable factors such as his or her intelligence, capability, the level of commitment etc.

Key Words: ZScore, General Certificate of Education, Common Currency Index (CCI)

1. INTRODUCTION

Admission of students to Universities are carried out based on the results of the G.C.E(A.L) examination (a curriculum based examination conducted under free education system) and students can qualify for certain University courses by offering different subject combinations in any one of a particular stream which consist of many subjects. Hence, it creates two types of competitions, "***Within combination***" (WC) and "***Between combination***" (BC) competitions. Due to the presence of ambiguities, the current University selection procedure based on the ZScore system does not eliminate unfavorable advantages obtained by offering subject combinations with easy subjects (Yatapana & Sooriyarachchi, 2006)). This paper aims to illustrate the application of CCI Method in step by step approach. The applicability of this new method is tested by simulated subject raw marks generated from actual frequency distributions of subject raw marks of the GCE(A/L) examination in 2001. Raw marks were generated for few subject combinations under each study stream, Science, Commerce and Arts satisfying their minimum sample sizes. With a view of educating laymen, this study was carried out using descriptive methods. Since, the ZScore, method is highly theoretical it can never be understood by laymen. Therefore, there will always be controversies. But, CCI method is a relatively much simpler technique and using descriptive statistics it can be explained easily to a layman.

This study reveals that CCI method performs correctly in both types of competitions whereas ZScore does not and hence, it can be considered that CCI method is an improved method to ZScore. This method does not distort the student's subject raw marks they earned at the examination. Hence, student performance in the combination as well as in the subjects can be disclosed. CCI method is transparent, simple and can be understood easily.

2. METHODS AND METERIALS

2.6 Steps for the Conversion of Combination Marks to a Common Type for Selection

2.6.1 Step 1- Calculation of Subject Combination Marks

For any combination j, (C_j) (j= 1,2,…,k) consisting of three subjects, let the raw marks obtained for the corresponding three subjects by the i^{th} student be $X_{i(j1)}$, $X_{i(j2)}$ and $X_{i(j3)}$.Where, $X_{i(jl)}$ is the raw marks of the student i for the subject l of the combination j (l=1,2&3). Then,

$$\text{Combination mark of the student i under } C_j \quad = \quad X_{ij} = \frac{X_{i(j1)} + X_{i(j2)} + X_{i(j3)}}{3} \qquad (2.1)$$

In other words, combination mark of the student i is defined as the average of the raw marks obtained by the student i for the C_j. Let X_{ij}, i=1,2,…….,n_j, j=1,2,……,k be the combination marks of all the eligible students for University admission arranged in descending order within each combination as in the Table 1.

Table 1: Combination marks of all the students arranged in descending order.

Student	**Combinations**					
	C_1	C_2		C_j		C_k
1	X_{11}	X_{12}		X_{1j}		X_{1k}
2	X_{21}	X_{22}		X_{2j}		X_{2k}
3	X_{31}	X_{32}		X_{3j}		X_{3k}
.	.	.		.		.
.	.	.		.		.
	.	X_{n22}		.		.
.	X_{n11}			.		.
.				X_{njj}		.
						X_{nkk}
No. of Students	n_1	n_2		n_j		n_k

n_j is the number of students who are eligible for University admission from combination j. j=1,2,…,k

2.6.2 Step II : Calculation of combination effects:

Now consider a copy of the data set in Table 1 and combination effects are calculated using this copy of the Table 1. Let the maximum possible size of the compulsory combination course j be $m_{j..}$ Next, the top most number of students from each combination j equal to m_j is removed because the students who are hoping to enter the compulsory combination courses do not compete for BC competition. Then the rest, is only the BC competitors' combination marks X_{ij}, i= (m_j+1),……..,n_j , $m_j \leq n_j$, j= 1,2,..,k and then the Table 2 is constructed.

Table 2 : Combination marks of all the BC competitors

Student	**Combinations**					
	C_1	C_2	…	C_j	…..	C_k
1	$X_{m1+1,1}$	$X_{m2+1,2}$		$X_{mj+1,j}$		$X_{mk+1,k}$
2	$X_{m1+2,1}$	$X_{m2+2,2}$		$X_{mj+2,j}$		$X_{mk+2,k}$
3	$X_{m1+3,1}$	$X_{m2+3,2}$		$X_{mj+3,j}$		$X_{mk+3,k}$
.	.	.		.		.
.	.	$X_{n2,2}$		.		.
.	$X_{n1,1}$			$X_{nj,,j}$		.
.						.
						$X_{nk,,k}$
No.of Students	(n_1-m_1)	(n_2-m_2)		(n_j-m_j)		(n_k-m_k)
Com. Effect	τ_1	τ_2	….	τ_j	…	τ_k

The "Combination effect" of the jth combination is defined as τ_j where,

$$\tau_j = \frac{X_{mj+1,j} + X_{mj+2,j} + \ldots\ldots\ldots + X_{nj,j}}{(n_j - m_j)}, (m_j \leq n_j) \text{ and } j=1,2,., k. \qquad (2.2)$$

2.6.3 Step III: Calculation of CC Index for a combination

Now we can assume that these combination effects are equivalent to each other as the average marks earned in any combination by homogeneous students are equivalent. Using the equivalence of the combination effects, all the different combination marks can be expressed in terms of the same type of combination marks. As there should be a fixed method, we can convert all the combination marks in to the lowest combination effect type marks. The lowest combination effect is expressed as

$$\tau = \min_{1 \leq j \leq k} \{\tau_1, \tau_2, \tau_3 \ldots\ldots\ldots\ldots \tau_k\} \qquad (2.3)$$

Then, it can be assumed that all the students have offered the same combination with the lowest combination effect at the examination.

CCIndex is the weight of any combination mark in terms of the combination marks associated with the lowest combination effect**.** Therefore,

weight of one mark of the combination j in terms of $\tau = \frac{\tau}{\tau_j}$, j=1,2,….k.

i.e. CC Index of the j[th] combination = $(CC\,I)_j = \frac{\tau}{\tau_j}$, for any j.

2.6.4 Step IV: Construction of Adjusted Marks Table for Selection

Now all the combination marks of the total data set given in the Table-1, can be converted to the adjusted marks Y_{ij} as follows**.**

$$Y_{ij} = \left(\frac{\tau}{\tau_j}\right) X_{ij}, \text{ for } i=1,2,\ldots\ldots,n_j \text{ and } j= 1,2,\ldots\ldots,k \qquad (2.4)$$

i.e. Multiply the combination marks X_{ij} in each combination j, by the corresponding Common Currency Index $(CC\,I)_j = \frac{\tau}{\tau_j}$ and obtain Y_{ij}, for i =1,2,…,n_j and j = 1,2,…,k. Then the pooled adjusted marks Y_{ij} can be ranked and the selection can be performed as required for WC and BC selection. All the students who are eligible for University admission can be ranked according to the adjusted marks, Y_{ij} and the selection can be performed for a single combination, or for any sub set of combinations out of all the available combinations.

2.7 Application of CCI Method to a Simple Data Set

Let A, B & C be three combinations and the subject averages of students are arranged in descending order as shown in the Table-3.

Table-3 Average of raw marks of students by combination

Combination-A	Combination-B	Combination-C
90	86	81
89	80	78
72	70	75
66	60	69
62	53	64
55	50	60
48	46	51
47		43
42		

Since students are allowed to select any combination they like, the choice of the combination should not affect their chance of admission to the University. Also it is assumed that a student select any combination of subjects expecting to enter the best possible course (Compulsory Combination Course) in the University. If any student qualified for the Compulsory Combination Course wants to enter any other course at the University he/she will be able to get selected to that particular course by indicating his/her preference.

2.7.1 Calculation of CCIndex

CCIndex is defined as the weight of one mark in terms of the lowest combination effect type marks. Lowest combination effect is taken as the lowest average of combination marks of BC competitors. BC competitors are the homogenous set of students who will be competing for different courses, other than the compulsory combination courses. Hence, CCIndex is calculated from the combination marks of BC competitors.

In order to get the BC competitors' marks, top most marks equal to the number of vacancies available in the corresponding compulsory combination course shall be removed. (This is done only to calculate the CCI indices) If compulsory combination vacancies in the University for A, B and C are 3, 4 and 2 respectively, then the top most combination marks, 3 from combination A, 4 from combination B and 2 from combination C are removed from descending ordered combination marks. The remaining combination marks belong to BC competitors. The average of BC competitors' combination marks (combination effects), of A, B & C are calculated for each combination as shown in Table-4.

Since, the minimum combination effect is with combination B, we can calculate CCIndices of A and C (weight of one combination mark of A & C) in terms of combination marks of B.

Table- 4: BC Competitors combination marks.

	Combination-A	Combination-B	Combination-C
	66	53	75
	62	50	69
	55	46	64
	48		60
	47		51
	42		43
Combination effects	**53**	**50**	**60**
CCIndex	**.9434**	**1.0**	**.8333**

Therefore, CCIndex for A = 50/53 = 0.9434
CCIndex for B = 50/50 = 1
CCIndex for C = 50/60 = .8333

Using above we can convert all the combination marks in the Table-3 to combination marks of B (minimum combination effect type marks). This is done by multiplying all the values in combination A by .9434, values in combination B by 1.0 and values in combination C by 0.8333. These converted marks are called adjusted marks and are shown in the Table 5. Now we can assume all the students offered the same combination B at the examination.

Table: 5 Adjusted Marks

Combination-A	Combination-B	Combination-C
84.9	86.0	67.5
84.0	80.0	65.0
67.9	70.0	62.5
62.3	60.0	57.5
58.5	53.0	53.5
51.9	50.0	50.0
45.3	46.0	42.5
44.3		35.8
39.6		

(a) WC Selection

Select 3 students, 4 students and 2 students for compulsory combination courses of A, B and C respectively. It shall be noted that the student selected for compulsory combination courses using adjusted marks are the same set of students that will be selected by average of raw marks (Combination marks) in each combination.

(b) BC Selection

After removing the students selected for the compulsory combination courses, then for example, select 10 students out of all 3 combinations according to the ranks of the adjusted mark of BC competitors. It selects all the top most students in the considered combination or combinations.

2.7.2 Behaviour of τ on the Selection

It can be shown that the selection is independent of τ. In other words it gives the same selection when all the marks converted to any one type of combination marks. Thus it is like conversion of different types of currencies to one type of currency for comparison.

3.0 Application of the CCI Method to select students from Combinations with Different Number of Subjects in Two GCE(A/L) Examinations

Let C_A and C_B be two combinations belonging to two GCE(A/L) examinations with n and m students in each respectively. Let the number of subjects in C_A and C_B be 3 and 4 respectively. Suppose, the students from both combinations are eligible for a particular University course and both groups of students have the same chance to be selected to that particular course. So we assume that they are BC competitors.

Let the raw marks obtained for the corresponding three subjects of C_A by the i^{th} student be $X_{i(A1)}$, $X_{i(A2)}$ and $X_{i(A3)}$ and the raw marks obtained for the corresponding 4 subjects of C_B by the k^{th} student be $X_{k(B1)}$, $X_{k(B2)}$, $X_{k(B3)}$ and $X_{k(B4)}$ and hence,

The Combination mark of the student i under $C_A = X_{iA} = \dfrac{X_{i(A1)} + X_{i(A2)} + X_{i(A3)}}{3}$ (3.1)

Combination mark of the student k under $C_B = X_{kB} = \dfrac{X_{k(B1)} + X_{k(B2)} + X_{k(B3)} + X_{k(B4)}}{4}$ (3.2)

Then, the combination effects τ_A and τ_B are calculated.

$$\tau_A = \frac{\sum_{i=1}^{n} X_{iA}}{n} \quad \text{and} \quad \tau_B = \frac{\sum_{k=1}^{m} X_{iB}}{m} \tag{3.4}$$

We consider students belong to C_A and C_B are BC competitors. Let any student belonging to combination C_A earns average marks τ_A. If this student belongs to Combination C_B, then he can earn average marks τ_B under the circumstances of C_B. Under the assumption that mental development of the homogeneous students from both combinations is the same, the combination effects, τ_A and τ_B are equival. Hence, we can apply the CCI method as follows.

$$\tau = \min_{A,B} \{\tau_A, \tau_B\} \tag{3.5}$$

$$Y_{i(j)} = \left(\frac{\tau}{\tau_j}\right) X_{ij} \quad i = 1,2,\ldots,n_j, \quad j = A,B \ (n_A = n \text{ and } n_B = m) \tag{3.6}$$

Then by pooling all the adjusted marks selection can be performed, assuming that they have done the same examination. Selection from two GCE(A/L) examinations with several different combinations can also be done by combining marks of the corresponding combinations in each of the examinations separately as above. Then it can be assumed that those students have sat for the same examination and the selection can be performed by applying the CCI method again to the combination marks obtained. Investigation of CCI Method Mathematically performed together with an in-depth study using statistical experiment in (Yatapana & Sooriyarachchi, 2006).

5.0 RESULTS

5.2 Analysis of the Simulated marks:

According to (UGC, 2002), the marks were simulated by generating random marks to satisfy the actual frequency distributions of the subjects marks and sample sizes of the GCE(A/L) examination, 2001 using a MATLAB computer program. (the highest sample size was taken as 10,000) Then the simulated students' marks for each combination under each stream were ranked according to the average, Z-Score and the CCI methods separately for WC selection. Then Box plot diagrams were drawn for the rank differences of each student in each method with respect to the average ranks separately for all the combinations considered. Corresponding diagram for Combination -1 is shown in Figure 1. The boxplot shows the WC deviation of ranks for both ZScore and CCI methods. Similar diagrams were obtained for all the other combinations too.

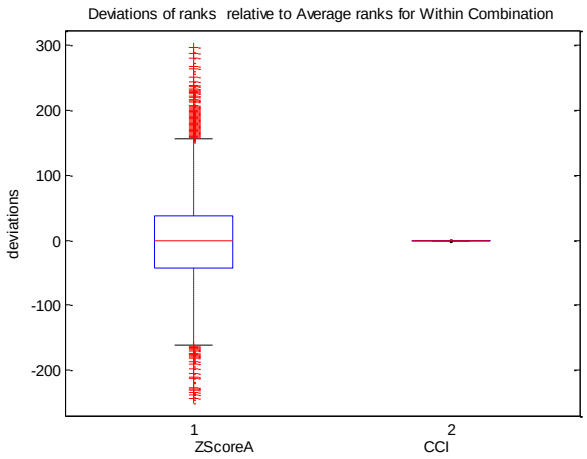

Figure 1: Box plot diagrams for the combination -1

Figure -1, shows that the rank differences of the CCI method and average method are zero for all the WC marks whereas ZScore ranks make large discrepancies with respect to average ranks in all the combinations considered. Hence, **CCI** method selects the same set of students as average method does and Zscore method does not select the same set of students as average method does. Hence CCI method selects WC selection correctly whereas ZScore does not.

Similarly, from the simulated marks for, **BC competitors** for the three combinations under each streams were obtained taking the highest sample size as 2000. (each combination sample sizes were taken to satisfy the ratios of actual sample sizes of the combinations). Then the combination effects were calculated and using the CCI indices for each combination, the adjusted marks were calculated. The students' performances were ranked in all three combinations according to ZScore method and the CCI method . Thereafter the top 100, **BC competitors** were selected from each method and the number of students selected from each combination corresponding to each selection method were counted and recorded. When constructing simulated marks of **BC Competitors** for Science stream, those, were obtained by removing the top 1.5% of ranked aggregates from each of Physical Science (combination-1) and Bio Science (combination-2), (i.e to remove the students with high potentials. eg: for medicine and Engineering).Then rests is

considered as BC competitors in the science stream. This process was done 100 times separately for each stream and the Average and the Standard Deviations of the numbers of students selected for each combination from ZScore and the CCI methods were calculated and displayed in the tables 4, 5 and 6.

Table 4: Numbers Selected in each method for BC in Science Stream

Combination	Z-Score method		CCI method	
	Average	Std	Average	Std
1	47	3.8	40	3.4
2	42	3.6	46	3.4
3	11	2.0	14	2.2

Table 5: Numbers Selected in each method for BC in Commerce Stream

Combination	Z-Score method		CCI method	
	Averag	Std	Average	Std
4	66	5.7	64	3.3
5	10	1.3	10	1.7
6	28	2.0	26	2.6

Table 6 :Numbers Selected in each method for BC in Arts Stream

Combination	Z-Score method		CCI method	
	Average	Std	Average	Std
7	3	0.5	3	0.5
8	14	1.9	9	1.2
9	83	1.6	88	0.9

Tables 1, 2 & 3 show that, the CCI method selects almost similar numbers (average numbers obtained under ZScore method and that of CCI method) with low Standard Deviations (Std values obtained under ZScore method and that of CCI method) in each combination as Zscore does for **BC** selection.

6. DISCUSSION

When selecting students for any particular University course (or tertiary course) students are selected either from a single combination or from several combinations. Hence we can say that there are two types of competitions that exist at the selection (WC and BC). We know that different subject contents are of different difficulty levels, the questions of the exam papers are with different difficulty levels and the existence of draw backs in the exam papers, examiner's differences etc. are uncontrollable in an examination. Therefore the selection of students should be independent from these uncontrollable factors which are beyond the students' control.

If the impact on the selection index is same for any one subject raw mark of any particular combination, then it could be seen that the selection is independent from the said uncontrollable factors for WC selection. Here the requirement is that the impact on the selection index by any subject raw mark of the combination shall be the same. It was seen that the impact on Zscore by each of the subject raw marks of the combination are different. Therefore the students who

concentrate on high impact subjects will get unfair benefits and at the same time the said uncontrollable factors arise in an examination also will not be eliminated.

In the BC selections, the use of both Average and Z-Score, has no meaning as these function values are governed by their combination characteristics, which are the marks for completely different subjects and related activities. In addition to the combination differences, it is important to consider the potential levels of the students between different combinations. That is bright students' select high challenging subjects for their GCE(A/L) examination. Hence, in calculation of the Common Currency Index it is important to consider only the marks of Between Combination competitors. (i.e. the students who had same chances to follow any of the combinations at the beginning of the GCE (A/L) course and aspiring to enter a same University course which select from different combinations. By ranking the complete data set according to the CCI method, the WC selection or BC selection can be performed as required.

Students have the liberty to select any combination as they wish for their GCE (A/L) Examination. CCI method selects students without distorting their inbuilt potentials they already had and the development they gained through the GCE (A/L) curriculum. In this method it is assumed that the students, who passed three subjects and compete for **BC competition**, are in the same potential level at the beginning of the GCE(A/L) course. In this method, the earned marks on average by fairly homogeneous students (BC competitors) under different combinations are equated to express all the combination marks in terms of one type of combination marks.

From the results obtained it could be seen by the analysis of the simulated data for **WC,** the CCI method selects the same set of students as average does whereas ZScore does not. For **BC** selection, CCI method selects almost similar numbers as Zscore does and further it preserves the average ranking order of students in each combination in the between combination selection. Hence, this method can be considered as an improved method to Zscore. The CCI method is an arguable, simple and straight forward method where top most competent students in all the combination will be selected without any discrimination. Students' extreme marks will not affect on the selection. The selection is independent from the number of students in any combination. This method can be applied to select students from a single, two or many GCE(A/L) examinations (or any other same level examinations) with equal or unequal number of subjects and also it is simple and transparent which does not distort students' raw marks.

REFERENCE

AL-BAYATTI M.F (2000) "Application of a model for borderline marks." Liverpool *John Moores University School of Computing & Mathematical Science.*

Daley, D. J. (1995). " Two-Moment scaling formulae for aggregating examination marks." Australian Journal of Statistics **37**(3): 20.

Yatapana, P.S. and Sooriyarachchi M.R.(2006). University selection among students from different streams: a comparison of methods, Sri Lanka Journal of Educational Research, NIE, Maharagama, Sri Lanka, Vol-10 (1-22)