# ARE SOUTH AFRICAN PUBLIC UNIVERSITIES ECONOMICALLY EFFICIENT? REFLECTION AMIDST HIGHER EDUCATION CRISIS

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ABSTRACT

The question of free quality higher education has possessed the soul of the nation since the 'fee-free university education for the poor report' was withheld by the Minister of Higher Education and Training. The article asks: are South African universities economically efficient and if they are efficient how many *more* students would they fully fund internally to increase financial access to, and academic success in, the academy? Using stochastic frontier modelling, I find that public universities, on average, are 12.7 per cent cost inefficient. The deadweight loss is the equivalence of 79,231 potential undergraduates who were denied access to fully university-funded 3-year degrees between 2009 and 2013. Universities are ranked in terms of their inefficiency scores. Determinants of cost inefficiency are modelled at an exploratory level and their implications discussed. The free quality education issue needs a multidimensional solution, part of which, in addition to those proposed in the No-Fee Varsity report, is the reduction of deadweight losses in university cost outlays.

**Key words**: inefficiency, stochastic, deadweight, fee, South African universities
**JEL Codes:** I21, I22, I23, I28

## PROBLEMATISING UNIVERSITY ECONOMIC EFFICIENCY

Badat (2016, 1) argued that the disappointing pace of transformation in higher education made the '2015 protests ... one manifestation of the "organic crisis" of South African higher education, which necessitates *major* "*formative action*" on the part of the state and other key actors' (emphasis mine). The actions of the state and those of other stakeholders, in retrospect, seem to not have been 'formatively strategic enough to be regarded as a major' attempt to offer a permanent solution. Indeed, Badat (2016, 12) says that the October 2015 summit that was called by the DHET was 'largely silent on how precisely problems and challenges will be addressed and overcome'. Nor did researchers concentrate their minds on researching the economics of efficiency in higher education in all its dimensions including, as I endeavour to do here, the assessment of cost efficiency in the production and delivery of this 'quality' public good, higher education. Cloete (2016) is an exception. Cloete's (2016, not

paged) trend analysis of efficiency was a critique to the free higher education for all ideology, which he believed could make for another 'self-destructive south African policy'.

Setting aside the question of whether higher education should be free or not, research on efficiency, for example, might have identified sources of economic waste in how public resources are utilised in public universities. Cost savings based on eliminating deadweight loses (inefficiencies) would have released some resources for interim remedial actions at university level to meet the needs of the most disadvantaged students, while broader policy initiatives are being taken at the national level. The National Treasury (2016, 6–7) raised the issue of eliminating deadweight losses, arguing that

> The question is whether, and to what extent, the PSET system produces graduates *efficiently* .... A key indication of success is the extent to which enrolled students graduate and find gainful employment. Measured against this goal, indicators from South Africa's PSET sectors are demonstrating an *inefficient* post schooling system .... Options for consideration on how to address the estimated funding shortfall [for implementing the 2013 White Paper for post-school education and training] in the PSET system include ... *improving inefficiencies* (emphasis mine).

Efficiency is measured in terms of the signalling effectiveness of higher education in the labour market. The report of the Commission on Fee-Free University Education for the Poor acknowledges that the higher education system has 'to improve its internal inefficiencies' (DHET 2012, 10). The 1997 White Paper on the Transformation of Higher Education, section 1.12, similarly emphasises the principle of efficiency stating,

> An efficient system or institution is one which works well, *without unnecessary duplication or waste*, and within the *bounds of affordability* and sustainability. It does things correctly in terms of making *optimal use* of available means, (DHET 1997, 13, italics and underscore mine).

At the core of all this is how to produce higher quality education with the fewest resources possible. This is the question of economic efficiency. Generally economic efficiency can be defined as producing the highest possible output (technical efficiency) at the least possible cost (cost efficiency) and producing the right mix of outputs (allocative efficiency). The university exists in a world of economic reality governed by the fundamental problem of scarcity of means. Notions of 'waste', 'duplication', 'affordability' and 'optimality' suggest the relevance of analysing economic efficiency. Consider Cape Peninsula University of Technology's (CPUT's) argument against duplication of laboratory facilities:

> Where possible, *consolidation of resources* should be a guiding principle to promote efficacy and *efficiency* amongst higher education. In the Western Cape for example, consideration should be give to whether all four public universities require separate chemistry laboratories or whether institutions could *partner and share* facilities (Nevhutalu 2016, not paged, emphasis mine).

The overarching realisation here is that historically disadvantaged institutions are under-resourced in terms of physical capital that has to be combined with intellectual capital to produce strategic outputs such as graduates and research papers. The sharing of resources increases overall systemic efficiency because of human capital externalities that emerge from sharing fundamental research resources such as laboratories and from productive institutional interaction. Times have been fast changing for the South African higher education sector, ranging from the age of massification driven by governmental funding regimes to potentially hastened massification through the ongoing struggle for free quality education. Universities need to attend to efficiency issues, while simultaneously lobbying government for scaling up funding levels.

The efficiency question has occupied many scholars who study the economics of higher education around the world (e.g. Agasisti and Esparrells 2007; Agasisti and Haelermans 2016; Agasisti and Johnes 2015; Daghbashyan 2011; Izadi, Johnes, Oskrochi and Crouchley 2002; Leshukov, Platonova and Semyonov 2016; Pietrzak, Pietrzak and Baran 2016; St. Aubyn, Pina, Garcia and Pais 2009; Veiderpass and McKelvey 2016; Wolszczak-Derlacz 2014). Motives for efficiency analysis are wide ranging in literature, not least to study internationalisation of education and the resulting competition for students and funding, public accountability of universities to taxpayers and fiscal austerity due to the global economic crisis (e.g. Leshukov et al. 2016; Pietrzak et al. 2016; Wolszczak-Derlacz 2014). As Cunha and Rocha (2012, 1) point out, under conditions of 'financial stringency ... accountability and efficiency questions gain an additional relevance in the higher education sector'.

The article asks questions and provides tentative findings to stimulate debate and further interrogation of efficiency factors in the South African higher education sector. How efficiently does the South African higher education sector operate? Are the resources allocated by taxpayers to the higher education sector utilised efficiently? Do higher education institutions operate at a homogeneous level of efficiency? What determines the economic efficiency of public universities in South Africa? To the best of my knowledge, only Taylor (2000) and Taylor and Harris (2002) researched on South African higher education efficiency using a non-parametric approach (the Data Envelopment Analysis (DEA)) and trend analysis. I approach the same question from a parametric standpoint, within a panel regression modelling context, and model some of the *potential* determinants of (in)efficiency. The article is organised as follows: it sketches the literature, then presents the methods and follows it up with estimation results and discussion, and the conclusion.

## LITERATURE SKETCH

In this section, I skim through a few recent works, which have examined efficiency in higher education across the world. Hypothesising that competition in the higher education sector engenders economic efficiency, Leshukov et al. (2016) analysed the regionalised system of higher education in Russia using the DEA approach and found an average efficiency of 72 per cent. They found a positive relationship between competition and efficiency.

St. Aubyn, Pina, Garcia and Pais (2009) compared the efficiency and effectiveness of European economy higher education institutions for 26 countries plus Japan and the USA. Using both the DEA and stochastic frontier model (SFM), they found that average cost efficiency in the utilisation of physical inputs (academic staff, students enrolled) was 71 per cent, but that it was a lot lower in the utilisation of financial resources, being 60 per cent. The SFM, on the other hand, revealed that higher education institutions in the 26 European Union economies were 35 per cent cost efficient on average. Staffing policies and quality of enrolled students were significant predictors of cost efficiency. Veiderpass and McKelvey (2016) used non-parametric methods to evaluate efficiency in 944 higher education institutions in 17 European countries. They found minimum efficiency to be 27 per cent and maximum efficiency to be 82 per cent in their sample. Overall, efficiency estimates are sensitive to the type of model one uses, sample size under consideration and assumptions about the production technology.

Pietrzak et al. (2016) analysed technical efficiency in Polish universities, using the DEA approach, with the faculty as a unit of analysis. Thirty-three faculties of social science were analysed and an average efficiency of 72 per cent was found (a minimum of 41%).

Cunha and Rocha (2012) evaluated economic efficiency in public polytechnics, public universities and faculties of the University of Porto in Portugal using the DEA approach. They found that these entities had an average input efficiency level of 83 per cent.

Izadi et al. (2002) evaluated 99 British higher education institutions for technical efficiency. They found the least efficient institution to be 37 per cent technically efficient and the most efficient institution being 99 per cent technically efficient. They found that there were increasing returns to scale for all programmes offered by the institutions in undergraduate and postgraduate studies. Johnes and Johnes (2009) evaluated 106 British institutions of higher education in a multiproduct cost modelling framework and found that higher education institutions, on average, were 75 per cent cost efficient, with universities in larger metropolitan cities being 92 per cent (the top five being 94%). Again, estimates vary

with study but they are close.

The next section presents the stochastic frontier model that was used to evaluate efficiency in South African public universities. Due to the involving algebra in the formulation of the models, I present the basic formulation and focus on discussing the results.

## METHODS AND DATA

The SFM has three components: a deterministic cost function common to all public universities (theoretical minimum), a university specific component, which is decomposed into a random shock $\{v_{it}\}$ and a persistence term or inefficiency term $\{\mu_{it}\}$. The inefficiency term is a non-negative term, with a non-zero mean and constant variance. The efficiency of all universities is measured relative to that theoretical minimum (cost frontier). SFM can account for random shocks, time variance of (in)efficiency, university heterogeneity and not make the mistake of attributing heterogeneity and random shocks to inefficiency of a university (Greene 2005). The true cost function is unknown. I use the translog cost functional form because of its flexibility and generality (Greene 2005).

I follow Greene's (2005) specification of a stochastic frontier model. The SFM, within a panel data context, is estimated using the true random effects model. The adjective 'true' is used to convey the sense that this model accommodates incidental parameters by allowing the model parameters to be random (Greene 2005). This means that they have to be estimated through simulation methods.

If one thinks of a university as a multi-output organisation (publications, postgraduate students and teaching outputs) then a cost function can be specified as follows:

$$Log(real\ expenditure_{it}) = \alpha_0 + \alpha_1 \log(publications_{it}) + \alpha_2 \log(PhD + masters\ students_{it)} + \alpha_3 \log(graduates_{it} + \alpha_{11}\frac{1}{2}log^2(publications_{it}) + \alpha_{22}\frac{1}{2}log^2(PhD + Masters\ students_{it}) + \alpha_{33}\frac{1}{2}log^2(graduates_{it}) + \alpha_{12}log(publications_{it}) * \log(PhD + Masters\ students_{it}) + \alpha_{13}\log(publications_{it}) * \log(graduates_{it}) + \alpha_{23}\log(PhD + Masters\ students_{it}) * \log(graduates_{it}) + v_{it} + \mu_{it} \quad (1)$$

Equation (1) is a translog cost function, with the $\alpha's$ as the coefficients to be estimated. The error term is made up of two components: $v_{it}$ which follows a normal distribution with a zero mean and a constant variance $\{\sigma_v^2\}$. It measures random shocks to the cost outlays. The other error term $\{\mu_{it}\}$ is a half-normally distributed variable with a non-zero mean and a variance

$\{\sigma_\mu^2\}$. It is something that persists in the production technology of a university. It measures path dependence or institutional lock-in. $v_{it}$ and $\mu_{it}$ are assumed to be uncorrelated between themselves and with explanatory variables.

To avoid burdening my reader, I state here the inefficiency equation, stripped of all the algebra, as follows:

$$\mu_{it} = g(\delta_i Z_{it}) + \varepsilon_{it} \quad (2)$$

Equation (2) states that inefficiency is explained by some other exogenous and endogenous factors $\{Z_{it}\}$ that cannot directly be entered into the cost function (Equation 1) because they are neither inputs nor outputs, but are significant factors (Greene 2005) e.g. the levels of racial and gender transformation in a university are not inputs or outputs, but they have a bearing on the evolution of cost (in)efficiencies. $\varepsilon_{it}$ is a random error term.

All the data used in the estimation process were obtained from the Centre for Higher Education Trust (2016). The data runs from 2009 to 2013. The data covered 23 universities, but I dropped Mangosuthu University of Technology (MUT) because it had zero outputs at PhD and masters levels for the 5 years.[1] I dropped one year for Fort Hare University because in 2009 it was recorded as having had zero staff costs. The sample became 109, thus I had an unbalanced panel.

In the stochastic cost frontier model, I estimated the log of real expenditure on the logs of the three outputs: log of publications; log of the number of graduates net of PhD and masters by research graduates and the log of the sum of masters and PhD by research graduates. In the inefficiency model the covariates were:

- staff expenses as a proportion of total expenditure, in percentage form;
- staff experience measured as the number of professors plus associate professors divided by the number of non-professorial staff; in percentage form;
- staff quality measured in a *restrictive sense* as the number of staff with PhDs divided by the number of those who have any other qualification below a PhD, in percentage form;
- gender transformation in the student community measured as the number female students divided by the number of male students, in percentage form;
- gender transformation in the lectureship community measured as the number of female lecturers divided by the number of male lecturers, in percentage form;
- racial transformation in the student community measured as the number of non-white

(black, coloured and Asian) students divided by the number of white students, in percentage form;

- racial transformation in the lectureship community measured as the percentage of non-white (black, coloured and Asian) academics divided by number of white academics, in percentage form;
- Fiscal dependence measured as proportion of total university income coming from government grants and other government financial support measures; and
- Percentage of income from student fees
- Percentage of income from private sources
- Log of the student-lecturer ratio
- Log of number of graduates to number of enrolled students (headcount).

## RESULTS AND ANALYSIS

Table 1 presents trends in enrolments, graduation, income and expenditures. Five stylised facts seem to emerge.

**Table 1:** Compounded annual growth rates of enrolment, graduation, income and expenditure 2009–2013

| University | Weighted graduates | Enrolment full time equivalent students | Total academics | Student-lecturer ratio | Real income | Real expenditure |
|---|---|---|---|---|---|---|
| **UNISA** | 11% | 8% | 10% | –2% | 11% | 9% |
| **UZ** | 11% | 3% | 2% | 0% | 8% | 4% |
| **UL** | 8% | 7% | 2% | 5% | 10% | 12% |
| **CUT** | 7% | 1% | 2% | –2% | 8% | 10% |
| **WSU** | 7% | –3% | –2% | –1% | 4% | –2% |
| **UFS** | 6% | 3% | 0% | 3% | 6% | 6% |
| **WITS** | 6% | 2% | 4% | –2% | 7% | 6% |
| **NMMU** | 6% | 1% | 1% | 1% | 8% | 11% |
| **VUT** | 6% | –1% | 5% | –6% | 10% | 13% |
| **UWC** | 5% | 6% | 2% | 3% | 9% | 11% |
| **NWU** | 5% | 4% | 9% | –4% | 10% | 10% |
| **UKZN** | 5% | 3% | 1% | 2% | 6% | 5% |
| **UFH** | 4% | 3% | 0% | 3% | 3% | 9% |
| **RU** | 4% | 1% | 4% | –3% | 8% | 9% |
| **UJ** | 4% | –1% | –9% | 9% | 9% | 8% |
| **DUT** | 3% | 2% | 2% | 0% | 5% | 4% |
| **UCT** | 3% | 1% | 7% | –5% | 6% | 8% |
| **UP** | 3% | 1% | 1% | 0% | 3% | 7% |
| **CPUT** | 2% | 2% | 3% | –1% | 8% | 8% |
| **SU** | 2% | 1% | 2% | –1% | 8% | 8% |
| **TUT** | 2% | –1% | 2% | –3% | 6% | 7% |
| **UNIVEN** | –4% | 0% | 5% | –5% | 11% | 11% |

Source: Calculated based on Centre for Higher Education Trust dataset

First, real expenditures have grown at the same rate as real income in the 5-year period,

suggesting that many universities are not accumulating reserves, which has implications for financial sustainability of South African universities. Second, real expenditures have grown faster than the growth rate of student enrolments, in full time equivalent terms. Third, real income has also grown at a higher rate than full time equivalent student numbers have. Fourth, graduation rates have grown at a higher rate than enrolment rates for full time equivalent students. Probably, this suggests that the rate at which cultural transformation of students into graduates is steadily increasing. Fifth, a stronger growth in the number of academics has resulted in a decrease in student-lecturer ratios in general.

Table 2 summarises the compounded annual growth rates of inputs and changes in their quality as well as the growth rate of research outputs. Generally, three facts seem evident. First, the growth rate of the number of academics (the production input) has been outstripped several tens of times by the growth rate of research output (masters/PhD by research graduates and publications combined). This suggests that the research productivity of universities has grown at phenomenal rates in the 5 year period. The productivity in terms of specific research outputs varies considerably, with others doing a lot better in publications. Interesting patterns can be explored but not here for economy of space. But to give one example, UJ has experienced a negative growth rate in its staffing but a 14 per cent growth rate in publications. In reality, therefore, the growth rate in publications is 14%-(-9%) = 23%, which is very high. All universities become extraordinary performers when postgraduate research students are brought into the picture.

**Table 2:** Compounded annual growth rate of staff and research outputs 2009–2013

| | Staff experience | | Staff 'quality' | | Research outputs | | | Input |
|---|---|---|---|---|---|---|---|---|
| **University** | **Not professors** | **Professors** | **PhD holders** | **Not PhD holders** | **Masters students** | **PhD students** | **Publications** | **Academics** |
| **UL** | 6% | 2% | –2% | 11% | 10% | –4% | 25% | 2% |
| **DUT** | 0% | –100% | 11% | –1% | 13% | 29% | 21% | 2% |
| **NWU** | 11% | 5% | 7% | 9% | 7% | 6% | 21% | 9% |
| **UNIVEN** | 5% | 0% | 3% | 6% | 14% | –6% | 21% | 5% |
| **VUT** | 5% | | 0% | 7% | 16% | 15% | 18% | 5% |
| **TUT** | 4% | 3% | 7% | 4% | 3% | 5% | 18% | 2% |
| **CUT** | 0% | 14% | 7% | 4% | 4% | 25% | 14% | 2% |
| **UJ** | 7% | 3% | 17% | –5% | 9% | 2% | 14% | –9% |
| **UFH** | –3% | 2% | 7% | –7% | 19% | –2% | 11% | 0% |
| **UNISA** | 7% | 3% | 5% | 5% | 28% | 23% | 10% | 10% |
| **NMMU** | 4% | 0% | 5% | –2% | 11% | 14% | 9% | 1% |
| **UWC** | 4% | 1% | 4% | 0% | 10% | 19% | 8% | 2% |
| **UKZN** | 1% | –4% | 4% | –11% | 7% | 5% | 8% | 1% |
| **WITS** | 3% | 3% | 4% | –2% | 6% | 12% | 7% | 4% |
| **SU** | 8% | 3% | 5% | 1% | 9% | 10% | 7% | 2% |
| **UP** | –9% | –5% | 2% | –19% | 9% | 4% | 6% | 1% |
| **RU** | 7% | –1% | 4% | –4% | 12% | 17% | 5% | 4% |

| | Staff experience | | Staff 'quality' | | Research outputs | | | Input |
|---|---|---|---|---|---|---|---|---|
| **University** | **Not professors** | **Professors** | **PhD holders** | **Not PhD holders** | **Masters students** | **PhD students** | **Publications** | **Academics** |
| **UFS** | 10% | 1% | 4% | 7% | 2% | 3% | 5% | 0% |
| **UCT** | 5% | 3% | 6% | –9% | 14% | 3% | 5% | 7% |
| **CPUT** | 1% | 9% | 8% | 0% | 3% | 18% | 3% | 3% |
| **UZ** | 5% | 2% | 3% | 8% | –3% | –8% | 4% | 2% |
| **WSU** | –2% | –5% | 4% | –3% | 45% | 25% | –1% | –2% |

Source: Calculated based on Centre for Higher Education Trust dataset

Secondly, with the exception of a few shocks like DUT, the growth rate in the number of professors is encouraging, suggesting that experience in knowledge production is being accumulated significantly (Table 2). Thirdly, there has been a significant increase in the number of academic staff acquiring PhDs and this is reflected in the high negative growth rates in the numbers of academic staff that do not hold PhDs. It can be said that universities have been investing in the quality of their staff to enhance productivity.

## COST FRONTIER ESTIMATION RESULTS

Table 3 summarises the results of the stochastic cost frontier estimation, estimated using the true random effects model. The results are based on a truncation of the translog model in equation (1) such that it becomes a quadratic formulation of the cost function. The truncation was necessary because with the cross products the log simulated likelihood did not converge.

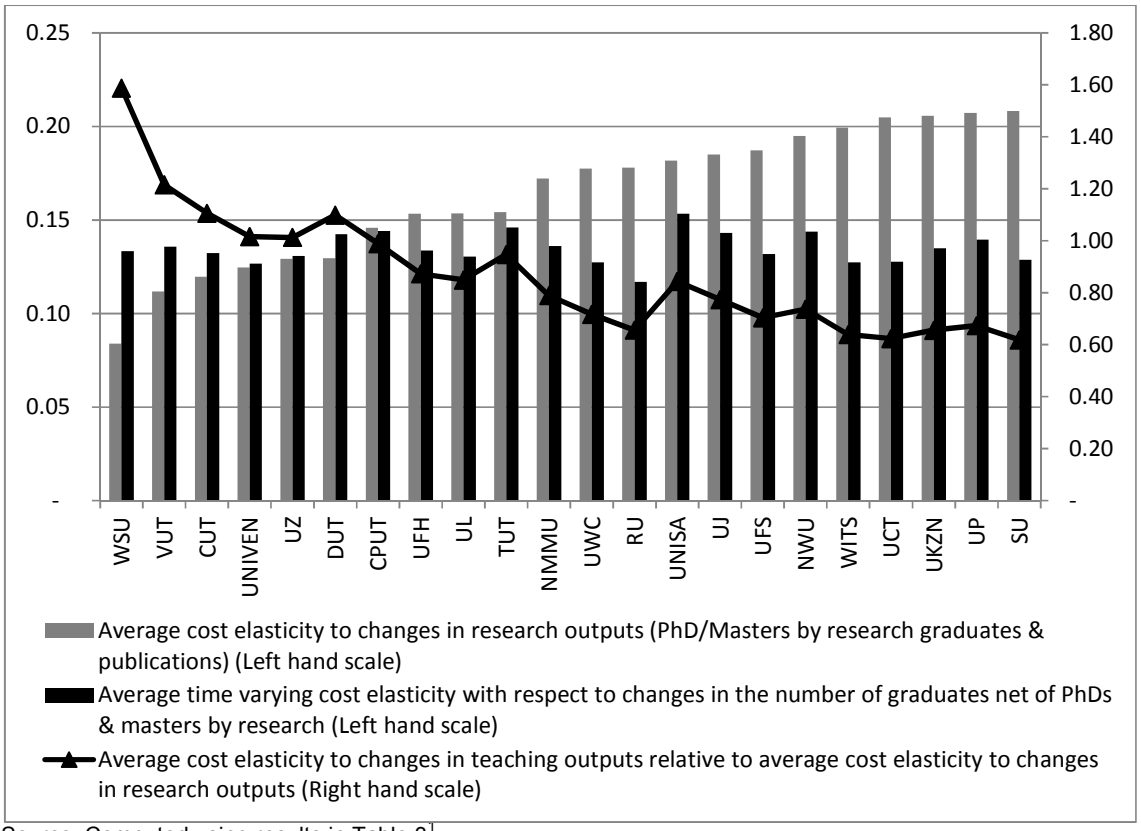
First, all the estimated coefficients carry theoretically correct signs with the exception of the coefficient for the log of PhD plus masters by research graduates. This might seem contradictory to theoretical expectations, but the hidden meaning is that many PhD and masters students provide teaching services of one form or another, which naturally reduce the university's staff costs. Daghbashyan (2011) also found a similar result in the Swedish higher education sector. Universities might actually use these postgraduate students in a deliberate attempt to reduce costs of producing education, especially in an underfunded higher education context of South Africa – a phenomenon that may lead to yellow dog contracts or casualisation of labour. Figure 1 gives a pictorial interpretation of results in Table 3.

**Table 3:** Stochastic frontier estimates based on true random effects (TRE)

| **Log total expenditure** | **True random effects** |
|---|---|
| Log (publications) | 0.298**<br>(0.125) |
| Log (masters & PhD by research students) | –0.514***<br>(0.065) |
| Log (graduates net of PhD & masters) | 1.645***<br>(0.566) |
| ½ $Log^2$ (publications) | 0.004<br>(0.025) |
| ½ $Log^2$(masters & PhD research students) | 0.131***<br>(0.018) |

| Log total expenditure | True random effects |
|---|---|
| ½ Log$^2$(graduates net of PhD & masters) | –0.144***<br>(0.063) |
| Constant | 11.190***<br>(2.488) |
| U Sigma: Constant | –4.274***<br>(0.320) |
| V. Sigma: Constant | –7.349***<br>(1.440) |
| Theta: Constant | 0.169***<br>(0.017) |
| E(Sigma_U) | 0.118***<br>(0.019) |
| Sigma_V | 0.025<br>(0.018) |
| Lamda | 4.652***<br>(0.035) |
| Number of observations (NxT=22x5) less 1 | 109 |
| Log simulated likelihood (TRE) | 92.450 |
| Wald Chi$^2$(3) | 1598.10*** |

[a] ***p<0.01; **p<0.05; *p<0.1; [b] The numbers in parenthesis are standard errors




Source: Computed using results in Table 3[1]

1. The average time-varying elasticities were computed as follows: $\frac{\partial(\log of\ real\ expenditure)}{\partial(\log of\ output_i)} * \frac{\frac{1}{2}(2013 \log of\ output + 2009 \log of\ output)}{\frac{1}{2}(2013 \log of\ expenditure + 2009 \log of\ expenditure)}$, where $i$ denotes each of the three outputs.

**Figure 1:** Average cost elasticity to changes in research outputs and to changes in teaching outputs 2009–2013

Figure 1 depicts average time varying elasticities of university costs to changes in research

outputs (publications and PhD/masters graduates) and teaching outputs. A 1 per cent increase in the throughput rate for all taught programmes, over the five-year period, increased cost of producing taught graduates by between 0.12 per cent and 0.15 per cent. A 1 per cent increase in the number of research outputs, in the five-year period, increased the cost of producing research outputs by between 0.08 per cent and 0.21 per cent. Although costs are relatively less responsive to changes in research and teaching outputs, two stylised facts seem evident. Firstly, historically disadvantaged universities (HDUs) and universities of technology (UTs), have higher average time varying cost elasticities to changes in teaching outputs than average time varying cost elasticities to changes in research outputs. Exceptions are UFH, UL, CPUT and TUT. Secondly, comprehensive and traditional universities have higher average time varying cost elasticities to changes in research outputs relative to average time varying cost elasticities to changes in teaching outputs. Two explanations seem plausible. First, comprehensive and traditional universities experience scale effects (hence economies of scale) in producing teaching outputs because of the teaching cost reducing effects of at least one of the research outputs, PhD/masters by research students. Izadi et al. (2002) found scale effects to be an important factor in British higher education institutions. I argue that this might be because PhD and masters students provide cheap labour to such universities while they are studying – an advantage may not necessarily be enjoyed by some UTs and HDUs. Thus, universities that are more research intensive than teaching intensive tend to have relatively low cost elasticities of producing an additional taught graduate (see right hand scale of Figure 1) e.g. all universities to the right of NMMU in Figure 1, using NMMU as the benchmark. Notice, universities to the left of NMMU are largely HDUs or UTs. There are positive externalities on university teaching cost arising from enrolling more PhDs and masters by research students in an underfunded higher education sector. In the long run, this should be a dominant strategy of South African Universities.

The second explanation is that there are research funding and infrastructure inequalities, largely explained by apartheid funding legacies and the subsequent advantage of traditional universities to attract other non-governmental research funding streams. Comprehensive and traditional universities have larger research funding budgets, which logically means that they spend more on research and, probably, target high impact factor journals and expose their staff and PhD/masters students to many international conferences. It is likely that such universities spend more on research incentive systems. Given the relative inelasticity of their cost structures to changes in research outputs, it is in their interest to spend more on research given that the social returns (positive externalities) to research outputs are far larger for both

the university and society at large. The fact that UTs and HDUs have relatively low average time varying cost elasticities to changes in research output, might also suggest that they are underutilising their research productive capacities. Such inference logically follows from their tendency to be teaching intensive as Figure 1 depicts. Allocative inefficiency (failing to produce the right mix of outputs) is the problem.

## RANKING UNIVERSITIES BY COST INEFFICIENCY SCORES

Table 4 ranks the universities by ascending order of mean cost inefficiency. Table 4 also extends the argument by asking: how many students could have been internally fully funded by each university for a 3-year degree had it been operating on the cost frontier? I took an average value of the full cost of a year of study to be R100, 000, which lies between actual rates varying between R80, 000 and R120, 000 in big universities, including accommodation, meals and books.

**Table 4:** Cost inefficiency rankings of South African public universities based on true random effects model, ranked by mean inefficiency for 2009 to 2013

| University | Median cost inefficiency score | Mean cost inefficiency (1) | Std. dev | Rank | Taylor and Harris DEA rank | Deadweight loss 2009–2013 = (1) x real expenditure | No. of students that could have been 3-year degrees fully |
|---|---|---|---|---|---|---|---|
| UJ | 7.77 | 8.18 | 3.54 | 1 | 1 | 905,075,859.90 | 3,016.92 |
| WITS | 8.94 | 8.63 | 5 | 2 | | 1,528,923,181.41 | 5,096.41 |
| TUT | 9.59 | 8.75 | 4.15 | 3 | | 889,265,590.30 | 2,964.22 |
| UCT | 8.20 | 9.23 | 5.32 | 4 | 7 | 1,357,006,126.34 | 4,523.35 |
| UFS | 9.15 | 9.40 | 4.13 | 5 | 8 | 671,233,241.80 | 2,237.44 |
| UNISA | 11.15 | 9.47 | 4.2 | 7 | 6 | 1,776,451,226.98 | 5,921.50 |
| SU | 9.25 | 9.51 | 4.05 | 6 | | 1,303,625,765.79 | 4,345.42 |
| UP | 9.21 | 9.61 | 4.75 | 8 | 5 | 1,740,671,297.13 | 5,802.24 |
| RU | 9.13 | 10.63 | 6.38 | 9 | 2 | 374,383,608.66 | 1,247.95 |
| UFH | 8.63 | 10.99 | 7.84 | 10 | | 335,387,417.41 | 1,117.96 |
| NMMU | 8.87 | 11.23 | 6.92 | 11 | 9 | 663,648,083.25 | 2,212.16 |
| UL | 11.40 | 11.87 | 7.22 | 12 | | 696,275,954.95 | 2,320.92 |
| CUT | 9.68 | 11.98 | 7.72 | 13 | | 257,289,035.12 | 857.63 |
| UKZN | 13.86 | 12.26 | 6.65 | 14 | 4 | 1,778,291,715.06 | 5,927.64 |
| WSU | 7.76 | 13.06 | 11.68 | 15 | | 721,741,915.78 | 2,405.81 |
| UZ | 17.41 | 14.21 | 9.32 | 16 | 10 | 383,325,923.00 | 1,277.75 |
| CPUT | 17.47 | 14.63 | 11.42 | 17 | | 992,214,434.72 | 3,307.38 |
| DUT | 17.13 | 14.76 | 9.92 | 18 | | 682,939,856.93 | 2,276.47 |
| UWC | 14.70 | 15.26 | 10.76 | 20 | | 790,060,760.87 | 2,633.54 |
| VUT | 11.95 | 15.63 | 14.42 | 19 | | 495,394,776.54 | 1,651.32 |
| NWU | 17.40 | 16.50 | 7.14 | 21 | 3 | 1,753,201,850.67 | 5,844.01 |
| UNIVEN | 9.37 | 33.12 | 42.84 | 22 | | 772,741,658.87 | 2,575.81 |
| All | 9.52 | 12.69 | 11.9 | | | 23,769,214,742.97 | 79,230.72 |

*Source: Author's analysis*

[a] The Taylor and Harris study happened before mergers of various higher education institutions had taken place.

[b] I have used R100,000 as an illustrative value, which is far above the NSFAS funding levels.

[c] For illustration purposes only, I assume that fees did not change between 2009 and 2013.

[d] These results are suggestive, the truth lies somewhere in their neighbourhood.

The level of inefficiency seems to vary considerably among the 22 universities with the least inefficient, University of Johannesburg (UJ), having a mean inefficiency score of 8.2 per cent. Holding its output structure constant at its current level, UJ could produce that very output level at 8.2 per cent less cost. Thus, 8.2 per cent of its real expenditure is equivalent to R905 million for the 5 year period and represents resources that could have been used to produce 3,017 more graduates. The most cost inefficient in this group was University of Venda (UNIVEN) with an average cost inefficiency of 33.1 per cent, equivalent to R773 million or 2,576 more graduates. UNIVEN could produce its current output at 33.1 per cent less cost. In terms of additional potential graduates that could have been produced had the university been operating on the cost frontier, CUT had the smallest deadweight loss (858 graduates) and UKZN had the largest (5,928 graduates). The total deadweight loss was R23.8 billion, which is equivalent to 79,231 more graduates that could have been internally funded by the universities. Consider this review in the fee-free university education for the poor report:

> In 2007, some 98 000 youth aged 18 to 24 possessed school-leaving certificates with university exemption, but were nevertheless unable to either get into university ... (DHET 2012, ix)

Some of these 98,000 youth might be among the 79,231 indicated by the results. Although my analysis here is very crude by all standards, it reveals the role of economic analysis of efficiency in public universities.

What Table 4 suggests is that with a deadweight loss of 12.7 per cent on average, a South Africa university is spending 112.7 per cent to produce the same output as it could have had it been on the frontier. These estimates are similar to the cost inefficiencies implied by the reviewed literature in this article which ranged from 0.1 per cent to 28 per cent (see Agasisti and Esparrells 2007; Cunha and Rocha 2012; Izadi et al. 2002; Johnes and Johnes 2009; St Aubyn et al. 2009; Veiderpass and McKelvey 2016).

A typical counterargument to the present findings is that introducing issues of cost efficiency in the provision of higher education is tantamount to corporatisation and commoditisation of higher education because 'it is this kind of thinking that has led, in some institutions, to the *deliberate reduction in contact time as a means of reducing costs*' (DHET 2012, 36, emphasis mine). While this counterargument is true obviously, it deliberately ignores that the concept of efficiency is not a corporate conceptual category by origin. Any social player, no matter for what reason they produce, still operates within the fundamental

problem of scarcity of means – they do not have unlimited resources – and, as such, must be efficient in the discharge of their functions with the limited resources they have.

## DETERMINANTS OF COST INEFFICIENCY

Table 5 reveals that a 1 per cent point increase in income from government, in income from students and in income from private sources as a proportion of total income leads to an increase in inefficiency by 0.02 per cent points, other things being equal. Economically, these are small effects. Though it is hard to understand why income from government causes inefficiency to increase, literature has established such effects e.g. in a study of 500 US and European universities Wolszczak-Derlacz (2014, not paged) concludes that

> Increased government funding is associated with an increase in inefficiency only in the case of European units, while the share of funds from tuition fees decreases the efficiency of American public institutions but relates to efficiency improvements in European universities.

The results are mixed, implying that efficiency is not necessarily universally determined by income sources in all contexts. From economic theory, it is likely that the utilisation of government funding is less systematically monitored and evaluated, which leads to the problem of university management pursuing their self-interests in the form of seeking larger budget sizes that are evidently driven by over-enrolment, over-staffing and personal benefits. Principal-agent problems, moral hazard and the too-big-to-not-be-funded-or-bailed-by-government effect can explain this puzzling finding. Consider, Cloete's (2016, 7) critique to the inefficiency-enhancing features inherent in government's funding formula stating that the 'South African undergraduate system is too expensive, mainly due to government underfunding and inefficiencies at the undergraduate level' and somehow, akin to opportunistic behaviour, 'universities have been able to maintain this unsustainable system due to fee increases and *a perverse incentive subsidy system*' (emphasis mine). Thus, it cannot be ruled out that self-interests of university top management explain the inefficiency engendering effects of government funding. To get more funding, enrol more students, especially those that are underprepared.

The reason why student fees increase inefficiency principally works through high student debt default rates. Private sources of income, like government income and apart from volatility, suffer from the principal agent-problem. The alumni, for example, may have no control over how university management decides to spend alumni funds. This suggests that university governance structures require other stakeholder voices to stem moral hazard.

**Table 5:** Cost inefficiency model

| Cost inefficiency | True random effects |
|---|---|
| % of female to male students | 0.0003<br>(0.0002) |
| % of female to male lecturers | 0.0009*<br>(0.0005) |
| % of non-white to white students | –0.00002<br>(0.00002) |
| % of non-white to white lecturers | 0.0001***<br>(0.00005) |
| Log (graduates/enrolment headcount) | 0.0599*<br>(0.0330) |
| Log (student/lecturer ratio) | 0.0474**<br>(0.0201) |
| Staff experience (% of professors to non-professors) | –0.0016*<br>(0.0009) |
| Staff quality (% of PhD holders to non-PhD holders | 0.0009***<br>(0.0003) |
| Staff expenses % of total expenditure | 0.00002<br>(0.00008) |
| % of income from government funding | 0.0236**<br>(0.0115) |
| % of income from student fees | 0.0232**<br>(0.0114) |
| % of income from private sources | 0.0244**<br>(0.0144) |
| Constant | –2.4578**<br>(1.1538) |
| N | 109 |
| Wald $Chi^2(12)$ | 29.92*** |

[a] ***p<0.01; **p<0.05; *p<0.1; [b] The numbers in parenthesis are standard errors.

As academic staff experience increases by 1 per cent point, inefficiency decreases by 0.2 per cent points (Table 5). Other studies have established this effect although they interpreted this ratio as an indicator of staff quality (e.g. Daghbashyan 2011). In this study I distinguish experience (proportion of professors to non-professors, which reflects experience in knowledge production) from staff quality (percentage of doctorate degree holders as a proportion of non-doctorate holders, a disputable measure of course). These variables have considerable overlap. I find that as the proportion of doctorate holders increases by a 1 per cent point, cost inefficiency increases by 0.09 per cent points (Table 5). It is hard to explain this coefficient although one can surmise that holding a doctorate is an indicator of quality *at face value*, but not truly an accurate one. It is very possible that some academic staff holding masters degrees do a lot better in everything than a doctorate holders. Such individuals might have written books, written lots of papers and have acquired significant intellectual currency through learning-by-doing. If that is the case, on average, then it is not surprising that a university will be highly paying the less productive. The National Treasury (2016) identifies increased number of lecturers with PhDs as a significant driver of university costs. As much as the cost is about a premium paid for a higher qualification, it is possible, too, that the premium might not be reflecting in research and teaching productivity. In other faculties, one can be a professor without having earned a doctoral qualification first. In such instances, my

explanation and distinction of the two might make a lot of sense.

A 1 per cent increase in the student-lecturer ratio (massification) leads to 4.7 per cent points increase in inefficiency, while a 1 per cent increase in the ratio of graduates to headcount enrolment leads to a 6 per cent points increase in inefficiency. The former result confirms the trend established in Table 1. The fee-free university education for the poor report argues that lower student-lecturer ratios are very critical for academic success in the university, given the underpreparedness of many newcomers to university (DHET 2012). The latter result is puzzling because theoretically an increase in the rate of cultural transformation of students into graduates must reduce cost inefficiency. Several functional specifications did not change this result. The only likely explanation is that given governmental funding conditionalities of massifying higher education, it is likely that universities have had to increase throughput rates at huge extra costs such as massive academic development programmes and other support measures. The problem here would lie in the over-recruitment of underprepared students, who also attract more funding from government (perverse subsidy system), yet imposing larger costs of cultural transformation.

As the opening comments to this reflective note suggested, scholars like Badat (2016) and Cloete (2016) expressed dissatisfaction with the pace of transformation in higher education. The positive signs on gender transformation in the student community and gender and racial transformation in the lectureship community seem to be contrary to theoretical expectations. The normative argument that is put forward is that gender and racial transformation lead to improved efficiency due to the productivity enhancing role of gender and racial diversity.

Upon reflection, the signs of the coefficients of gender and racial transformation are telling a story of social rigidities in higher education. Issues of transformation are matters of equity. Since equity has to be achieved through legislation/policy both in the student education market and in the lectureship labour market, it is likely that universities, by law, will be forced to employ less productive labour and enrol more underprepared students to meet transformation threshold requirements. Economic theory suggests that if the marginal productivity (additional research and teaching output) of an additional labour hour or worker is less than average productivity, the marginal (additional) cost of employing that extra unit exceeds the marginal (additional) benefit it brings to the organisation. Since, in most cases, those who enter through affirmative action are likely to have failed to open the door competitively through their qualifications, it is likely that they might be less academically productive. In this case, it is non-white female and male lecturers (although not all of them

enter by law) since the legal remedial interventions precisely focus on gender transformation twinned with staff de-whitening. While there is no discernible data on how people got into the academic jobs they hold, it is possible that not all white academics entered by merit just as not all blacks entered by merit. My discussion is precisely premised on the empirical patterns revealed by the data in existence.

The positive sign on racial transformation for the lectureship community implies that as the lectureship community becomes more de-whitened, cost inefficiency increases by a small effect of 0.01 per cent points (Table 5). It seems that white academic staff possesses significant intellectual capital relative to non-white academics, especially given the white privileging historical divide in the entire education system. In that sense, the proportion of non-white academic staff members that enters through employment equity legislation (there is no hard data on how many enter through affirmative action) might not necessarily be of the same academic productivity as the white academic staff members. In that sense the marginal productivity (number of additional publications, research students successfully supervised to graduation and taught graduates) of academic staff members that enter through employment equity laws might be lower than that of the proportion of white academic staff members. Since a university is forced to hire academic labour which has a lower marginal productivity, the cost inefficiency inherent in that equity-enhancing decision is tremendous.

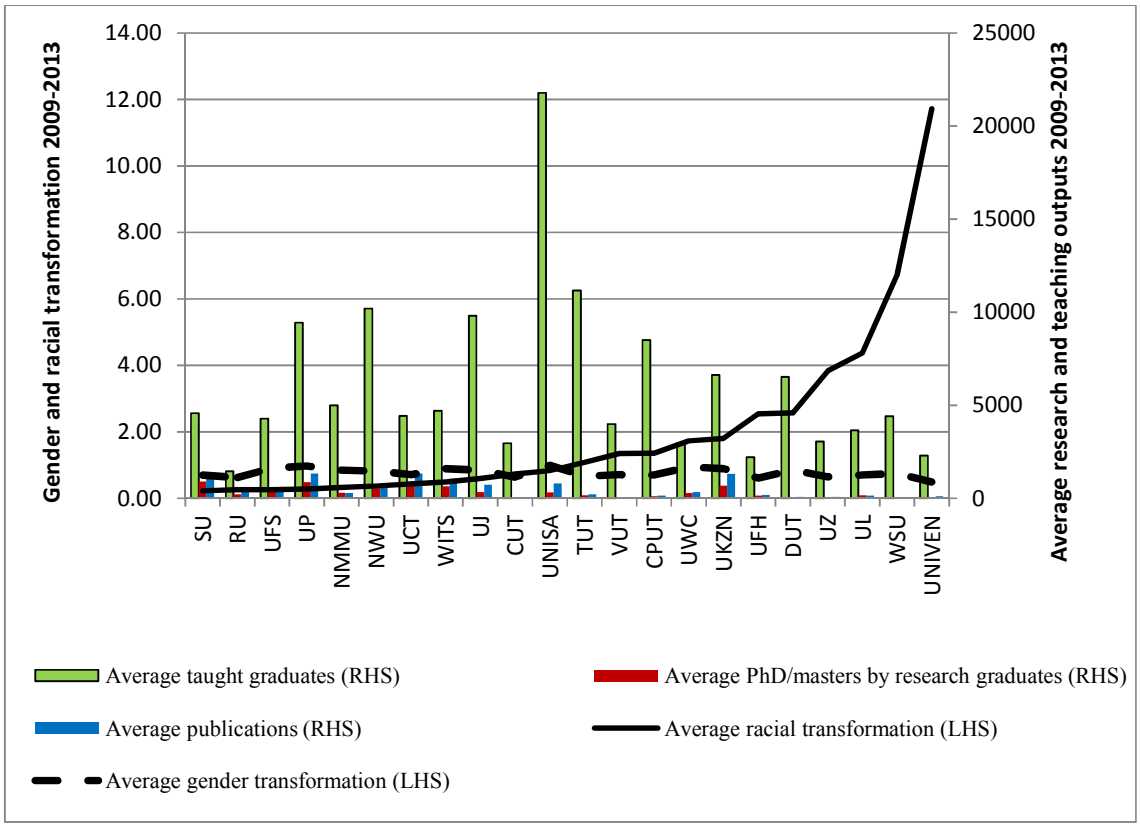



**Figure 2:** Relationship of degree of gender and racial transformation and academic productivity

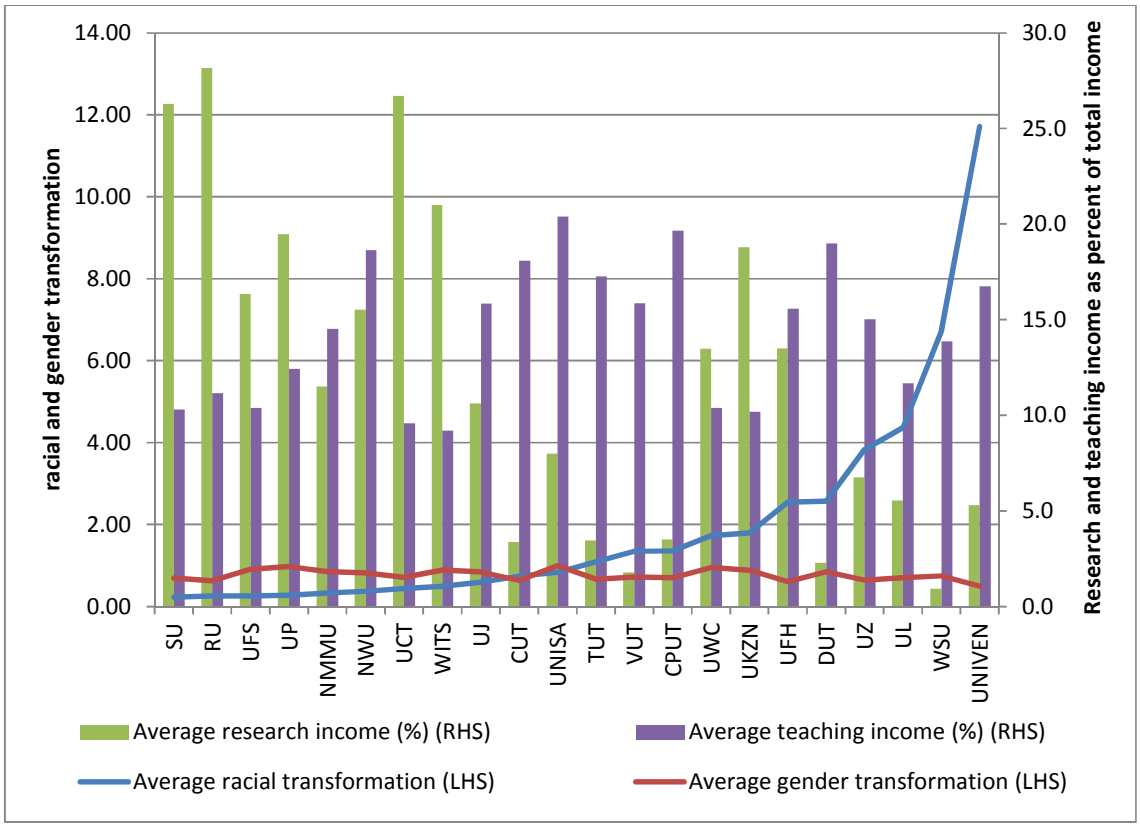



**Figure 3:** Relationship between racial and gender transformation and research and teaching income 2009–2013

While regression analysis gives a *general* (*average*) picture as opposed to *specifics*, Figures 1 and 2 remedy that by representing the university specific relationship between gender and racial transformation variables and research and teaching outputs and incomes between 2009 and 2013 in average terms. Four stylised facts seem self-evident and confirm regression results. Firstly, HDUs and UTs are the most racially transformed (de-whitened, so to say) e.g. University of Venda has as many as 12 times black academic staff as its white academic staff; Walter Sisulu University 7 times as many black academics as white academics, but Stellenbosch University, Rhodes University and University of the Free State, among others, have a small fraction of black academics relative to white academic staff (Figures 2 and 3). Secondly, there is an *inverse* relationship between research outputs (publications and PhD/masters graduates) and racial transformation (de-whitening of the academic staff). The more de-whitened the academic staff is, the less the quantum of research outputs, the exception being UWC and UKZN (Figure 2). Thirdly, it follows that there is an inverse relationship between research income and the degree of racial transformation (de-whitening) of the universities, exceptions being UFH, UWC and UKZN (Figure 3). However, the fourth fact is that teaching income seems to increase with de-whitening of the academic staff, and

this holds consistently for all HDUs and UTs.

Some universities have complained about the unfair and unequal research funding terrain in the South African higher education sector:

> Part of the State funding consists of the research output .... Traditional universities therefore receive approximately 10–20 times more funding for research than UoTs. Not only have the traditional universities emerged from the merger scenario relatively unscathed, they are more affluent, with a flexible income base allowing them to perpetuate the existing, inherent inequalities in the higher education system. Coming from a relatively *low research* and fees basis, with increased expenditure on Work Integrated Learning, the need for a strong technology base, building research and innovation and not yet receiving sufficient funding for redress and merger issues, the tensions created on UoTs to address the principles of massification, redress and equity is evident (Nevhutalu, Vice Chancellor of CPUT, 2016, not paged, emphasis mine).
>
> With regard to the research output grant, the University has, due mainly to its historic past, not been able to produce a higher number of Masters and Doctorates and peer-reviewed publications (Makgalong, UL Vice Chancellor, 2016, 2).

These two quotations make plain the fact that the differences in academic staff productivity (by race) has its historical origins in apartheid which patterns keep socially reproducing themselves and being reinforced through governmental funding regimes that are non-transformative. As such the envisaged superior academic productivity of white academic staff might be different in some cases if one were to conduct a with-and-without historical privileges analysis (somewhat an impossible task for lack of reliable data).

Transformation must move beyond the 'concern largely with numbers and demographics' (Badat 2016, 6) towards embracing the 'law of high quality' without compromising on the former. Taken together, it means that transformation (opportunity equalisation) programmes through remedial legal interventions must be accompanied by 'truly' transformative measures to empower effectively the non-white staff, especially those who enter by the employment equity law, so that in the shortest possible time such academic staff can compete individually. The law protects the weak until they are able to defend themselves dynamically through innovation and other competences. But what if they fail to develop those survival capabilities? The cost implications, and therefore inefficiency outcomes, are sobering.

The findings in this article need to be qualified. By using the university as the unit of analysis, a lot of heterogeneity within the university has been assumed away. Analysis at the faculty level (or even department level) in each of the 22 universities would have revealed more information about the source and structure of cost inefficiencies. While a theoretical minimum was imposed on the data, the analysis could have gone a step further to cluster the universities by their histories: formerly white universities and formerly black universities

have different financial management cultures and endowment funds as well. The present results could be radically sharpened by incorporating this historical information, which could reveal new patterns of inefficiency. The foregoing discussion, by no means, suggests that white academics or students are *intrinsically* superior to non-white academics and students but serves to highlight underlying drivers of inequality in the education sector that national policy has so far failed to address in any meaningful sense beyond quantitative equalisation of opportunity between the genders and the races.

## CONCLUDING REMARKS

With the caveat that this is an exploratory study with so many factors not yet accounted for, it was established that South African universities have deadweight losses approximately equivalent to 12.7 per cent of their annual expenditure in real terms for each of the 5 years covered by the study. Back of the envelope calculations indicated that, on average, the combined level of cost inefficiency is equivalent to 79,231 potential undergraduate students who were denied a chance in life to study an undergraduate bachelor degree to completion because there was none to support their tertiary education.

Indeed, the ability of universities to operate economically efficiently could have freed some financial resources that could have been redirected to some really suffering students who might have dropout because they struggled financially in the university or who could not have enrolled for lack of funding. Thus, while the national government has to scale up funding of higher education, there is a *prima facie* case against cost inefficiencies in the public university system. The twin evils of cost inefficiency and underfunding of higher education need to be addressed. It is very possible that after more funding is unveiled, a lot more waste will be created, a situation that will lock out of the university thousands of students. Universities, as responsible citizens, can themselves contribute towards the funding of needy students if they reprioritise their expenditures to weed out deadweight losses. Needy students deserve all the assistance they need from the national government, the provincial government, the corporate sector, the donor community, the churches and the universities themselves. While the study has demonstrated that there is cost inefficiency, what remains to be critically evaluated are the sources, nature and structure of the inefficiency. This requires further study with much more disaggregated data.

## NOTE

1. University of Cape Town (UCT), University of Johannesburg (UJ), University of Pretoria (UP), Stellenbosch University (SU), Rhodes University (RU), North West University (NWU), Nelson

Mandela Metropolitan University (NMMU), University of Western Cape (UWC), Tshwane University of Technology (TUT), University of KwaZulu-Natal (UKZN), University of the Free State (UFS), Durban University of Technology (DUT), University of Venda (UNIVEN), University of Fort Hare (UFH), Central University of Technology (CUT), University of Limpopo (UL), Mangosuthu University of Technology (MUT), Walter Sisulu University (WSU), University of Zululand (UZ), University of South Africa (UNISA), Vaal University of Technology (VUT), University of the Witwatersrand (Wits) and Cape Peninsula University of Technology (CPUT).

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