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EDUCATION INEQUALITY AND AFFIRMATIVE ACTION

Towards a Better Estimation

WORKING PAPER

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1. Introduction

Education might be the most important means of human progress, and there are two directions that one could take in appreciating education. One is to see its value in developing skills that lead to job opportunities and human resources which contribute to both individual and societal economic success (the *human-resource* approach); the other is to see its value in forming a human being and enriching the experience of being human (the *human-being* approach). The human-resource approach focuses more on an instrumental aspect, while the human-being approach focuses more on an intrinsic aspect. This compartmentalisation is useful to mention mainly in terms of analytical approach. In consequential terms, the instrumental focus does also have positive consequences in the intrinsic direction.

Whatever the direction of concern, there is no doubt that education is hugely important. It is a vital aspect of policy therefore to pay attention to the investments in education. This paper is written at a time in Sri Lanka where there have been strong social movements drawing attention to the neglect of education in the spending priorities of government. This has been seen particularly in the gradual reduction of budgetary share on education over the last decade (from about 2005 to 2014). The present paper looks at an aspect that has been neglected in this discussion of over-all education investment. It is the inequality in the distribution of educational opportunities within the country. This is certainly likely to be compounded by the reduction in investments, but it is also a matter deserving special scrutiny altogether.

There are both generic reasons and a special reason for looking more carefully at education inequality in Sri Lanka. The generic reasons have to with understanding the positive consequences of education (with regard to employment, incomes as well as health status and even democratic contribution) and an interest in resolving problems of poverty alleviation and equitable development through education. The special reason is that Sri Lanka has a program of affirmative action in university admissions. In addition to regularly changing the percentage of the student intake that is allocated on the basis of a district quota, this program has periodically specified a list of ‘disadvantaged’ districts that have been then favoured by an additional quota in the allocation of limited university seats.

But if there is any method or rationale for the specific manner in which these two affirmative criteria are calibrated, (the extent of the intake on the quotas, and how the disadvantaged districts are selected) then it is has not been accessible to the authors, nor deducible from the available data. The last date that a revision was made in the list of disadvantaged districts is uncertain, but there are at present 16 districts that have been classified as educationally disadvantaged, while 60% of the intake is allocated through district quotas. The post-war context of Sri Lanka and rapid changes, especially through the expansion of private schooling, implies that regular and careful attention needs to be paid to the assessment of disadvantaged districts and the calibration of quotas to avoid undue unfairness to students.

This paper develops a new composite indicator of education inequality and applies it to understanding the inequality of education across districts. A central policy problem that can be engaged with this composite inequality indicator is that of recognising and designating the districts that should be considered 'disadvantaged' for the purpose of affirmative action in university education. It can further assist in calibrating the affirmative action quotas over time and assessing the consequences of district based education investments – how much have they helped with regard to improving the educational outcomes from the district?

2. Indicators of Inequality and non-separability

2.1. Aspects and Indicators of Inequality

There are several ways in which inequality in education can be gauged. The three categories/aspects of inequality that are generally assessed are: (1) inequality of performance, (2) inequality of participation and (3) inequality in the allocation of resources. Each of these categories/aspects can be assessed using several types of indicators. For instance performance can be measured by using, as an indicator, the level of educational attainment (pass rates or the ratio of those achieving higher levels of education) or the level of success in standardised test scores (the ratio of those who gain top marks in the tests). Participation can be measured by using as an indicator the enrolment rates but this indicator can be applied to different grade levels or age groups. Resource allocation in turn can be measured by using, as an indicator, the variations in the quality of resources or the variation in the quantity of resources.

Much of the research in education inequality has been attempted for the purpose of cross-country comparisons. A significant cross section of early measures in this regard focused on the inequality of participation. That is, by looking at indicators of enrolment (at different grade levels) in schooling. Key contributions in this regard include Barro (1991), Mankiw et al (1992), Levine and Renelt (1992), Levine and Zervos (1993).

There are also many other studies that look at indicators of achievement. Several of them have focused on average years of schooling achieved by the population. Significant contributions include: Psacharopoulos and Arriagada (1986), Barro and Lee (1993, 1997, and 2000) and Nehru, Swanson, and Dubey and King (1996). All of them attempted to create databases of cross comparison in educational attainment.

Since 2000 there have been a number of new cross country measures that have been based on looking at performance in a different way, as level of cognitive achievement. Typically, they have administered identical cognitive achievement tests to samples of students through school based surveys. The best known amongst these include the OECD’s Program of International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) assessment by the International Association for the Evaluation of Educational Achievement.

2.2. Recognising Non-Separability

It important to recognise that many of these aspects and indicators – that is different indicators within each aspect measured, as well as the different categories of aspects measured – have significant causal and correlative connections.

That different indicators within a category of measure might tend to be correlated is easy to recognise. Places in which performance in test scores tend to be higher (e.g. O’level performance is higher), would also tend to have a larger proportion reaching higher grade levels (e.g. enrolling for A’levels).[1] These are both different indicators of performance.

The expected correlation between the different categories of measures, likewise, should not be surprising either. For instance, inequality in the allocation of resources across districts can take various forms.

[1] It should be noted that there can be many situations of non-correlation as well. For instance, the inequality in the quantity of schools between districts is not necessarily correlated in the inequality of the quality of facilities or teachers. A simple example for this might to look another sector. Every district in Sri Lanka would have a District Hospital – and there might be no inequality to detect in the existence of such hospitals. But the quality of facilities and services at such could be subject to large variation.

- When it takes the form of reduced number of schools, it will imply less ease of access, which will in turn tend to show up as a reduced level of participation/enrolment, which will also lead to reduced levels of education attainment over-all in the district.
- When resource allocation disparities takes the form of reduced quality of facilities and teachers, then it will tend to show up as reduced performance both in levels of education attainment and in the success levels in test scores.

Therefore, each of these measurement categories and indicators are affected by factors beyond them – by factors that belong to the other categories and indicators. For short we will refer to this feature of inequality measures as **non-separablity**.

The extent to which non-separability matters, or does not, could depend on the policy purpose to which the inequality measures are applied. If the purpose is to understand how the level of education performance affects growth prospects of a country, it does not matter much whether the performance disparities are driven by lower levels of ability/participation in the population, or lower levels of education resources/investments. But if the purpose is to find a policy intervention that improves the level of education performance, the question of what is driving the poor performance does indeed become pertinent – especially since teaching cultures and social attitudes to education can vary a lot across countries and places.

2.3. Atomic and Composite characterisation within Non-Separability

The core feature of non-separability is that inequality in one category of measure is causally linked to inequality in another category. But these causal linkages will tend to be stronger in one direction rather than another. For instance, the tendency for more resources to engender larger enrolment rates is likely be stronger than larger enrolment rates to engender increased resources. So we can say that enrolment rates tend towards being more composite while resource allocation tends towards being more atomic, in relation to each other.

Likewise better quality resources are much more likely to influence better performance than vice versa. Making performance more composite in relation to quality. Therefore, the causality can be conceived as building upwards, with some categories of measures having wider causal impact (more atomic), and others reflecting wider consequential impacts (more composite).

In this nuanced light of non-separability, resource allocation (including the quality of resources, not just the quantity) can be thought of as being more of an atomic factor – not capturing too much information beyond itself.[2] Likewise, certain performance measures could be thought of as being the highly composite – indicating in itself the cumulative consequences of various other measures.

Different aspects of more atomic measures, such as resource allocations, can have different consequences on more composite measures such as performance. For instance, poor quality resources will have a direct consequence on performance by affecting the individual learning outcomes of equally able students; where poor availability (quantity) of resources will have an indirect consequences by affecting the collective ability to enrol and attend, which can then in turn have some impact on overall performance measures.

2.4. Benefits and limits of present inequality measure

In the measure of inequality developed in this paper we seek to take advantage of non-separability, rather than treating it as a problem. In doing so we are seeking to design an inequality measure that absorbs and combines the complex combination of factors that affect educational outcomes. The strategy therefore is to select a composite indicator, and within such to select one that is likely to be highly composite with regard to most of the atomic factors with regard to which education policy should be concerned.

The benefit of using a composite measure is that combines the consequences of more atomic measures and aggregates them into an indicator that has further intrinsic information. It thus becomes a cumulative combination of the other indicators, which as a single indicator still embeds a richer set of information.

The added benefit is that the factors aggregated in composite indicator could include those that cannot be independently measured. For instance, there is data to measure teacher to student ratios, but available data cannot reveal much about the discrepancy in the quality of teaching

[2] When resource allocation works the other way – of being more composite – it is usually due to a purposive policy measure that links more spending to better performance. Allocations in Sri Lanka are not positively linked to performance. The pressures are likely to be in the reverse: to increase allocations to areas with poorer performance.

at the school level. But a composite measure, using performance, would still, amongst other things, reflect the combined consequences of these two.

The composite performance measure we settle upon in that regard is one that measures the extent of educational achievement at the A'level exams adjusted for the size of the district population. Because the marks of each student is not published, and pass rates are too crude a measure of success (they are only half the story of how well a group performs) we use the Z-score cut-offs announced for each district by the university admissions system to reverse engineer its embedded information and build an indicator that functions (to a great extent) **as-if** we had every single mark of all the students. This will be explained in detail in the next section.

An important limitation of this indicator is that the resulting inequality measure does not distinguish between performance differences amongst districts that are created by differences in opportunity (which is mostly based on resource distribution and related logistical factors) as opposed to differences in ability/effort (which can be driven by social and cultural factors). This is a weakness in many performance based indicators. But this can be re-examined separately by comparing different indicators. For instance by comparing the disparity in this composite indicator against disparities in more atomic indicators.

Therefore, when this measure is used to deduce a discrepancy in opportunities provided through the structure of resource allocations, then if there are significant difference across districts in how opportunity translate to performance, the deduction will be imperfect, and should be evaluated through some extra filters of caution. For instance, where cultural factors cause parents and students to strive harder in improving educational levels, this will show up as better opportunities for education. Where social factors cause higher drop-out rates and less interest in pursuing education, this will show up as a poorer level of opportunity.

At the conclusion of this paper we will provide some guidelines on dealing with this issue – it will be based on examining the correlation across districts between the composite indicator against more atomic indicators such as resource allocation, and picking out significant outliers.

3. Affirmative Action in Sri Lankan Education

3.1. Justification and parameters of affirmative action

Affirmative action, with regard to any type of access (in this case university education) is by definition a mechanism for providing a more favoured treatment of particular groups that are thought to have suffered some prior injustice that has affected their competitiveness. The moral justification is on the basis of correcting the consequences of past injustice with regard to those who have been adversely affected (often identified in a group context).

While concerns for ensuring a measure of diversity can lead to some affirmative action type decisions, it is not exactly a justification, and its application will usually be quite minimal as to forestall the protest of it being 'unjust'. To justify diversity based affirmative action, it is important to argue that the diversity itself provides some wider group or social benefit apart from the obvious benefit to the person selected by such affirmative action.

The reason that affirmative action needs to be justified on the basis of a 'higher cause of justice' is precisely because an affirmative action program necessarily involves an apparent discrimination against some people, who will need a satisfactory explanation. The better performers who are denied access due to affirmative action need not be provided with a reason for their exclusion in favour of those with lower qualifications. A suitable explanation is one that can reasonably be seen as addressing a larger injustice/discrimination than the one being created, and likewise fostering a larger social benefit. When such an explanation cannot be provided, then the term affirmative action becomes an unsuitable description. It is then better understood as discrimination. For instance, the 'Bhumiputhra' policies of Malaysia, though they are defended in the name of affirmative action are largely an exercise of discrimination against minorities by a majoritarian state. "A rose by any other name is still a rose."

3.2. The use of proxies for affirmative action

One of the obstacles to explaining affirmative action systems is the fact that the favoured group is often defined in terms different from the specific group subject to the injustice. For instance the injustice might be lack of opportunities to develop skills. But the affirmative action program to address this might favour those of a lower caste in the provision of government jobs (a case in point in India). In this case caste is being used as a proxy to identify those who have been deprived of opportunities.

The justification for the use of proxies has two reasons: one is if the disadvantaged group can be more effectively identified by using a visible proxy than attempting to identify them through information that is often complex, invisible and hard to access. The opportunities that have been enjoyed by a person is difficult to estimate at the individual level, but we may know of a strong correlation between that and being in a low caste. In that context caste, as a proxy, could become a reasonably effective method of identification.

A second reason to use a 'proxy' rather thing being attempted to measure itself, is that the indicator can often be gamed – what in economics is sometimes captured as Moral Hazard. For instance, if government jobs are given disproportionately to the very poor, then people who are less poor people have a reason to misrepresent their income – and this is very difficult to detect. In such cases, using a proxy, such as caste, could help to select more accurately (though still imperfectly), than the precise indicator that is susceptible to being gamed.[3]

3.3. Affirmative action on university admission in Sri Lanka

When it comes to University admission in Sri Lanka, the justification for the present form of affirmative action has at least two foundational arguments, even if they are implicit. One is that students of equal ability have differing **performance levels** due to different quality of education facilities they've received. Second is that the variation in the **proportion of students** competing from districts is affected by also the quantity (in addition to quality) of education facilities. Both these arguments are needed to justify a distribution of admissions places in proportion to the population of a district – rather than merely on the number of students sitting from a district.

But the genesis of the practice has a more convoluted history. Initially, it seems to have been motivated by a discriminatory move to limit the university entrance of Tamil students (de Silva, 1997). Therefore, affirmative action quotas were set indirectly by language stream (using performance 'standardisation' across language streams), without specific evidence that language streams were the right criteria for identifying the educationally disadvantaged.

Later this was combined with an additional district based quota. But after 1977 the language based affirmative action was stopped; and the district based quota took on two tiers. Some districts were favoured additionally on the basis of being 'educationally disadvantaged'. K. M. de Silva (1997) records the many changes the university admission system has gone through

[3] Private health insurance schemes use age as a proxy for health risk, for the same reason. The actual risk is likely to be misrepresented, but the correct age can be reliably verified.

over time in terms of the application of these district based quotas (Figure 1). This paper does not question the concept of a district quotas as opposed to other possible focal points for applying the quota – for instance, by category of school attended, rather than district location of the school. But uses the inherent to logic of a district quota to analyse the calibration of its application.

This does not mean that we support or justify the use of districts as a proxy for fixing affirmative action criteria. But, given that the districts are indeed used, this paper attempts to develop the best possible measure of district disparities in educational achievement. By doing this we are able to provide a means for identifying 'disadvantaged' districts, as well as measure the extent of inequality and need for affirmative action. This type of transparent measure and calibration method can help to reduce the space for ad-hoc bureaucratic decisions and political favouritism, and protect the affirmative action program from sliding into a system of discrimination.

Figure 1

Year	Admission Policy	Educationally Disadvantaged Districts
Up to 1965	Universities had their own entrance examinations	
1966	Centralized admission policy – 100% merit based	
1970	Restriction of student support depending on medium of instruction, applied according to subjects. This is called "standardisation", because is done by rescoring marks across -- done by rescoring marks across different language streams to standardise them around the same mean.	
1971	Standardisation is continued	
1974	A direct quota is applied to each district based on population, and this is done on top of "standardisation"	
1976	The direct district quota is reduced to 30% of the intake. 70% is on merit -- all island ranking. The district quota is made two tiered. Half of it is distributed across all districts according to population, and the other half is distributed across a selected list of 'educationally disadvantaged districts' according to the population ratios amongst those districts. All this is on top of "standardisation"	1. Ampara 2. Anuradhapura 3. Badulla 4. Hambantota 5. Mannar 6. Monaragala 7. Nuwaraeliya 8. Polonnaruwa 9. Trincomalee 10.Vavuniya
1977	Standardization by medium of instruction is removed.	
1978	An eleventh district was added to the 'disadvantaged' list.	11. Batticaloa
1979	30% all island merit, 55% districts quota and 15% for educationally disadvantaged districts; plus a twelfth district was added to the disadvantaged list.	12. Mullaitivu
1980	A thirteenth district was added to the disadvantaged list	13. Puttalam
1985	30% all island merit, 65% district quota and 5% for educationally disadvantaged districts. Disadvantaged districts were reduced to 5.	Reduced to; 1. Ampara 2. Badulla 3. Hambantota 4. Mannar 5. Mullaitivu
1990	Another seven districts were added to the disadvantaged list, to bring the total to twelve.	6. Anuradhapura 7. Kilinochchi 8. Monaragala 9. Nuwaraeliya 10. Polonnaruwa 11. Trincomalee 12. Vavuniya
1996	A thirteenth district was added to the disadvantaged list.	13. Jaffna
Unknown[4]	40% all island merit, 55% district quota and 5% for educationally disadvantaged districts	
Unknown[5]	Disadvantaged list was increased to sixteen, by adding three more.	14.Batticaloa 15.Puttalam

[4] Estimated to be sometime between 1997 and 2002
[5] Estimated to be sometime between 2002 and 2009

		16. Ratnapura

4. A Composite Measure of Inequality

Section 2 has argued that performance measures tend to be more composite than atomic inequality indicators; and that they are therefore better measures of various combined factors of resources inputs (both measurable and non), and resulting educational opportunities, beyond what would be measurable by available data on measures such as resource allocation.

4.1. Shortcomings of existing measures.

In measuring the disparity in performance, it is first important to understand what performance disparities are proper measures of inequality. There are three grade levels at which standardised performance statistics are available at a district level. (1) the Grade 5 scholarship (percentage getting above the cut off mark); (2) the O'Level pass rate; (3) the A'Level pass rate.

Grade 5 Scholarship: On average, over all regions, about 50% of the students get above the cut-off mark at the grade 5 examination. However, Grade 5 Scholarship performance is not a suitable measure of performance disparities. The reason this measure is unsuitable has to do with choice and incentives which creates a selection bias in the sample.

The grade 5 scholarship examination is not a compulsory exam as in the case of O'level and A'level exams. It is of interest mostly to those who are in weaker schools and aspire to switch to better schools. This means that students in better schools are simultaneously less likely to take the exam, and when they do, less likely to strive to pass, while students in worse schools have a greater incentive to sit as well as to strive. This then gets compounded to districts with worse schools relative to districts with worse schools. Both the selection and performance of students will be biased by this incentive structure, such that the performance distribution becomes unsuited as a measure of education quality in different districts.

O'level and A'level exams: These are national exams required for proceeding with education. The average pass rate at O'Level is quite low, at 59% of the students who sit, and remains in the same ballpark with dip of about 3 percent at A'Level's. There is significant regional variation in performance at these examinations across districts. The largest variation between districts is at O'Level where Colombo shows the best performance. Kilinochchi, Mullaitivu, Monaragala, Trincomalee and Nuwara Eliya are the poorest performing districts at O'Level (Figure 2).

The O'level pass rates by themselves are not an excellent indication of district performance for two reasons. (1) the pass rate is just a binary indicator, and will not distinguish between two districts which had the same pass rates but a large difference in the average marks of those who passed. (2) they pass rates could be higher in schools with low survival rates (that is when students drop-out at grade 8). That is effectively biasing the results in the wrong direction – by indicating a higher pass rates in the context of higher drop-out rates (reflecting a higher performance measure instead of a lower one).[6]

The A'level pass rates are an even worse measure, because in addition to the problems with O'level pass rates, they also suffer from additional drop-outs after O'levels. The A'Level's can be pursued only by students who have passed their O'Level's. In schools and districts with weaker educational outcomes it is disproportionately the better students, who manage despite weaker teaching, who will qualify to pursue A'Level's. This will make the A'Level cohort in weaker schools/districts smaller in number and from amongst the higher percentile of competency, than in a better schools/districts. This means that A'Level pass rates could tend to be relatively high, in schools/districts where O'Level pass rates are relatively low.

In fact this is borne out in analysis. Looking at A'level pass rates suggests a very different picture of education inequality than looking at O'level pass rates. To take just one district, at O'levels, the pass rate performance of Colombo comes out between 2 and 3 standard deviations above the mean. But in A'levels Colombo is within 1 and 2 standard deviations below the mean (Figure 2).

The problem of dropouts on the way to O'level and A'level exams could be addressed by taking these rates as a percentage of the population, rather than a percentage of those sitting. But the problem of not distinguishing beyond the binary pass and fail will remain.

Figure 2: Discrepancies in pass rate measures, Grade 5, O'level, A'level

Performance indicator	Within 2 SDs below	Within 1 SD below	Within 1 SD above	Within 2 SDs above	Within 3 SDs above
Gr 5 Scholarship	Kilinochchi	Mullaitivu N'Eliya Mannar	Trincomalee Ampara Monaragala Batticaloa Puttlam An'pura Matale	Colombo Jaffna Badulla Polonnaruwa Vavuniya Ratnapura Hambantota Kandy	Kalutara Matara Kegalle Gampaha Kurunegala

[6] Enrolment to O'levels and A'levels are also affected by students who might leave to schools in other districts after passing the grade 5 scholarship exam. The extent of such moves and its implications has not been evaluated here.

				Galle	
O'Level	Kilinochchi Mullaitivu Monaragala Trincomalee N'Eliya	Polonnaruwa Badulla Ampara An'pura Matale Batticaloa Mannar Ratnapura Jaffna	Puttlam H'tota Kandy Galle Gampaha Vavuniya Matara	Kegalle Kalutara Kurunegala	Colombo
A'Level	Polonnaruwa Gampaha Matale Colombo Kandy	Badulla N'Eliya H'tota Ampara Kilinochchi Trincomalee	An'pura Kurunegala Mullaitivu Monaragala Matara Ratnapura Kalutara Batticaloa Kegalle Galle Puttlam	Jaffna Mannar	Vavuniya

* SD = Standard deviation from the mean

Therefore, each of these popular pass rate measures provide a different picture and each of them pose significant theoretical problems. Grade 5 scholarship exam pass rate indicator is affected by selection bias since students in the better schools have less incentive to attempt the exam. The O'level pass rates indicator is biased by enrolment and drop-out disparities and fails to distinguish performance beyond passing and failing. The A'level pass rates indicator suffers from the same issues as the O'level indicator, but the problem is significantly compounded by the exit of lower competency students after O'levels.

4.2. Methodology for a composite inequality measure

What is developed herein is an inequality indicator that is less susceptible than the traditional measures to the problems described above as: differential incentives to perform, differential enrolment rates (which could be affected by resource allocation disparities) or the cumulative effect of previous pass rates, and lack of gradation in performance (when only pass rates are measured)

The aim of the composite measure is to quantify overall achievement in a manner that overcomes the shortcomings listed for pass rates in various exams. We use performance at A'levels because we want to capture the compounded inequalities at all levels of the education system, not just up to O'levels. But we don't simply use the numbers passing A'levels as a percentage of the population, because this does not reflect gradations of performance beyond the binary outcome of passing and failing.

The composite indicator is designed to measure the graded difference in performance across districts in the post A'level applications to three of the most competitive streams of university education; Engineering, Medicine and Management. That this difference in performance is a valid measure of inequality depends on three broad assumptions about the similarities across districts.

Assumptions on similarities across districts:

1. **Equitable distribution of ability:** The basic level of human intelligence and innate ability is the same across the population in every district.
2. **Equivalent student demographics:** The demographics of all the districts are the same in terms of the cohorts in each year of schooling, in relation to the total population.
3. **Corresponding interests and choices:** When provided the same resources for enrolment and same opportunities for advancement in education and work prospects, the populations of each district would have the same distribution of responses in enrolment and effort, as well as choices in terms of subject streams.

The last assumption may require some explanation. It does **not** mean that at present students in different districts would have the same interests and choices. It does however assume that these differences are a result of the differences in the educational and opportunity environment across districts. The assumption is applied in relation to applications for university entrance in Engineering, Medicine and Management – which tend to be the most competitive aspirational goal of those in the A'level streams of maths, science and commerce. Therefore differences amongst districts that cause students to show less interest in Engineering, Science and Management are judged to be reflecting some lack in the broader educational infrastructure, compared to districts where students show a greater interest.

The implication of these three assumptions put-together is that differences in overall achievement amongst applicants to Engineering, Medicine and Management, as a proportion of the district population, indicates (or is deciphered as) the measure of inequality in the broader educational infrastructure in the districts.

For example, if student demographics are equivalent, and interests and choices correspond to the educational infrastructure then differences in the percentage of students enrolling for A'level math and applying for engineering reflects differences in the educational infrastructure. Furthermore, if the enrolment and application percentages are equal, the assumption of equitable distribution of abilities means that differences across districts in graded performance reflects differences in the educational infrastructure.[7]

The final reason why this approach and the connected assumptions are suitable for a composite indicator is because these assumptions are already inherent in the district quota system used in the country. The present district quota system allocates the district selection in each of these subject areas in accordance with the population ratios in each district. Not according to the numbers sitting (which is affected by both demographic differences and choices on enrolment – assumption 2 and 3), nor by making any adjustment for ability differences (assumption 1). In other words these three assumptions are not new, they are simply an articulation of the assumptions embedded in the system that is currently followed.

4.3. Construction of the Composite Indicator

If the marks that every student got at the A'level exams along with their choice of university program was available, then the composite indicator could be built more simply by looking at the difference in performance across districts. But the University Grants Commission does not publish such data. It does however publish the total intake from every district, as well as the Z-score cut-off announced for each subject stream for each district. For a particular mark in a subject, its Z-score specifies its distance from the mean in terms of standard deviations. So a mark that is 2 standard deviations above the mean would have a Z-score of 2 (plus 2), and a mark that is 1 standard deviation below the mean would have a Z score of -1 (negative 1).

Before specifying the composite inequality indicator developed here, it is important to be clear about the present process followed in university admissions to the three competitive subject areas specified.

Method followed in admissions:

- **40% on National merit list:** that is the first 40% of the intake depends on all island performance, the top 40% of performers in the nation are admitted irrespective of their district.

[7] Weak educational infrastructure has two effects. (1) It affects enrolment in and university applications for the most competitive subject streams; (2) It affects performance in these subject streams. The composite measure described accounts for both these consequences.

- **55% on standard district quota:** that is, the next 55% are selected on the basis of top performers in the 25 districts, not at national level. Each district is allocated a standard district quota, in proportion to the district population, from 55% of the targeted intake. If a particular district in this way gets a quota of *n*, getting in on the district quota requires being amongst the top *n* performers in that district, after leaving out those who get in from the district on the merit list.
- **5% on disadvantaged district quota:** that is a number of districts, 16 at present (see figure 2 for list), are designated as disadvantaged districts. Each of these districts is allocated an additional quota, called the disadvantaged district quota, in proportion to the district population from the total population in the selected districts. If a particular district is classified as disadvantaged and gets this additional disadvantaged quota of *m*, getting in on this disadvantaged district quota requires being amongst the top *m* performers in that district, after leaving out those who get in on the merit list and those who get in on the standard district quota.

After all the calculations are made the selection is announced, not by announcing a cut-off **mark** for the last student who is accepted into university from a district, but by specifying the **Z-score** cut off. The reason for this is that students could sit different combinations of subject and apply to the same university course. In this case, the absolute mark achieved is not a good reference for comparison since the difficulty levels of the exams could vary, and the marks are not adjusted to a standard curve. But the percentile performance level in relation to those sitting that exam remains a suitable reference point. In other words the Z-scores and their rankings create a way of comparing student performance across different subjects, and it is this score that is presently used in announcing the selection to universities in Sri Lanka.

Variation in Z-score cut-offs for admission is not the right indicator

It's tempting to think that the variation in the Z-score cut-offs would be an indicator of inequality in performance between districts. This would be correct if 100% of the admissions were on a district quota. But because 40% are on the merit list, relating the differences in Z-score cut-off to performance variations becomes more complicated. The reason is that acceptance on the merit list can be distributed unevenly across districts.

Take a simple case of just two districts of equal size: A and B. If all 40% on the merit list get in from district A, then fulfilling the district quota would require reaching beyond that 40% to students who might have performed less well than the last student who gets in on the district quota from district B, where none got in on the merit list. But it's clear that district A is the better performing district, even though it ends up with a lower Z-score cut-off for admission.

The composite inequality indicator is derived in two steps

What is known is the Z score cut-off for each district. What needs to be constructed is method of using this information as an indicator of performance, since interpretation of the Z score cut-off is complicated by the merit list.

The composite indicator is developed using a straightforward approach:

1. Construct a Z score benchmark for each district, based on its intake, on the assumption of no inequality in performance. That means that the base case is the performance level required if all districts had performed equally to achieve a given total national result.
2. Derive a score for each district on the difference between the actual Z score and the benchmark – the difference in the scores will yield the measure of inequality.

Starting with the point of no inequality

The first technical step in constructing our indicator of inequality then, is to construct the base case and quantities which would arise if there were no inequality. The inequality would be measured by comparing the actual results against this base case.

There are two closely related options for a base case of no-inequality. We present them as BC1 and BC2:

BC1: given the total intake, if there was no inequality, what would be the total **expected intake** from each district, under the present method of apportioning places?

BC2: given the actual intake from any particular district under the present method of apportioning places, if there was no inequality, what would be the **corresponding total intake**?

BC1 and BC2 and closely related in terms of calculation. They just switch from estimating a district intake on the basis of the total intake, to estimating a total intake on the basis of a district intake – both on the basis of all districts performing equally.

We explain later why our inequality indicator is built on BC2. But even to build BC2, it is instructive to start by building BC1.

Construction of BC1:

A note on notation: We use subscript *i* to denote district wise variation of a variable; and capital letters to denote a total from all districts. Therefore while a_i is used to denote actual intake (admissions) for each district *i*. The total admissions from the districts is denoted as A.

If there is no inequality in performance, the admissions for the merit quota would be distributed according to population proportions, just as it is in the case of the district quota. Therefore the resulting distribution would be the same as if the district quota was 95% instead of being 55%. The remaining 5% of admissions will be distributed only to the disadvantaged districts, according to the further affirmative action formula. Therefore, in BC1, the quantity e_i is the ***expected*** **district intake** from each district *i*, given the ***actual*** **national intake** to universities in the subject stream.

[1] $$e_i = \left(\frac{p_i}{P} \cdot A \cdot 0.95\right) + \left(\frac{p_i}{\sum d_i \cdot p_i} \cdot A \cdot 0.05\right) \cdot d_i$$

Where:

$A =$ Total actual university intake to subject stream from all districts

$p_i =$ Population of district *i*; and $P = \sum p_i$ (total population)

$d_i = 1$ if district *i* is designated as a disadvantaged district, 0 if not

This derivation of expected intake, alone, is not adequate to build a composite performance indicator[8]

[8] The difference between the expected and the actual university intake (e_i and a_i) does not quantify the graded performance at A'Levels. If two districts get 10% more than expected, it does not mean that they did equally better. The actual marks of those in one district could have been much higher. This cannot be captured by BC1, because it does reference the Z score cut-off of the district. The Z score cut-off could be referenced against the Z-score equivalent of e_i, but this would not result in a meaningful measure either, since a district with a lower cut-off because it had a higher proportional intake would look less good than a district with a lower proportional intake, which has a higher Z-score value because of it – even though the first district is clearly the better performing one. Both the Z-score and the proportional increase carry important information for a performance indicator, and using only one would compromise the indicator.

Construction of BC2

The second base case, or BC2, calculates the ***expected*** **national intake** that corresponds to that ***actual*** **district intake**, when all districts are performing equally. This expected national intake, corresponding to the actual intake of a district i, will be denoted as C_i.

When there is no inequality of performance across districts, each district's admission would be in proportion to its population. Therefore C_i is a simple derivation from equation [1].

[2] $C_i = A \cdot \frac{a_i}{e_i}$

Where:

$a_i =$ Actual admission intake from district *i*; and $A = \sum a_i$ (total national admissions intake)

In words, C_i is the changed new value of A which would make e_i equal to a_i. The C_i that corresponds to the actual intake of district *i* would be larger than A if the district got in a larger share from the merit list than its population share, and vice-versa.

Z score benchmarks for BC2

The actual intake a_i of district *i* corresponds to a total intake of C_i if all districts were performing equally, this much has been derived. This means that our second base case BC2 provides us with a different C_i for every district *i*. Therefore, we can derive a separate benchmark Z-score cut-off for every district *i*, on the no inequality basis of BC2.

This is derived from C_i as follows:

Using the standard assumption that the marks are normally distributed along a probability density function, the area under the curve to the right of the Z-score is interpreted as the probability of being selected from amongst those who sat the exam –since it is the top performers who are admitted, this can also be read as the percentage of top performing students admitted. That is, if the probability of being selected is 5%, it means that it is the top 5% that are admitted.

Maintaining the base case no inequality assumption, the area under the curve available to any district is given by two considerations. First, the proportion of C_i available to the district in relation to S_i. This S_i is the proportion of the exam sitting population that is competing for that allocation in relation to the total that sat the exam in all the districts. From our equivalent student demographics assumption we also have that our sitting populations are considered to be in the same ratios as our district populations, from each of the districts.

Therefore, the area under the curve available to each district can be denoted as $D(C_i)_s$ for standard districts, and $D(C_i)_d$ for the disadvantaged districts, can be derived as follows.

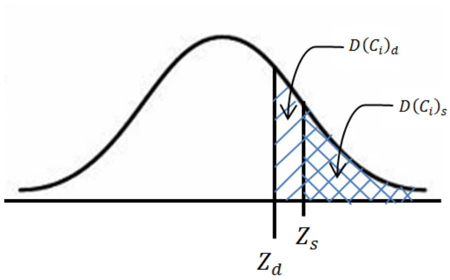
$$D(C_i)\begin{cases} D(C_i)_s \\ D(C_i)_d \end{cases} = \begin{cases} {}^{0.95C_i}/_{S} & \text{standard district} \\ {}^{0.95C_i}/_{S} + \left\{ {}^{0.05C_i}/_{S} \cdot {}^{P}/_{(\sum d_i \cdot p_i)} \right\} & \text{disadvantaged district} \end{cases}$$

If the disadvantaged districts spanned all the districts instead of being just a subset, then the equation would boil down to $D(C_i) = {}^{C_i}/_{S}$

Given that the total area under the normal curve has a probability of 1, the Z score benchmark for district *i* can be derived by recognising that $\rho(Z_{ki}) + D(C_i) = 1$, $\rho(\cdot)$ is the left-tailed probability function of the Z scores, and $\rho(Z_{ki}) = 1 - D(C_i)$.

The inequality indicator

Figure 3



From the Z-score benchmark, we can proceed to calculate the level of inequality by specifying the distance between the benchmark Z score of the equality position in BC2, denoted Z_{ki}, and the data on actual Z score announced for the same district denoted Z_{xi}. We know that Z scores do not change linearly with probabilities; and therefore the simple difference in Z scores will not give us a linear measure that places the same value on the same difference in performance. For that reason the distance function we use to measure the extent of inequality between districts is the percentile rank equivalents of the Z scores. This can be derived from the probabilities, and is a linear measure.

$\rho(Z_{xi})$ → probability of achieving a Z score ≤ Z_{xi}

$1 - \rho(Z_{xi})$ → percentile rank of those achieving a Z score = Z_{xi}

Likewise therefore:

$\rho(Z_{ki}) = 1 - D(C_i)$ → probability of achieving a Z score ≤ Z_{ki}

$1 - \rho(Z_{ki}) = D(C_i)$ → percentile rank of those achieving a Z score = Z_{ki}

The resulting performance measurement function that measures inequality is:

$$Q_i = D(C_i) - [1 - \rho(Z_{xi})]$$

It can be read as **the percentile rank increase or decrease in performance from that which would have resulted in gaining only as much intake into universities as was the districts share (**under the existing distribution scheme) **if all districts had performed equally**.

This makes the base case performance equal to zero. When the performance score is zero, it means the district has performed such that its intake would have been what it is, if all districts had performed equally. Therefore districts that have a measurement indicator Q_i better than zero are doing better than could be expected under the condition of all districts performing equally, and vice-versa for districts that have a measurement indicator Q_i of less than zero

5. Results

The latest data that this inequality measure can be calculated for, at the time this paper was written, is the 2010/2011 intake[9]. Consequently, the following results depict education inequality based on the 2010 A'Level (same as 2010/2011 university intake).

Between streams

The normalized average sum of deviations from the mean of the inequality measure (R) of each district allows the calculation of a total inequality of a given stream. R ranges from 0 to 100, with 0 indicating no inequality and 100 the most inequality.

$$R = \frac{\sum_{i=1}^{n}(\frac{\Delta^2}{25})}{n}$$

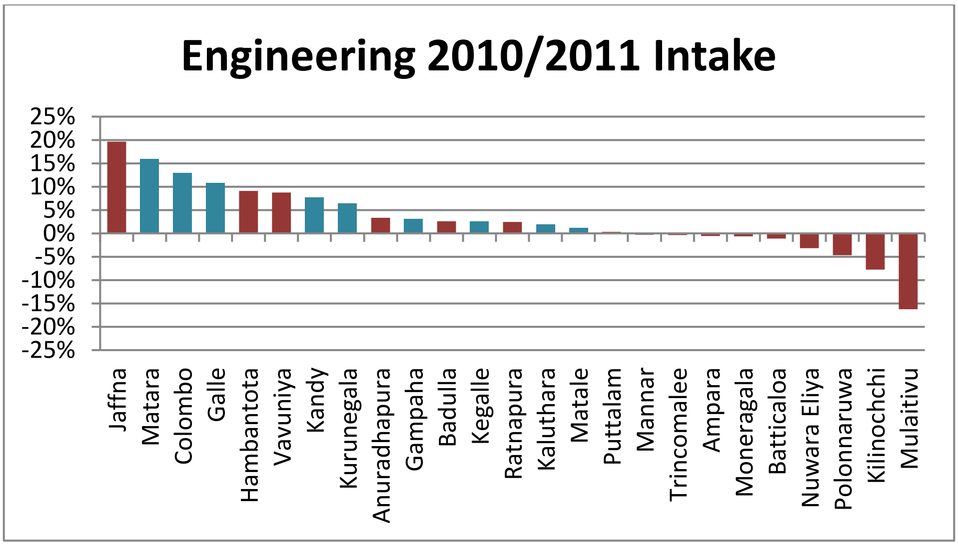
[9] The two years following, although the data is available, cannot be used as the z-scores were affected by the two syllabi issue at the 2011 and 2012 A'Level exams.

The largest amount of inequality is observed in the engineering intake. The total stream inequality of engineering is 2.2 where as in management it is 1.3. The lowest total stream inequality is in medicine, only slightly lower than in management, with 1.2.

Within streams

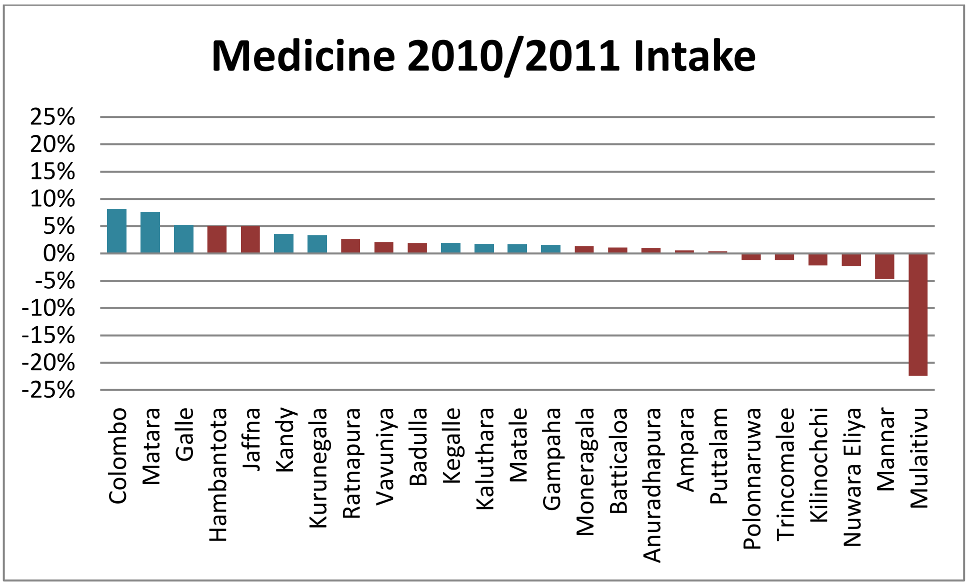
The stream that has the largest total stream inequality, engineering also has the largest over-performance observed. Jaffna that is the largest over-performing district in engineering, is doing 20 percentiles better than expected (Figure 4). Even overall, more districts over-perform than underperform in engineering.

Figure 4



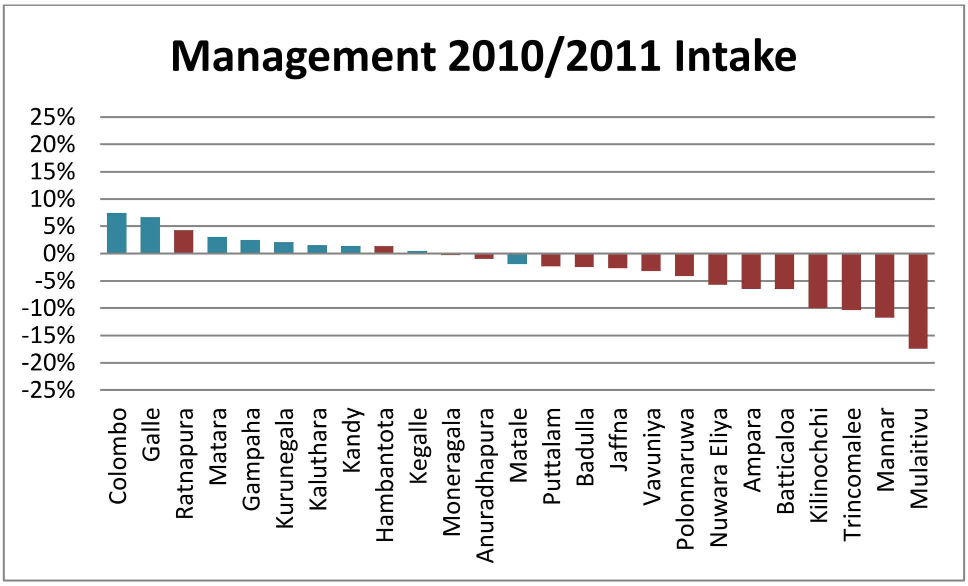
The stream that has the least total stream inequality, medicine, is also where the largest underperformance is observed. Mullaitivu, the largest under-performing district in medicine is doing 22 percentiles less than expected (Figure 5). Most other districts in medicine are doing close to as expected.

Figure 5



Management is the only stream where there are more under-performing districts than over-performing ones (Figure 6).

Figure 6



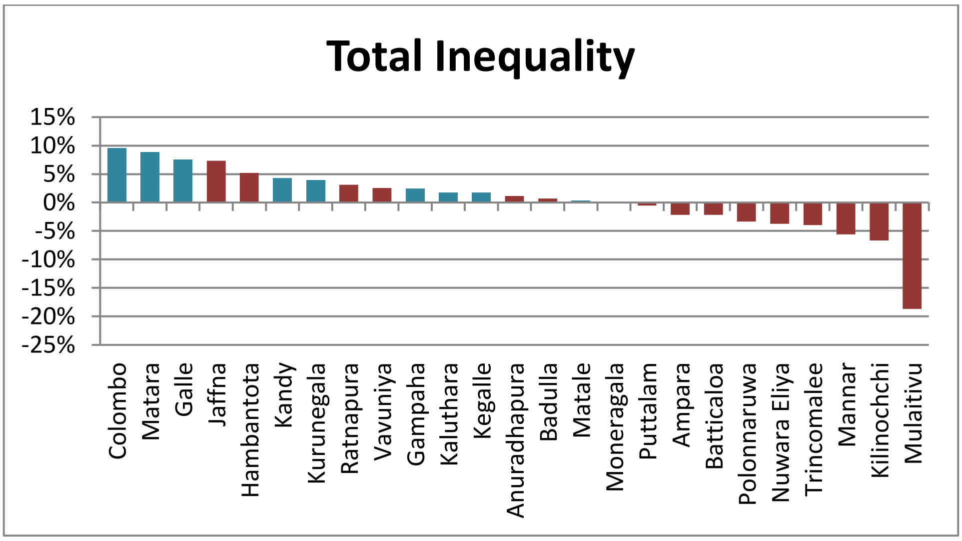
Between districts

Based on calculations for the 2010/2011 intake alone, there is a definite difference between the over and underperforming districts. This is because, the performance of each district does not change drastically across streams. The performance of districts in all streams can be classified into four groups: Consistently over performing, mostly over performing, mostly underperforming and consistently underperforming (Table 1). These categories are further proven by the total inequality (Figure 7), that is the mean of the inequality measure across streams for a given district.

Table 1 : District Performance (disadvantaged districts in red text)

Consistently Over Performing	Mostly Over Performing	Mostly Under Performing	Consistently Under Performing
Colombo	Jaffna	Ampara	Polonnaruwa
Galle	Vavuniya	Trincomalee	Kilinochchi
Matara	Anuradhapura	Batticaloa	Nuwaraeliya
Ratnapura	Badulla	Mannar	Mullaitivu
Gampaha	Matale		
Kurunegala	Puttalam		
Kalutara	Monaragala		
Kandy			
Kegalle			
Hambantota			

Figure 7



The disadvantaged status ascribed by the Ministry of Education mostly aligns with the worst performing districts. The inequality measure shows that Ratnapura and Hambantota, despite being classified as 'disadvantaged' by the Ministry of Education, are performing well. All 'mostly over-performing' districts, except Monaragala, are over-performing on all streams except management. This implies that these districts are over-performing on the hard sciences.

This observation brings us to explore the connection between resource allocation and performance. It is a commonly held notion that hard sciences require more resources (for lab equipment etc.) and consequently, under-performance in these streams is explained by the lack of resources. As such, resource allocation is the likely cause for under-performance in the hard sciences if there is a correlation between resources and performance in such streams. Table 2 lays out several indicators of resource allocation. Districts with higher proportions of teachers with post-secondary training are also the ones that are over-performing (Table 3). Teacher qualifications therefore have a close relationship with education performance. The second most suggestive measure for hard sciences is the proportion of national schools[10] which are general better funded. Therefore, for the hard sciences, better funding has a close relationship with education performance, combined with teacher qualifications. For the soft sciences, management in this instance, have a closer relationship with the congeniality of schools[11] in the district. Schools with higher rating on the congeniality index are deemed more desirable by teachers. For soft sciences therefore, the quality of teachers seems to be the sole indicator of education performance.

Table 2

	% of Schools with A'Level Science	% of National Schools	% of congenial and very congenial schools	% of teachers with post-secondary training	Total Inequality
Colombo	17%	9%	73%	49%	10%
Matara	11%	7%	45%	42%	9%
Galle	9%	6%	46%	44%	8%
Jaffna	6%	3%	32%	43%	7%
Hambantota	8%	5%	39%	40%	5%
Kandy	10%	5%	28%	46%	4%
Kurunegala	10%	3%	72%	45%	4%
Ratnapura	10%	1%	32%	46%	3%
Vavuniya	5%	2%	38%	40%	3%
Gampaha	5%	3%	50%	39%	2%
Kalutara	10%	4%	51%	43%	2%
Kegalle	3%	2%	7%	32%	2%
Anuradhapura	6%	4%	37%	39%	1%
Badulla	4%	1%	23%	35%	1%
Matale	6%	5%	30%	35%	0%
Monaragala	10%	3%	16%	38%	0%
Puttalam	6%	2%	41%	33%	-1%

[10] National schools are centrally governed and are better funded (UNDP, 2012)
[11] The congeniality index classification that the Ministry of Education developed in 2007 to depict the level of infrastructure and facilities of schools in a province - the lower the score the worse the infrastructure and facilities. It is often used in the process of teacher placements.

Ampara	7%	3%	23%	41%	-2%
Batticaloa	7%	2%	21%	32%	-2%
Polonnaruwa	6%	2%	17%	38%	-3%
Nuwaraeliya	6%	1%	12%	27%	-4%
Trincomalee	6%	3%	17%	24%	-4%
Mannar	7%	0%	2%	25%	-6%
Kilinochchi	8%	2%	15%	24%	-7%
Mullaitivu	6%	0%	0%	18%	-19%

Table 3

	% of Schools with A'Level Science	% of national schools	% of very congenial and congenial schools	% of teachers with post-secondary training
Engineering	0.380	.662*	.635*	.749*
Management	0.503	.673*	.757*	.877*
Medicine	0.393	.669*	.635*	.779*
Total Inequality	0.455	.721*	.726*	.861*

Significant at 0.01 level (2-tailed)

The overall indication is that education performance is compensated by resource allocation; in infrastructure for hard sciences and qualified teachers for soft sciences. The current total allocation of 60% of university placements distributed by districts therefore should be considered given the direct link between performance and resource allocation. If current affirmative action is designed to compensate for resource allocation, higher proportions of placements need to be allocated to district quotas.

6. Conclusion

In light of the sporadic nature in which affirmative action originated and evolved since 1970, it is evident that the rationale by which it exists today is unknown. In developing a new composite inequality measure of education performance, this paper has grappled with two aspects of the current affirmative action policy.

First is that certain re-evaluation is required in determining the disadvantaged districts as they are not necessarily giving advantage to the most under-performing districts. Specifically, as revealed by the inequality measure, Ratnapura and Hambantota are consistently over-performing districts that are classified as ‘disadvantaged districts’ by the Ministry. These two districts should either be removed from the disadvantaged district list of justified for being there regardless of their high performance. The inequality measure also allows developing further criteria for defining ‘disadvantaged districts’ and determining a new number of such districts based on their performance.

Second is the re-assessment of the break down for merit and district quota (40% and 60% currently). Since there is a significant correlation between resource allocation and inequality; resources of infrastructure for hard sciences and qualified teachers for soft sciences; it is evident that affirmative action is compensating for lack of resources in poorer performing districts. The implication then is that the 60% allocated by district quota is lower than what is required.

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