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Comparison of the Applicability of Two University Selection Methods, the Common Currency Index Method and the Zscore Method from Curriculum based Public Examinations over Several Years

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Comparison of the Applicability of Two University Selection Methods, the Common Currency Index Method and the Zscore Method from Curriculum based Public Examinations over Several Years

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Abstract

In Sri Lanka, under the free education system the university admission is based on the General Certificate of Education (Advanced Level), GCE (A/L), a curriculum based examination conducted by the state examination department, which is highly competitive due to limited capacity in Universities. After implementation of the new GCE (A/L) system in 2001, the students are required to select a combination of three different subjects for the examination and the selection index was changed from average to average of standardized subject raw marks (Z-Score). However during the past 13 Years, the selection process has been highly criticized by the public due to discrepancies in the admission process.

The new ranking method, Common Currency Index Method (CCI Method), where the selection is independent from the levels of difficulty of subject contents, levels of difficulty of examination papers of different subjects as well as mistakes and unclear parts that exist in the examination papers, examiner differences etc. those are beyond student's control. Also the potential differences of the students by different combination of subjects are also taken in to consideration in this method up to some extent.

This research paper discusses the effect of the applicability of CCI Method against the ZScore method over a period of six years. Descriptive analysis and the Cochran Q test (Cochran, 1950) were used to analyze the data. It was revealed that the two methods select almost equal number of students from different combinations, except the years with the skewed subject marks for which Z values of subject mark are

not meaningful. Therefore, application of CCI method instead of ZScore method will not have any serious repercussions on the selection procedure as both methods select almost the same number of students but moreover, CCI method preserves the combination wise average ranking order.

The CCI method is an arguable, transparent and simple method which can be applied to select the best performing set of students out of a single combination or out of several combinations in any GCE (A/L) examination or out of two or many different GCE (A/L) examinations with equal or unequal number of subject combinations.

Key Words: University Admission, Advanced Level (A/L), Common Currency Index (CCI), ZScore, Ranking methods

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Introduction

In many countries, including UK and Australia University admissions are based on GCE(A/L) examination conducted by different boards or colleges in different territories (Coe et al., 2008). Hence they experience comparison difficulties of different subjects in a same examination or between different examinations conducted by different examination bodies. Literature review on comparison methods revealed that these methods are constantly suffering from the problem of subject incompatibility (Goldstein and Cresswell ,1966).

It was mentioned that the GCE (A/L) Examination is a curriculum based examination conducted by the Examination Department. According to the new GCE (A/L) system, the students opt to select combination of three different subjects out of many subjects for the examination. The selection index was changed from average to Z-Score. Due to the public criticism regarding the discrepancies in the admission process, available ranking methods in Sri Lanka were studied mathematically and a new method, Common Currency Index Method (CCI Method) was developed and tested statistically (Yatapana & Sooriyarachchi, 2006) and it was proven that the CCI method is an improved method to available ranking methods used in Sri Lanka. This study aims to investigate the effect of the applicability of these two methods (Z-Score and CCI Method) over several years, in order to apply the improved method for University admission.

Materials and Methods:

GCE (A/L) Examination in Sri Lanka

Sri Lanka has a free education system and the GCE (A/L) examination is extremely competitive due to limited capacities in the state Universities in the country. There is no doubt that the Universities should provide a quality education to the country. Hence it is imperative that the cream of the student body facing the GCE(A/L) Examination need to be selected for University entry.

According to the current system, students opt to select combination of three subjects for the GCE (A/L) examination out of many available subjects in their selected study stream. Generally, students who obtain high results in GCE(O/L) select subject combinations in Science Stream. However, a smaller percentage of students with high GCE(O/L) results willingly select combinations in Commerce or Arts streams too. Also, bright students, with high GCE(O/L) results who desire challenging work select difficult and challenging subject combinations. Thus it is important to consider the existence of potential differences between the students in different subject combinations at the start of the GCE (A/L) curriculum. Therefore the selection procedure has to be developed so as not to distort the students' performance in any of the combination selected by them and their potential levels should be utilized in a proper way. Further, the selection to universities should not be affected by the

choice of the combination of subjects as they opt to select any three subjects that are equally important.

Z-Score Method : Average of subject wise ZScores method

UGC [1] has identified the following two main complexities in the average selection method.

1. Selection of students from two types of examinations accounted different weightings of marks,
   (a) weight of 1/4 for each subject, for four subject examination in the year 2000
   (b) weight of 1/3 for each subject, for three subject examination in year 2001
2. Unfair competitive advantage obtained by selecting easy subjects for the examination.

The second discrepancy arises due to the fact that exam papers in all subjects do not have the same level of difficulty. For example, students can qualify for university degree course in biological science by offering two different subject combinations, one is Chemistry, Physics and Biology and the other is Chemistry, Biology and Agriculture. There is evidence that students are able to obtain higher marks for Agriculture than for Physics. It has been revealed that offering Agriculture instead of Physics improves the chances of gaining entrance to Universities (Thattil, 2001). In this way those who offered easy subjects will have educationally undesirable competitive advantage at the selection process, (UGC, 2001/2002). Under the circumstances UGC has decided to select students for Universities using Z-Score marks of students. Z-Score is taken as the average of the standardized scores (Z) of the raw marks earned by the candidate for the subjects he or she offered at the GCE(A/L) examination.

Let, x_i, i=1, 2, 3 are the raw marks earned by the student for the three subjects he offered at the GCE(A/L) Examination, $\bar{x}_1, \bar{x}_2$ and $\bar{x}_3$ are the island averages of the respective subjects and S_1, S_2 and S_3 are the island standard deviations of the respective subjects.

$$Z-\text{Score} = \frac{z_1 + z_2 + z_3}{3}$$
$$= \frac{1}{3}\left[\left(\frac{x_1-\bar{x}_1}{S_1}\right)+\left(\frac{x_2-\bar{x}_2}{S_2}\right)+\left(\frac{x_3-\bar{x}_3}{S_3}\right)\right]$$

[1](http:/www.ugc.ac.lk/ugc_Announcements/Admissions_release 2002_03.html), 16.07.02

Two Type of Competition among Students

The University selection from GCE (A/L) examination incorporates two types of competitions. We name them as (a) Within Combination (WC) competition and (b) Between Combination (BC) competitions. The WC competition is the competition among students who take the same combination of three subjects at the GCE (A/L) examination. The BC competition is the competition among students who take different combination of subjects for their GCE (A/L) examination to enter one particular course of study at the university. Further, at the BC competition, both competitions occur at the same time as students compete from the same combination as well as from different combinations to enter a same University course. Hence, both WC and BC competitors should be evaluated correctly by the selection criterion.

Problems that should not affect the Selection of WC Competition

The existence of following characteristics can be observed for a particular combination of subjects,

(i) different difficulty levels of the subject contents (theory, practical work etc.)
(ii) different difficulty levels of the exam papers (difficulty levels of Questions)
(iii) different problems/drawbacks existing in exam papers (mistakes, examiner effects etc.)

Therefore, any measurement of the students' ability for the selection should not be affected by those differences, as they are beyond the students' control.

Problems that should not affect the Selection of BC Competition

The following two problems exist when selecting students from several different combinations competitively.

i) combination differences (different difficult levels of subject contents, exam papers and other differences in the combinations)
ii) Students' existing potential levels at the start of GCE(A/L) are different (Bright students select combinations with high challenging subjects)

Properties of Fair Selection Index / Criteria

Any fair selection criteria should eliminate the WC and BC problems stated under (2.2.1) and (2.2.2) as far as possible. Otherwise it will affect the selection of the best set of students (top most students) in all the combinations. In order to select students from a single combination (WC selection), the best selection index is the raw marks aggregate or any index which is linearly proportionate to the raw marks aggregate (Daley, 1995). Therefore, the students' ranks according to any common selection index shall not deviate from the ranks according to the average for WC selection. Development of the common ranking scale for selection from different combinations shall be done without affecting the WC performance order.

Also, application of indices such as average, ZScore or any index linearly proportional to the average are not suitable to select students from different combination of subjects as it violates the fundamental principles in mathematics as well as statistics (Yatapana and Sooriyarachchi, 2006).

Common Currency Index Method (CCI Method)

Concept of CCI Method

Concept of exchanging different type of currencies is considered as the basis for the Common Currency Index method (Yatapana and Sooriyarachchi, 2006).

For example if we want to compare the values of 200 £ with 200$, as the amounts of goods that can be bought by either currency are different, we compare pounds with dollars by converting one currency to the other or both in to a third type of currency. This concept is used to convert all the combination marks in different combinations to the same type of combination marks (Adjusted marks). Then the selection to Universities can be performed using the Adjusted marks. This method, while preserving the average ranking order of WC competitors, does not create an unfair advantage to those who offer different subject combinations with easy subjects. Further, CCI method eliminates the WC problems and BC problems stated under sections 2.2.1 and 2.2.2 respectively. The differences of the combination wise students' potentials are also taken in to account as far as possible under the Common Currency Index Method.

Affect of the choice of the Combination on University Admission

Since students are allowed to select any one of combinations out of many for the GCE(A/L) Examination, it is clear that all available combinations are equally important for the admission to Universities. There are also courses at the University which select students only from a single combination of subjects which we named as "compulsory combination courses".

Examples:

Only the Students from the compulsory combination [Physics, Chemistry and Combined Mathematics] are eligible to apply for Engineering course at the university. Therefore Engineering course is said to be 'compulsory combination course'. Similarly Medicine course is also a 'compulsory combination course' which selects students only from Physics, Chemistry and Biology combination.

In general the ambition of any student who selects any combination of subjects is to enter the highest demanded course available at the University for that particular combination. And also students have the option to apply for any University course available for that particular combination indicating their preference. Those who are unable to qualify for or do not wish to enter the highest demanded course for that combination, can opt for other available courses according to their preference.

Assumption used to derive the CCI Method

The combinations that are applicable to this category of students are considered as equally important and they will be subjected to Between Combination (BC) competitions. Thus the choice of any such combination shall not affect their selection to university.

Hence, it is assumed that sets of fairly homogeneous students when allowed to follow different combinations during a fixed time period develop their mental abilities in the same way.

Based on this assumption the combination marks in any of the combination are converted in to the combination marks with the highest combination effect. Using the equivalence of the combination effects of the BC competitors, it is possible to calculate the weight of one mark of any combination mark in terms of another type combination marks.

Computation of CC Index of the j^{th} Combination

The CC Index should be calculated using only the marks of the students who compete in the BC competition. We can assume that these BC competitors are of the same standard at the start of the GCE(A/L) curriculum and they had the same chance of offering any of the combinations as they wished. Hence, the combination marks obtained on mean (if marks distributions are skewed use medians instead) for the GCE(A/L) examination by similar standard students (BC Competitors) under different combinations can be equated, because according to the assumption, (Refer 2.3.1.1) that the mental development and their abilities improved equally under each combination during a same duration and it will eliminate the effect of their choice of the combination on the University selection . Therefore the earned mean marks in any combination by those students (BC competitors) can be compared.

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

Step 1: Calculation of Combination Mark

For any combination j, (Cj) (j= 1,2,…,) 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 $X_{i(j3)}$. Then,

Combination mark of the student i under C_j

$$= X_{ij} = \frac{X_{i(j1)} + X_{i(j2)} + X_{i(j3)}}{3} \quad (1)$$

In other words, combination mark of the student i is defined as mean mark 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

Step II: Calculation of combination effects

In order to calculate the combination effects, consider a copy of the data set of 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 course 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,

$$\tau_j = \frac{X_{mj+1,j} + X_{mj+2,j} + \ldots\ldots\ldots + X_{nj,j}}{(n_j - m_j)} \qquad (2)$$

$$(m_j \leq n_j) \text{ and } j=1,2,., k.$$

Step III: Calculation of CC Index

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

$$\tau = \min_{1 \leq j \leq k} \{\tau_1, \tau_2, \tau_3 \ldots\ldots\ldots \tau_k\} \qquad (3)$$

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

Definition of CCI Index of a Combination

It is the weight of any combination mark in terms of the combination mark associates 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.

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

$$Y_{ij} = \left(\frac{\tau}{\tau_j}\right) X_{ij}$$

, for i=1,2,……,n_j and j= 1,2,……,k (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 or out of all the combinations.

Cochran's Q test

In the analysis of two-way randomized block designs where the response variable can take only two possible outcomes, Cochran's Q test is a non-parametric statistical test to verify if k treatments have identical effects.

As shown in the table 3, each of k treatments is independently applied to b blocks (or subjects) and each outcome is measured as success (1) or as a failure (0).

Table 3. *Two Way Randomized block Design Lay Out*

	Treatment-1	Treatment-2	…….	Treatment-k
Block-1	X_{11}	X_{12}		X_{1k}
Block-2	X_{21}	X_{22}		X_{2k}
. . .	. . .	. . .		. . .
Block-b	X_{b1}	X_{b2}		X_{bk}

Hypothesis: H_0: Treatments are similarly effective
H_1: Treatments differ in effectiveness

Test Statistics:

$$T = \frac{k(k-1)\sum_{j=1}^{k}\left(X_{\bullet j} - \frac{N}{k}\right)^2}{\sum_{i=1}^{b} X_{i\bullet}\left(k - X_{i\bullet}\right)}$$

Where, k is the number of treatments
$X_{\bullet j}$ is the column total for the j^{th} treatment
b is the number of blocks
$X_{i\bullet}$ is the raw total for the i^{th} block
N is the grand total

For significance level α, the critical region is $T > \chi^2_{(1-\alpha),(k-1)}$ Where, $\chi^2_{(1-\alpha),(k-1)}$ is the 1-α quartile of the Chi Square distribution with (k-1) degrees of freedom. (Cochran, 1950)

Marks Generation and the Application of the Methods

Since the actual raw marks are confidential, the raw marks for this study were generated using the actual GCE(A/L) grade distributions published in the Statistical Hand Book for the years 2005 to 2010 by University Grants Commission in Sri Lanka. A MATHLAB computer program was developed to generate the raw marks. The ranges of grading system considered in Sri Lanka for GCE (A/L) are Grade A [75-100], Grade B [65-74.99], Grade C [55-64.99], Grade D [40-54.99]. Grade F [0-30.99]. Hence, raw marks were generated for three possible combinations of selected subjects, under each study stream, Science, Commerce and Arts for University admission.
The Combinations considered in this study is as below.

Science
Combination 1: Physics, Chemistry & Combined Mathematics
Combination 2: Physics, Chemistry & Bio Science
Combination 3: Chemistry, Bio Science & Agriculture
Commerce
Combination 4: Accounting, Business Studies & Economics
Combination 5: Accounting, Business Studies & Business Statistics
Combination 6: Accounting, Business Studies & Geography

Arts
Combination 7: Indian History, Buddhism & Home Economics
Combination 8: Geography, Economics & Home Economics
Combination 9: Geography, Economics & Logic and Scientific Methods

By considering 5000 simulations of the generated raw marks, under each study stream for Between Combination competition 100 students were selected according to each selection method and the selected numbers from each combination were recorded. This procedure was performed for the data for the years 2005 to 2010.Then the calculated average and the standard deviation of the numbers selected from each combination for both methods were tabulated and descriptive analysis was performed.

Application of Cochran's Q test for generated Raw Marks

For the selected 100 students under each study stream, if the student is selected for University admission, from both methods (ZScore & CCI methods) then the value of the dichotomous variable X_{ij} (i^{th} student in the j^{th} year) was taken as a success (1), otherwise it was taken as a failure (0), i=1,2,…,100 and j=2005,2006,…..,2010 and applied the Cochran Q test, to test the hypothesis,

Hypothesis:
H_0: effectiveness of the methods ZScore and CCI is similar over years
H_1: effectiveness of the methods ZScore and CCI differs over years

Results and Discussion

Comparison of Combination Wise Selection by Each Method

According to the sample sizes given in the Statistical Hand Book the raw marks were generated. Students for Engineering and Medicine courses are taken from Combination 1 and 2 of Science stream which has very high demand compared to other university courses. The actual percentages of vacancies for Engineering and Medicine courses at the University were calculated and a proportionate number of students were removed from combination 1 and 2 respectively according to the descending average rank order. Then the rest of the raw marks of combination 1 and 2 and whole of combination 3 marks were used for BC Competition.

Next, out of these students 100 were selected under each of the selection methods, namely, ZScore and CCI Method. The number of students selected from each method were recorded for each combination. The total generated data from other two study streams were considered as BC competitors and the same process was performed for each study stream. Mean and Standard deviation of the recorded numbers from each combination were calculated for the years from 2005 to 2010 separately for each study stream and were tabulated in Tables 4, 5 and 6.

Table 4. *Overall Mean and the Standard deviation of the selected numbers from each combination out of 100 in Science stream for 2005 to 2010.*

Combinations	Zscore Method		CCI Method		Minimum sample sizes
in Science	Mean	Standard deviation	Mean	Standard deviation	
Combi -1	81	13	48	18	20,737
Combi -2	10	11	43	20	24,938
Combi- 3	9	8	9	4	3602
Total	100		100		

Selected numbers of students from combination 3 are almost same for both methods while those for Combination 1 and combination 2 are very much different and with high standard deviations. These differences may occur due to the number of candidates who offered different combination may differ considerably and also the distributions of raw marks may be different as well.

Table 5. *Overall Mean and the Standard deviation of selected 100 students from each combination in Commerce stream for 2005 to 2010.*

Combinations	ZScore Method		CCI Method		Minimum sample sizes
in Commerce	Mean	Standard deviation	Mean	Standard deviation	
Combi-4	69	11	75	7	37,934
Combi-5	0	0	1	1	1073
Combi-6	31	11	21	7	20,104
Total	100		100		

The number of students selected from combination 5 is i.e. too low for both methods compared to other combinations. It may be due to the lesser candidates who offered combination 5.(accounting , Business studies and Bussiness Statstics) compared to the other combinations.

Table 6. *Overall Mean and the Standard deviation of selected 100 students from each combination in Arts stream for 2005 to 2010.*

Combinations	**Zscore Method**		**CCI Method**		**Minimum**
in Arts	**Mean**	**Standard deviation**	**Mean**	**Standard deviation**	**sample sizes**
Combi-7	1	1	2	1	474
Combi-8	13	3	14	3	2400
Combi-9	86	4	84	3	17585
Total	100		100		

Combinations 7, 8 and 9 select almost similar numbers from both methods with lesser standard deviations.

Figure 1. *Selected Mean numbers by Combinations for Science for 2005 to 2010*

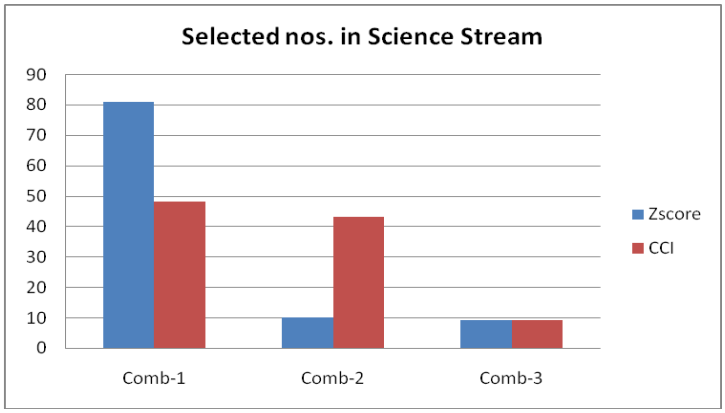


Figure 2. *Selected Mean numbers by Combinations for Commerce for 2005 to 2010*

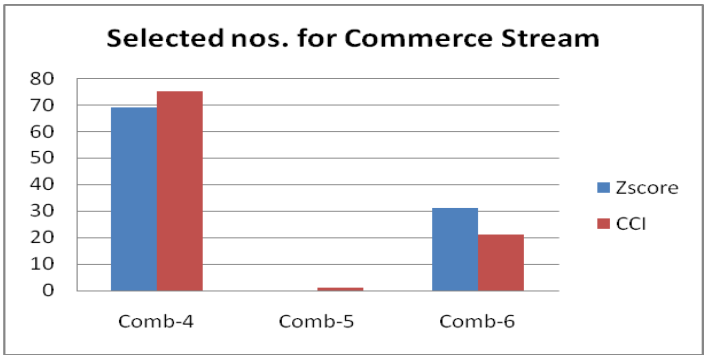
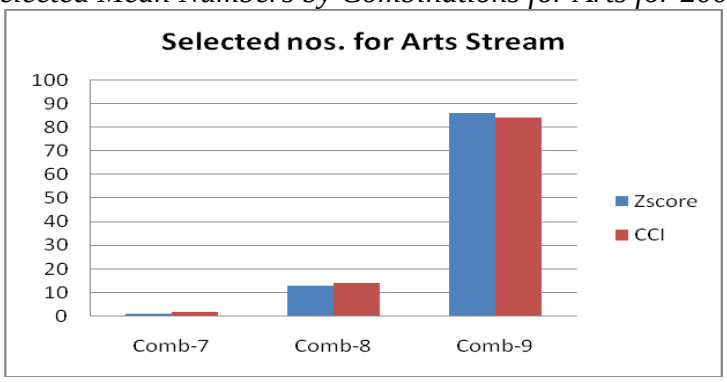


Figure 3. *Selected Mean Numbers by Combinations for Arts for 2005 to 2010*



From the tables 4, 5 & 6 and the Figures 1,2 & 3 it is clearly seen that almost similar numbers have been selected from both methods except Combination 1 and Combination 2 in Science.
In order to investigate the phenomena behind these differences, the raw marks distributions are analyzed further.

Comparison of Probability Distributions of Subject Marks in GCE (A/L)

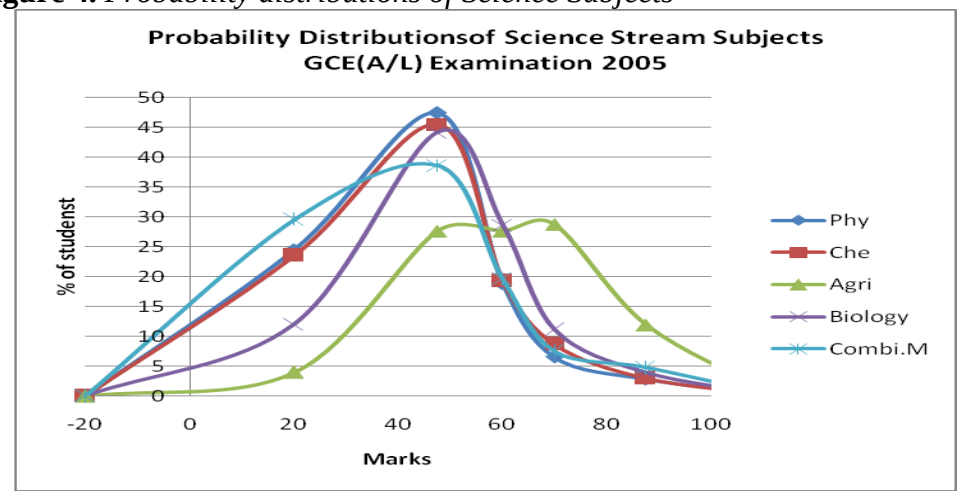
In order to observe the shapes of the distributions of raw marks, their grade distributions were obtained from the Statistical Hand Book 2005-2010 and drawn.

For example, the probability distributions of the subjects in Science and Commerce streams in the year 2005 are shown in Table 7 and Table 8 together with their graphed probability distributions in Figure 4 and Figure 5 respectively.

Table 7. *Grade distributions of some subjects in Science Stream in 2005 GCE (A/L) Examination*

Raw Marks	Physics	Chemistry	Agriculture	Biology	Comb. Maths
0.00 – 39.99 (F)	41.3%	3.27%	11.22%	23.67%	48.82%
40.0 – 54.99 (S)	29.59%	7.73%	29.12%	32.52%	23.94%
55.0 – 64.99 (C)	20.11%	17.12%	40.42%	28.09%	16.13%
65.0 – 74.99 (B)	5.83%	30.37%	16.74%	10.94%	6.24%
70.0 – 100.0 (A)	3.18%	41.59%	2.5%	4.78%	4.87%

Figure 4. *Probability distributions of Science Subjects*



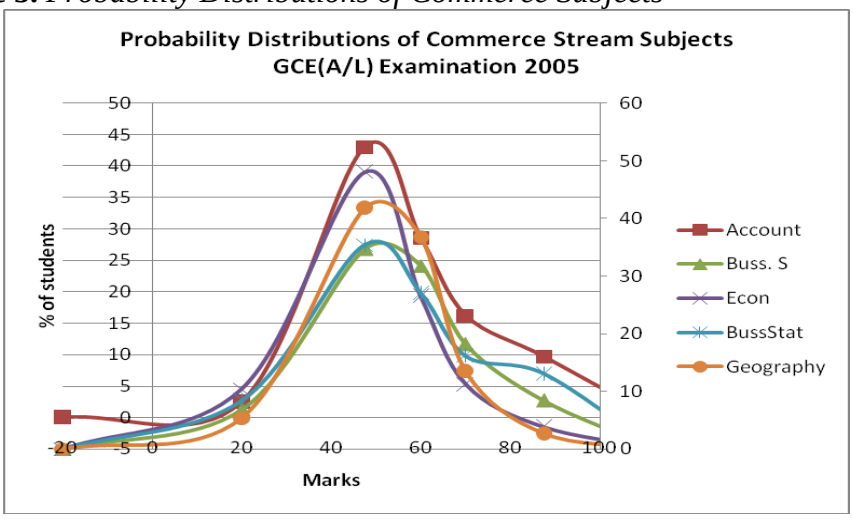
It can be seen from the figure 4 that the raw marks distribution of some subjects (Physics Chemistry and Biology and Combined mathematics) in Science Stream are skewed to right while Agriculture marks are symmetric for the year 2005. Similar shapes of subject marks distributions in science stream could be seen for other years too.

It can be concluded that the Agriculture is an easy subject compared to other subjects in the Science Stream. Therefore, students can earn high marks by offering Agriculture instead of Physics. As the GCE (A/L) Examination in Sri Lanka is the highest competitive examination in the country, the raw marks distributions should be skewed to right in order to clearly differentiate good students from the weak.

Table 8. *Grade distributions of some subjects in Commerce Stream in 2005 GCE (A/L) Examination*

Raw Marks	Accounts	Buss. Stud.	Economics	Buss. Stat	Geography
0.00 – 39.99 (F)	3.67%	13.61%	20.85%	16.4%	11.26%
40.0 – 54.99 (S)	23.94%	25.97%	36.28%	25.82%	32.75%
55.0 – 64.99 (C)	21.24%	31.74%	26.67%	26.28%	38.49%
65.0 – 74.99 (B)	12.02%	18.16%	11.21%	15.66%	14.04%
70.0 – 100.0 (A)	9.01%	10.53%	4.98%	15.84%	3.46%

Figure 5. *Probability Distributions of Commerce Subjects*



The raw marks distributions of many subjects in Commerce Stream are almost in similar shapes which are symmetric. Similar shapes could be seen for other years, subjects too.

Same patterns of probability distributions of subject marks could be seen in Commerce and Arts streams in all the years considered. It can be concluded that almost all of the subject raw marks distributions in commerce and Arts are approximately Normally distributed. It can also be concluded in order to suit for a highly competitive examination; the examination papers of those subjects should include questions to have the raw marks distributions right skewed.

Comparison of the Effectiveness of the Methods over Year

Cochran Q test was applied for the selected 100 students under each study stream for the years from 2005 to 2010 separately, and it was revealed that the observed Cochran Q statistics are 207.33, 108.66 and 30.47 for Science, Commerce and Arts subject combinations respectively. Since, the Chi-square table values for 5% and 1% significant levels with 5 degrees of freedom are 12.8 and 15.1, the observed values are far greater than those table values. Therefore, it can be concluded that the Null Hypothesis (H_0) is highly significant. Hence, the effectiveness of the two methods differs significantly

Conclusion and Recommendations

The two methods select almost equal number of students from different combinations, except the years with the skewed subject marks for which Z values of subject marks are not meaningful. Therefore, application of CCI method instead of ZScore method will not have any serious repercussions on the selection procedure as both methods select almost the same number of students. Moreover, CCI method preserves the combination wise average

ranking order eliminating the uncontrollable factors that affect the students' performances differently.

CCI Method is an improved method to Zscore, which has been mathematically and Statistically tested (Yatapana and Sooriyarachchi , 2006) and this study reveals that when marks are distributed approximately normally, both methods select almost similar numbers of students from each of the combinations. And also CCI Method selects completely different set of students preserving the combination wise average ranking order.

Hence, CCI Method can be applied instead of ZScore Method for selection of students for University admission in Sri Lanka. The application of CCI method instead of ZScore method will not have any serious repercussions on the selection procedure as it is simple and transparent.

Also, this study gives evidence that the examination papers of the subjects in Commerce and Arts streams together with Agriculture in Science stream should be redesigned by including questions with different levels of difficulty, so that the distributions of raw marks become right skewed in order to clearly identify the good students from the weak.

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