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Capstone or deadweight? Inefficiency, duplication and inequity in South Africa's tertiary education system, 1910–93

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This paper presents time series on South African tertiary education. The data series presented cover inputs and outputs for the university, technical training and teacher training systems. Modern growth theory has emphasised the importance of human capital, though empirical studies have attempted to isolate human capital impacts through single aggregate measures that capture only a quantity of human capital dimension. While data analysis in the present study is exploratory in nature, we show that strong quality differentials exist both within and between different parts of the tertiary education system. The methodological implication for growth studies is that fully accounting for both the quantity and quality of human capital in aggregate human capital measures thus faces significant measurement difficulties. The data also establish that discrimination in the South African tertiary education was not simply a question of underresourcing of Black institutions. Quality of output was low, but attaining it was frequently very expensive.

Key words: Human capital creation, Growth, Tertiary education, South Africa
JEL classifications: I21, N37

1. Introduction

Modern growth theory has emphasised the importance of human capital. The means by which human capital has been introduced into growth theory differs markedly across the seminal contributions to the debate, with strong implications both for the conception of the role of human capital in the growth process, as well as for the policy implications that arise from the theoretical insights. In Mankiw *et al.* (1992), we see human capital introduced in an augmented Solow production function simply as an additional factor of production. The implication is of a direct and immediate impact of human capital on output, with clear separability between human and physical capital stock. Romer (1986) introduces knowledge spill-over effects arising from the process of physical capital production,

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thus emphasising the possibility of joint production of different types of capital stock in the production process. Romer (1990) finally offers a fully developed Schumpeterian conception of explicit knowledge production in the economy, with associated possibilities of increasing returns in production under appropriate distribution of human capital across final goods and knowledge production.

These illustrative alternative conceptions of the role and function of human capital in production and growth thus differ profoundly. And yet empirical studies of the role of human capital in the growth process have flattened these distinctions. Human capital is almost invariably included in the form of a single aggregate measure. This emphasises the quantity of human capital created in the absence of all attempts to identify its distribution across different uses in the economy, as well as ignoring all questions surrounding the impact of the different forms (and qualities) of human capital at the disposal of producers in the economy. Thus, the majority of empirical growth studies have ignored the nuance and significance of contributions that have arisen from endogenous growth theory.[1]

In this paper, we present evidence suggesting that such omissions are likely to matter. We extend earlier work providing detailed human capital indicators for a particular country, South Africa. The significance of the evidence presented here is that the human capital indicators collected show that the undifferentiated approach of empirical growth studies is not satisfactory. In particular, we demonstrate that the production of human capital is distinguished by considerable heterogeneity. That there are different sorts of human capital output is of course a trivial observation. But we show also that there is evidence (at least in the case of South Africa) both *within* and *between* the different sorts of human capital being produced not only of inefficiency and quality differentials, but also that these differentials differ between the different forms of human capital production, as well as over time.

The implication for empirical growth studies is potentially profound: the use of single aggregated human capital measures of human capital is inappropriate given such findings. Such measures are unable to capture the heterogeneity of the human capital factor of production under the Solow approach, or the forms of human capital production that are present in any concrete economy under Schumpeterian assumptions. For any adequate empirical growth model, questions of both the quantity and the quality of human capital production are likely to be of central importance if the contribution of human capital to the process of economic growth is to be adequately understood. More detailed datasets that capture both quantity and quality dimensions in human capital production, as well as wider ranges of different forms of human capital, such as those contained in the present as well as an earlier study (see Fedderke *et al.*, 2000B), are essential if this goal is to be realised.

To this end, we have collected, assembled and analysed data on the principal sectors of South Africa's tertiary educational system, including universities, technical training institutions and teacher training colleges. We examine the following inputs into the educational process: student numbers, size of lecturing staff and real expenditure on tertiary education by type of tertiary education, both in absolute terms and on a real per student basis. In addition, our concern extends to the output of the tertiary educational system, as measured by degrees, diplomas and certificates issued. Such output is reported both in absolute terms and in terms adjusted for the quality of the output. The efficiency of the tertiary educational system in transforming student enrolments into qualifications is

[1] See for example the standard citation of Barro (1991).

examined, and the cost per qualification is estimated. Finally, where appropriate, we consider the quantity of research output generated by the tertiary educational system.

Earlier work has identified significant inequalities and inefficiencies within South Africa's schooling system.[1] These earlier findings showed that, in terms of both the quality of inputs and the quality of output produced, South Africa's schooling system over the 1910–93 period essentially divided into two main parts: one for Whites and one for Africans. Although even the best part of the schooling system, that for Whites, was of limited quality, the African schooling system was a frankly cheap and nasty affair over the entire 1910–93 period.

The results that emerge from the present study are somewhat more differentiated. The study points out that the form that discrimination took in South African tertiary education is not necessarily one of the underresourcing of African educational opportunities. Certainly, there is evidence of this form of discrimination also. But our data show that discrimination was in fact often very resource-intensive. What is a common feature of African education, however, is that the quality of output was poor. First, we find that, for universities, the distinction between the White universities and universities designated for other race groups[2] is not in terms of the quality of inputs as measured by student–lecturer ratios, or by expenditure per student. Indeed, real expenditure per student for universities was often *higher* in the African universities than it was for Whites. Nevertheless, our findings show that the quality of output of African universities in terms of both the degrees they issued and their research output lay considerably below that of the universities designated White. In effect, the African university system proved expensive and nasty, rather than cheap and nasty. Only the teacher training college system reproduces the results we found for South African schooling. Here again, inputs as well as outputs of the teacher training colleges prove to be of considerably lower quality for Africans than for Whites. In technical training, the differential between Whites and Africans emerges primarily in the form of poor access to such training by Africans, rather than in the form of poor inputs into African technical training as measured by student–lecturer ratios and real per student expenditure.

A more general finding to emerge from our data on technical education in South Africa is that significant under-investment in technical forms of human capital has been maintained over the sample period, and for all population groups. This raises serious concerns for a semi-developed country like South Africa. The over-emphasis on academic tertiary education has resulted in a chasm between the schooling and tertiary systems without providing a middle ground. Under-prepared students might well have been better served by appropriate forms of technical education. This begs the question of whether a country at South Africa's level of development would not have been better served by a more fully differentiated tertiary educational system, which placed greater weight on technical training.

The study thus identifies considerable degrees of heterogeneity and quality differentials in human capital production and usage. In this respect, the findings carry general import. For a narrower interest in the South African economy, the findings also carry important insights into the nature and structure of discrimination as practised under the minority political dispensation. The university sector's experience shows that discrimination is not necessarily cheap—not only in the form of forgone development opportunities, but simply in the absolute cost of running a racially segregated tertiary educational system.

[1] See Fedderke *et al.* (1999, 2000B).

[2] Other race groups here refer to African, Coloured and Asian. See footnote 3 on p. 380.

2. The South African tertiary educational system: the role of universities

The historical development of South Africa's university system mirrors that of the wider society.[1] While in the pre-1948 era the universities were not racially segregated in principle,[2] access to universities by other race groups was severely curtailed. Post-1948 South Africa saw a twofold development. First, the exclusion of African, Coloured and Asian[3] students from universities they previously had had access to, at least in principle. Second and simultaneously, a series of new universities individually ear-marked for specific racial and ethnic groupings were to be founded.[4]

The series that we consider in the discussion that is to follow include the total student numbers, the total academic lecturing staff, hence student–lecturer ratios, total real expenditure and per student expenditure, total degrees issued, as well as the proportion of degrees issued in what we term core scientific disciplines. We choose the natural and engineering sciences (NES) as a means of providing a quality measure of the education offered, because of their clearly identifiable objective performance standards, and their centrality to the process of economic growth. Again, wherever possible, data series will be presented in terms of a racial breakdown.

2.1 Student–lecturer ratios

The time series show that White students as a proportion of the total student body began to fall rapidly only from the mid-1970s onward. This accords well with the findings of Fedderke *et al.* (2000B), in which the number of pupils in the African schooling system began to show dramatic increases during the course of the 1970s.[5] The rising proportion of Black students in the total student body comes mainly from African students, suggesting that the increased throughput of the African schooling system had a knock-on effect on university institutions, with rapidly accelerating student intakes during the course of the 1980s, in particular.

Data on student and lecturing staff numbers allow us to compute the student–lecturer ratios reported in Figure 1. The most striking feature of the evidence is that student–staff ratios show relatively little variation across race groups. Indeed, during the course of the 1960s and 1970s, the student–staff ratios at the Black institutions lay *below* those maintained in the White university system. Moreover, this is true even where (as in Figure 1) we employ White university student enrolment figures which do not count the students of other races attending these universities. Where the adjusted student enrolments for White universities are employed, there is a further though marginal upward adjustment in the

[1] We have provided a somewhat more detailed and quantified account of this in Fedderke *et al.* (1999). Readers are referred to this discussion, since space considerations preclude a recounting of the full evidence in the present context. Needless to say, educational policies in South Africa were not independent of the general ideological bent of past policy.

[2] Note that there are different interpretations of the extent to which the post-1948 statutory formalisation of practices of racial exclusion and domination mark a significant structural discontinuity in the character of South African institutions. Bromberger (1982) is of the opinion that the evidence weighs more heavily in favour of the 'discontinuist' interpretation. Greenberg (1980) might provide one instance of a more 'continuist' interpretation of South African history.

[3] The official categorisation was: White, Asian, Coloured and African (previously Bantu). Black denotes Asian, Coloured and African without differentiation.

[4] We also note that, while the South African university system is generally based on residential universities, UNISA (University of South Africa) offers distance education at a university level, and incorporates the single largest student body in the university system as a whole. While we have data on UNISA available, we focus on the residential universities in our analysis.

[5] See Fedderke *et al.* (2000B, Figure 2).

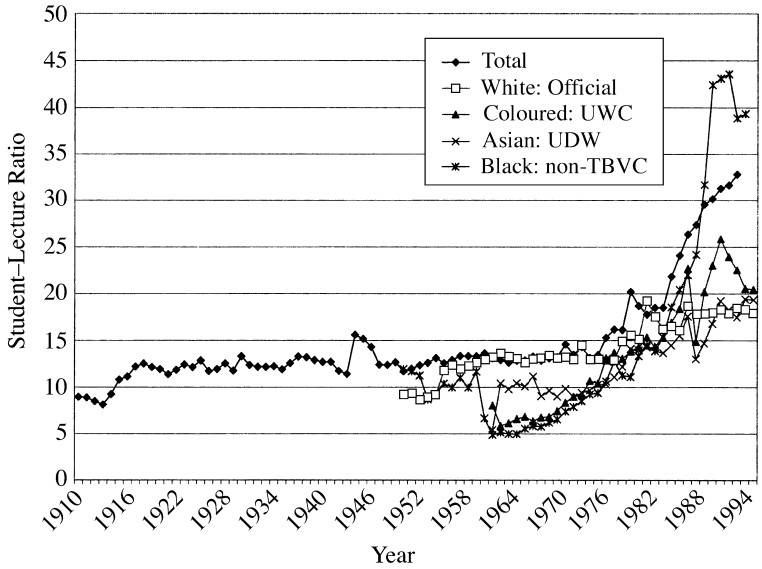

Fig. 1. *University student–lecturer ratios.*

student–lecturer ratio at White universities. Thus the point that student–lecturer ratios at Black institutions over the course of the 1960s and 1970s were, if anything, better than at White institutions strengthens.

This pattern only changes after 1980, when the student–staff ratio of all parts of the university system begins to demonstrate an upward trend. During the course of the 1980s, the student–staff ratio of both the Coloured and Asian universities is of essentially the same order as of the White universities, though there also appears to be greater cyclical variability in Asian and Coloured student–lecturer ratios. However, the strongest change during the course of the 1980s is evident in the African university system. Consistent with the evidence of rising student numbers in African universities, the student–staff ratio in African universities rises dramatically during the 1980s, to approximately double that which prevails in the White university system.

There are two immediate and important implications that emerge from the evidence provided by student–lecturer ratios. First, the low student–lecturer ratios in Black universities during the pre-1980 sample is likely to be influenced by the poor performance of the Black-schooling systems, detailed in Fedderke *et al.* (2000B). Thus the ability of the Black tertiary education system to attract sufficient student intake is likely to have suffered from a supply-side constraint, making it difficult to attract students in sufficient numbers.

Second, it becomes likely that student–staff ratios for universities may well not be reliable indicators of the quality of the learning environment,[1] particularly since we know the student intake to have been poorly prepared for tertiary education (see Fedderke *et al.*, 2000B).[2] This is thus quite unlike the case for the South African schooling system, where

[1] The ratio of students to lecturers does not control in any way for the quality of the lecturing staff employed in the respective sets of institutions. Ideally, the ratio should be appropriately weighted for the quality of lecturing input. Unfortunately, no ready statistics were available to enable such a quality adjustment.

[2] In particular, see Figures 1 and 5 of that paper for pupil–teacher ratios, Figure 9 for real per pupil expenditure and Figure 10 for teacher qualifications for the schooling system. On the output side, see Figure 12 for matric pass rates.

pupil–teacher ratios were found to show strong variation across the racially defined schooling systems, and this variation was found to exert strong influence on educational attainment (see Fedderke and Luiz 1999).

2.2 Real per student expenditure

We have already seen that a fairly standard measure of the quality of learning environments, the student–lecturer ratio, fails to detect quality differentials between the White and Black university systems. This is again true of a second standard measure of the quality of educational processes provided by real per student expenditure. Once again, this measure fails to indicate a quality differential between Black and White universities.

Real absolute expenditure on historically White universities dominates expenditure for the sector. By comparison, total absolute real expenditure on African universities in 1993 still lagged behind total absolute expenditure on White universities by a factor of approximately 3:1.

Nevertheless, expenditure on the African university system was subject to sharp proportional increases during the course of the 1980s—approximately doubling from 1980 through 1985. Corresponding to this sharp upturn in real expenditure on African universities, historically White universities experienced an equally sharp, and in total absolute magnitude greater decline in real expenditure over the same period. The first implication to emerge from the expenditure figures is thus of a reallocation of funding in the university system of South Africa during the course of the 1980s.

The pattern that emerges from the per student expenditure figures is perhaps even more startling, as Figure 2 illustrates. For historically White universities, real per student expenditure has remained essentially constant over the full 1910–93 period, though the 1980s and early 1990s have seen some decline from the height of per student expenditure achieved during the course of the 1970s. For all other racial groupings in the university system, per student expenditure during the course of the 1960s and 1970s was higher than for the White university system, though the 1980s has seen convergence between the expenditure figures for the various sections of the university system. The African university system did not differ from Coloured and Asian universities in this respect. For

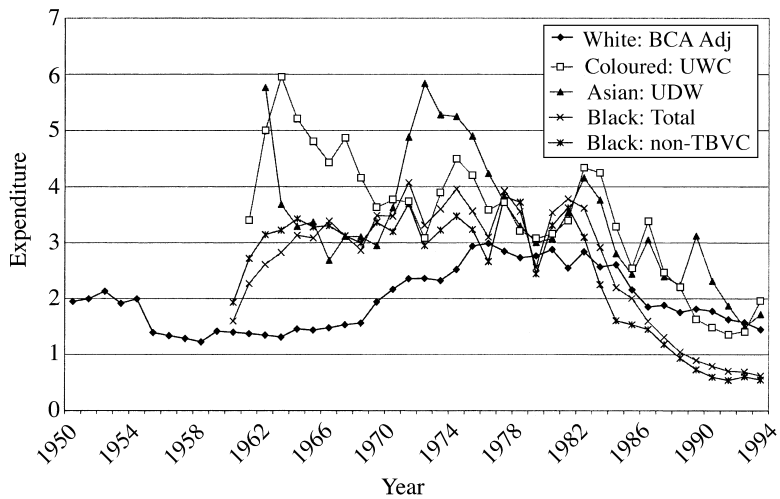

Fig. 2. *University real per student expenditure.*

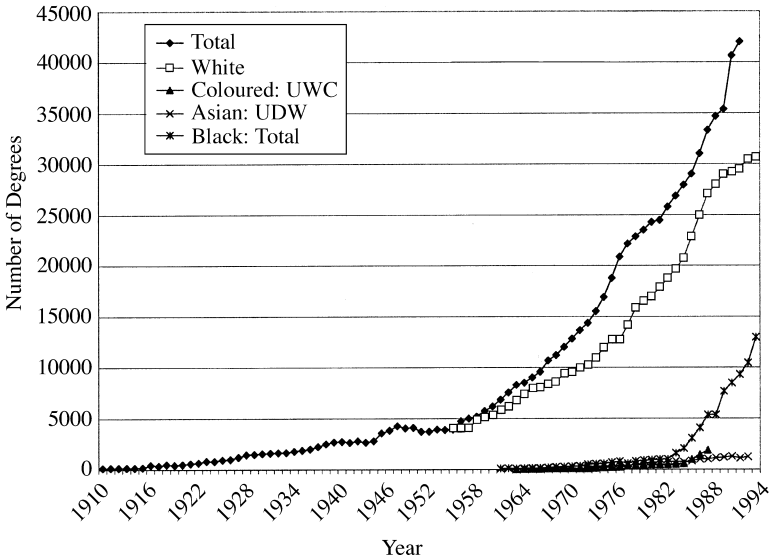

Fig. 3. *Total number of degrees issued by universities.*

African universities, real per student expenditure consistently lay above that for the White university system during the 1960s and 1970s, and it is only the sharp increase in student numbers at African universities during the 1980s that drives down per student expenditure below that of other parts of the university system.

A number of explanations account for these data patterns—and a number of implications follow. First, the high per student expenditure figures in the Black universities can be accounted for in terms of the start-up costs of any new university system.[1] Again, consistent with our suggestions emerging under the discussion of the student–lecturer ratio, the difficulty likely to have been experienced by the Black universities is the recruitment of a suitable student body due to poor schooling. Thus, the investment in infrastructure and in the human capital required to start up a new set of universities was for a small student body, who were in consequence funded to a disproportionately high level on a per capita basis. Only during the course of the 1980s does a quality differential come to be indicated by per student expenditure levels at universities.

2.3 Measurement of output: degrees issued by universities

Absolute output measures of the university system suggest a steady and, since 1960, sometimes steep increase in the total degrees granted by universities—see Figure 3. The evidence is once again consistent with that obtained from student and lecturer numbers—the White universities dominate the university system in output terms as much as in input terms, despite the growing degree output of African universities particularly during the course of the 1980s.

While the absolute output of degrees suggests that African universities were expanding their output in line with the increasing numbers of students entering the system, absolute numbers of degrees do not yet control for the quality of the output being generated by the African university system. A number of pieces of evidence suggest that the quality of

[1] African institutions may well also have been more expensive due to poor financial controls and due to their rural location.

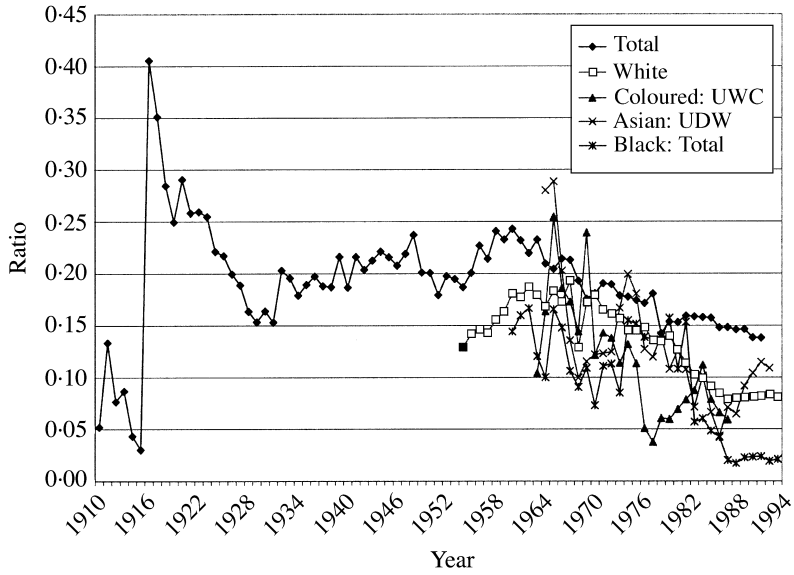

Fig. 4. *Proportion of degrees in natural and mathematical sciences—universities.*

output to emerge from the African universities was not comparable with that of the White university system over our sample period.

First, in Figure 4 we report the proportion of total degrees issued by the various university systems that emerge in the NES.[1] We choose NES degrees for a number of reasons. The mathematical sciences have as clearly identifiable objective performance standards as any subject available to university students. Application of subjective standards of assessments are therefore minimised. Moreover, we consider the mathematical sciences to be foundational to a wide range of cognitive activities and vocational skills. Lastly, mathematics (and science) was used as the central indicator of the quality of the educational system in the Hanushek and Kim (1995) growth study—and proved a more significant predictor of long-run economic performance than the quantity of education.

For the White and Asian university systems, the proportion of NES degrees falls from a high point of 20% in the mid 1960s to a little under 10% in the early 1990s.[2] While the African university system was similar to the White system in the 1960s, during the course of the 1980s at precisely the time when student enrolments were expanding rapidly, the NES proportion fell rapidly, and by 1993 had reached a low of 2%.[3] While the trend for

[1] See the Working Paper at www.wits.ac.za/economics/ersa for a full exposition of how we defined these degrees.

[2] The higher proportion of NES degrees in the total student body is attributable to the impact of Coloured and Asian students present in the White university system, but classified in terms of their racial categories.

[3] There are two points which need to be made in this regard. First, it could be argued that a reason for this is to be found in low returns to education for Africans as a result of Apartheid legally excluding them from certain professions. However, studies by Lam (1999) and Wittenberg (1999) carry countervailing evidence for tertiary education. They find that post-matric levels education substantially increases the return on education, and that only investment in tertiary level human capital increases the probability of employment in South Africa (education up to an including matriculation does not). Second, over the 1980s and 1990s, legal job restrictions have declined. This is precisely the time frame over which the NES degree proportion has also been declining—and for all race groups. It is thus difficult to attribute the *declining* trend in NES degree proportions to the *increasing* job opportunities available to Blacks in South Africa's labour market.

both systems has been downward, the performance of the African universities in producing science graduates is far poorer than that of the White university system. Moreover, while the strong increase in student numbers in the African university system in the early 1980s was matched by an increasing conferral of degrees (see Figure 3), this was clearly achieved by an expansion of students reading toward 'soft' rather than science degrees. Figure 4 demonstrates a sharp decline in the proportion of science graduates precisely at the point at which both student numbers and total degrees conferred were experiencing sharp growth.

Thus the African university system, while beginning to absorb increasing numbers of African students emerging from the African schooling system, was unable to translate the increased enrolment into NES graduates with the same facility as the rest of the university system. While this may point to the poorly prepared student intake that the African university system had to contend with, it is also indicative of a low capacity within the African university system to generate NES graduates.

The limited output of NES degrees and the poor output more generally may partly be a function of a closed stagnating economy with limited exposure to competition and innovation, as well as bounded academic 'competition' and access to new ideas. Certainly, the closure of the economy and of society more generally had deleterious effects, not least on educational capacity. The academic and cultural boycotts, for instance, almost certainly impeded knowledge transfers and made South African universities less desirable destinations for scholars and scientists.

Second, we consider the ratio of degrees conferred in each year to the total student body in the racially categorised university systems. The ratio serves as a proxy for the throughput of the relevant university system, viz., the ability of the university system to translate its intake of students into graduands. The most striking implication of the evidence is that the White and African university systems have significantly different throughput rates. For White universities, approximately 17% of the total student body in 1993 was receiving a degree, and the trend for the White university system was upward. By contrast, African universities, while sharing an upward trend in the total degree throughput rate since the early 1980s, had reached a throughput rate of only 10% in 1993, significantly below that of White universities. In the case of the throughput of NES degrees, African universities reported 0·002 in 1992, while White universities reported 0·01. Particularly the NES throughput ratio could be argued to be unhealthy for both the White and the African university systems. Nevertheless, African universities were not able to translate the increasing student intake of the 1980s into a higher throughput of NES degrees. To the extent that one accepts that NES degree output is central to the labour market needs of a modern economy, therefore, the quality of African university output during the course of the 1980s and early 1990s was low. Moreover, trends in the NES throughput ratio suggest that matters were not improving over time.

Thirdly, Figure 5 notes the real expenditure per degree conferred in the different parts of the university system. All sections of the university system saw an increase in the cost per degree produced over the course of the 1980s.[1] However, the increase has been the most dramatic in the African university system, to the extent that the cost per degree in the African university system in 1993 had reached 1·5, the level maintained in the White universities.

[1] Perhaps reflecting the poorer preparation of students entering the university system across the board—see also the discussion of the mathematics preparation of pupils from White as well as African schools in Fedderke *et al.* (2000B, Figure 13).

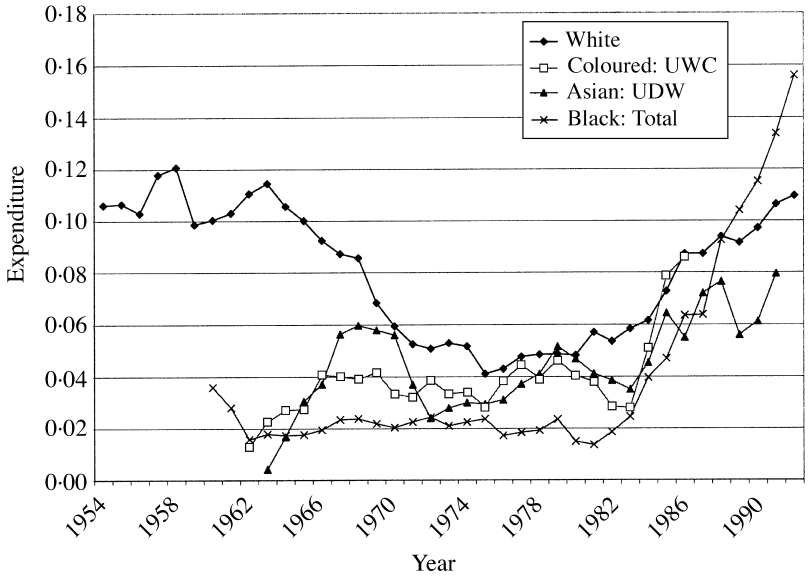

Fig. 5. *Real expenditure per degree—universities.*

The final but perhaps also most important indicator of the differential quality of South African universities is given by their contribution to the advancement of knowledge through the publication of original research. In Figure 6, we report both the absolute level of research unit output of the racially categorised universities,[1] as well as their per lecturer research output.[2] The evidence confirms the suggested quality differential that we have already established as existing between the 'White' universities and Black universities. Not only is the absolute level of research output in White universities considerably higher than in Black universities, but this is also translated into considerably higher per capita research output.

However, we note that even the best part of the university system in South Africa has at the very least manifested declining quality in research dimensions over time. First, the White university research output has ceased to increase in absolute terms from the late 1980s and, in per lecturer output terms, the output declined through to the early 1990s, though it has since stabilised. Furthermore, the per lecturer output of approximately 0·6 publication unit per annum can be questioned as to its adequacy.

2.4 Implications of the evidence for the university system

Thus far, our discussion has presented time series on conditions and developments in South Africa's university system. Such evidence carries implications generally on how human capital indicators can be included in growth studies. It also supplies considerable modulation to widely held perceptions on the nature of racial discrimination in South Africa.

The first point worth noting is that the development of separate university systems for the distinct ethnic groupings of South Africa's population was an inefficient use of scarce

[1] The data are courtesy of C. Borresen, University of Natal Research Office, University of Natal, Durban.
[2] Publication units are not quality adjusted.

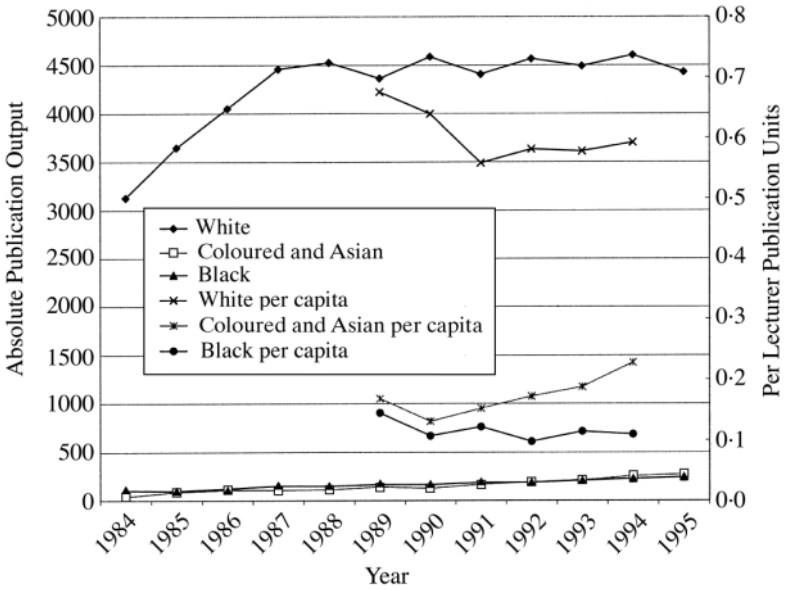

Fig. 6. *Research output of universities.*

resources. Universities are notoriously expensive in terms of start-up costs. Black universities were expensive in at least two distinct senses. The first is in terms of direct student expenditure: Black universities required a greater input of scarce resources in order to produce the same output of students. But second, we have seen that the high per student expenditure in Black universities also translated into a lower-quality human capital output than that being produced in White universities. To develop entirely new universities with a student body generally poorly prepared, and with very low student–staff ratios, may well have prevented the already existing universities from improving their quality, and to take advantage of economies of scale in incorporating Black students into their historic student body.

Thus the opportunity cost implications of the development of the Black university system are substantial. Considerable resources devoted to the production of low-grade human capital came at the expense of reduced opportunities for developing better and cheaper human capital production in the already existent university system. This may well have damaged the global development prospects of South Africa's tertiary educational system by preventing capacity deepening in the best parts of the system. This manifests itself most obviously in the declining capacity of the front-ranking research universities in South Africa to continue to fulfil their research function.[1] The assumption is that, had all the financial resources been allocated to the more efficient institutions, they would not

[1] In a broader developmental context, it raises the important question of whether it is desirable for a society to concentrate solely on devoting resources to a broad-based mass tertiary educational system premised on the lowest common quality denominator. Or whether it is not desirable to have at least some tertiary education devoted to the production of both high quality degrees, as well as world quality research. If the latter route is chosen (and the experience of the East Asian countries may be taken to at least suggest that it is not entirely unfruitful—as long as the right type of output is emphasised), the implication would be for the identification of a small number of core institutions, properly funded, and with appropriate incentive structures designed to encourage greater attention to research activity.

only have been able to expand the scale of their operations, but would have better converted the additional input into output.

The development path chosen for South Africa's tertiary system has thus been towards relatively poor-quality output at relatively high expense, thereby missing the opportunity to develop the 'good' parts of the system.

Second, the evidence shows that strong quality differentials are hidden even in the relatively specific category of human capital associated with university education. The implication of this finding is that growth studies that simply control for human capital by a single quality undifferentiated measure are unlikely to produce unbiased estimates of human capital contributions to even narrowly defined developmental measures such as per capita GDP.

The current study has made some attempt to provide more differentiated measures of human capital production. What is instructive in general terms from the exercise is just how difficult establishing such quality differentials proves to be. Many standard measures employed in the literature as indicators of quality differentials of education, simply did not reflect such differentials in South Africa's case. The quality differentials did not come to be apparent in terms of the *inputs* into educational production, but only with respect to careful consideration of output measures. Unfortunately, appropriate data on quality adjusted output is very difficult to collect. If we hope to understand the contribution of human capital to economic growth, it appears as if a long and data-intensive path stretches out before us.

A final point further reinforces this general finding. We have already pointed out that different sections of South Africa's educational system are characterised by different *forms* of inefficiency and inequality. To this extent, developing an understanding of the contribution of human capital to long-run development faces the difficulty not only of *measuring* quality differentials, but of measuring different *sorts* of quality differentials across different parts of the educational system.

At the very least, the evidence here assembled and the above considerations make it difficult to argue that a single aggregate human capital measure will provide a reliable measure of human capital's impact on economic growth.

A final implication to emerge from the data is that racial discrimination is more subtle than is often thought. The schooling system's 'cheap and nasty' format for Africans was not replicated for universities. Instead, the apartheid state was prepared to spend relatively large resources on the development of African universities. Perhaps the intention was to buy off a pliant élite. While not successful in the long run, it is worth reflecting on the extent to which this contributed to apartheid's survival even in the face of substantial international opposition.

3. Applied training

3.1 Apprenticeship contracts

Discussion of the tertiary educational system of South Africa frequently centres on the training provided by academic institutions such as universities. Academic training, and the university system as a whole, is undoubtedly of central importance to the long-run development of South Africa, both in terms of the prospects for long-run economic growth, and in terms of wider conceptions of human development. However, academic training provides only one aspect of the human capital needs of a modern economy. The experience provided by the development of economies such as Germany and Japan

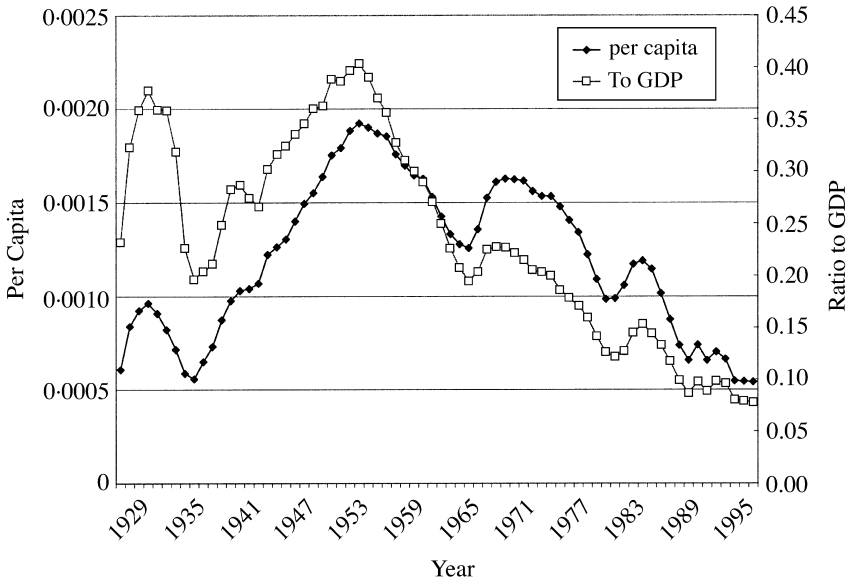

Fig. 7. *Apprenticeship ratios.*

among others,[1] suggests that the provision of formalised training in applied and practical trade skills may be of central importance also. Modern economies require a wide and diverse range of skills, and practical as well as rational–critical analytical capacity are important. Such imperatives may be all the more pressing, given that South Africa is a middle-income country with only a partially modernised economy, and a population at relatively diverse levels of economic and human capital development.

For this reason, we extend our examination of post-secondary training opportunities in South Africa to apprenticeship contracts registered with the Department of Manpower. Such a series is consistently available over the 1926–97 period, though it proves impossible to provide a racial classification of the contracts registered.

We have seen that the South African university system has been subject to rapid and sustained expansion over the course of the 1980s and 1990s, though there are indications that the absolute expansion of the system has not been accompanied by adequate quality assurance of output. The evidence to emerge from apprenticeship contracts in South Africa is even more disturbing. While the absolute number of apprenticeship contracts registered rose through to the mid-1970s, the *absolute* number of apprenticeship contracts in South Africa has been declining at least since 1985. Moreover, the per capita ratio and the ratio of contracts to GDP reported in Figure 7 show that the production of the sort of human capital generated by apprenticeships in South Africa has been in long-term decline since the 1950s.[2]

One reason for this decline may be that modern economies require a smaller proportion of its labour trained in practical skills. However, given the middle-income country status of South Africa, and the relative preponderance of manufacturing and mining activity in

[1] See the discussion in Landes (1998).

[2] Various job reservation-type laws from the onset of the Union in 1910 effectively excluded the African population from apprenticeships. The relaxation of these laws began in the 1970s as shortages of skilled workers frustrated further capitalist development (see Lipton, 1989).

aggregate output even in the 1990s, such an explanation is unlikely to have much purchase. A second possible explanation of these trends is that the payoff to academic university training is sufficiently high to have generated a flow of school leavers to universities rather than into trades (see Lam,1999; Wittenberg, 1999). Again, while this may provide some insight, the continued existence of a large body of unskilled workers in the South African workforce (with little formal training of any sort) suggests that this too is at best but a partial explanation. Indeed, the evidence raises the question of why training of the sort offered in apprenticeships is not used more frequently in order to raise the productivity of labour in South Africa, given that concerns have often been expressed about the productivity of South African labour. Yet direct intervention to raise labour productivity seems rarely to address training of an applied, practical sort—and the national debate surrounding productivity has rarely suggested that more extensive and formal recourse to apprenticeships might be useful.

This suggests a third reason why apprenticeship training in South Africa has been in long-term decline. We have argued repeatedly that human capital production in South Africa has been poorly managed in virtually all of the dimensions that we have touched upon. Apprenticeship training may well be just one more item to add to this list. One might wish to question whether South Africa's level of economic development might not make a greater focus on formal training in applied practical skills required in trade applications, of at least equal importance to formal academic training. In Germany, for instance, training offered in *Technische Hochschulen* has long been at least partly responsible for the high productivity and quality of the German labour force. In South Africa, paying greater attention to labour productivity may require not only focus on the quality of the schooling system, but also an attempt to improve the training that labour receives in the applied skills it requires in the workplace.

3.2 Technikons

South Africa introduced a system of tertiary technical training in the form of Technikons that are analogous to the Polytechnics of the UK in 1978.

The evidence suggests that student enrolments in technical tertiary training was dominated by the White race group—indeed African enrolments had still not reached White levels in 1993, even in absolute terms. The second notable feature concerning student numbers is that African students enrolled in Technikons designated for the African race group were a relatively small proportion of the total number of African students enrolled in all Technikons. To the extent that African students have therefore entered tertiary technical training, it has been primarily through the auspices of Technikons designated for other race groups. Moreover, the increase in African student numbers has occurred considerably later than that for other forms of tertiary education (only in the 1990s).

While the student–lecturer ratio for White and Asian Technikons increased from below 10 to 15:1 levels during the course of the 1980s, the increase in African and Coloured student–lecturer ratios is considerably more dramatic: from below 5:1 in the 1970s to above 30:1 in the 1990s, as illustrated in Figure 8. Despite these increases in student–lecturer ratios, however, we note that ratios remained below those maintained in South Africa's university system. While the student–lecturer ratio for universities in aggregate was approaching 35:1, only African and Coloured Technikons had similar ratios—and in absolute terms these Technikons were a small proportion of the total. Relatively speaking, therefore, tertiary technical training in South Africa was relatively well endowed in terms of lecturing inputs, when compared with the university system.

The pattern already noted above with regard to tertiary technical training continues with respect to real expenditure patterns. Real expenditure on White training dominates the tertiary technical training system, with all other racial categories being negligible by comparison. However, Figure 9 which reports real per student expenditure shows that the difference between race groups does not arise in terms of discrimination in the funding

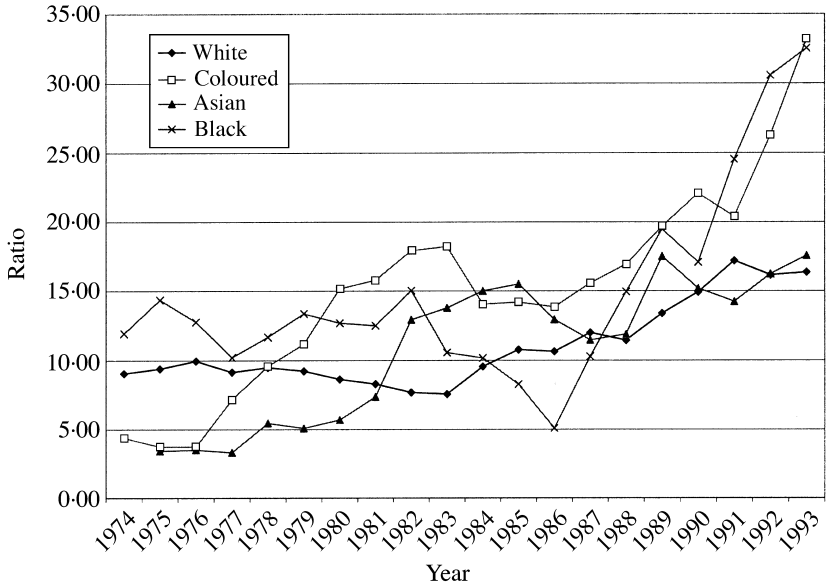

Fig. 8. *Student–lecturer ratio—Technikons.*

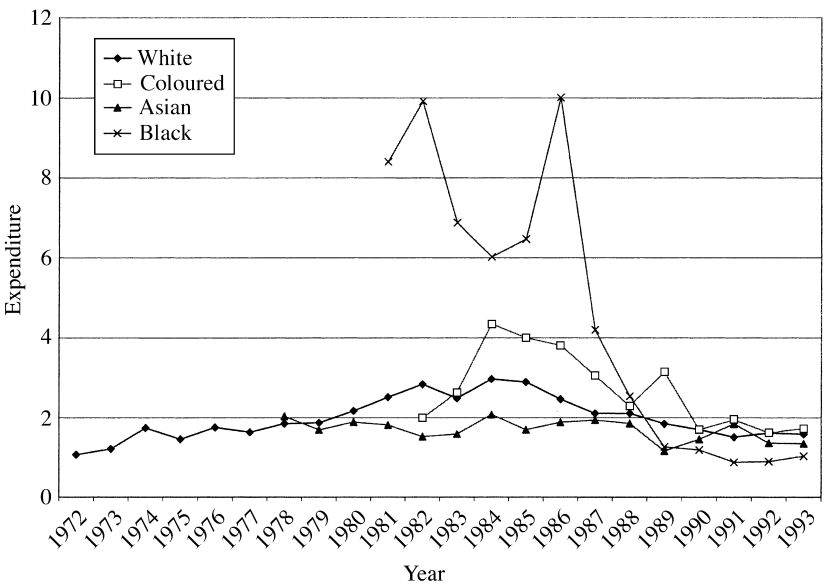

Fig. 9. *Real per student expenditure—Technikons.*

per student by race. Indeed, in the early 1980s real expenditure on African students far outstripped that of other race groups—which is perhaps again attributable to the capital start-up costs associated with the development of Technikons for Africans.

What the data suggest instead is that inequality between White and African students arose simply in the form of *access* to technical tertiary training. African student numbers remained relatively small even into the 1990s, unlike the expansion of African student numbers in universities and teacher training colleges (see below). This restricted access is likely to have been due to both the restricted number of institutions dedicated to African training under Apartheid structures, and the fact that White Technikons restricted access to African students considerably longer than White universities did.

A second implication to emerge is that much as for the university system, the development of parallel Technikons for various race groups proved expensive in real per student expenditure terms—and it remains to be seen whether the high developmental costs proved justified in terms of the quality of output achieved in terms of diploma and certificate output. At the very least, the suspicion has to be that the resources might have been more usefully deployed in deepening capacity in already existing institutions.

While the absolute level of output of diplomas and certificates by Technikons is again dominated by the White Technikons in South Africa (see Figure 10) evidence for a clear quality differential between White and Black Technikons is considerably less clear than it is for universities. In terms of the proportion of diplomas and certificates awarded by Technikons in mathematics and science-related disciplines, the surprising result is that the White Technikons performed worse than any other racial category—with consistently approximately 4% of diplomas and certificates being in the mathematics and science category. For both African and Coloured Technikons, the proportion is on average twice as high, and for Asians even greater. Thus the quality differential that emerged between African and White schooling and university education is at least not evident in the same dimension for Technikon education.

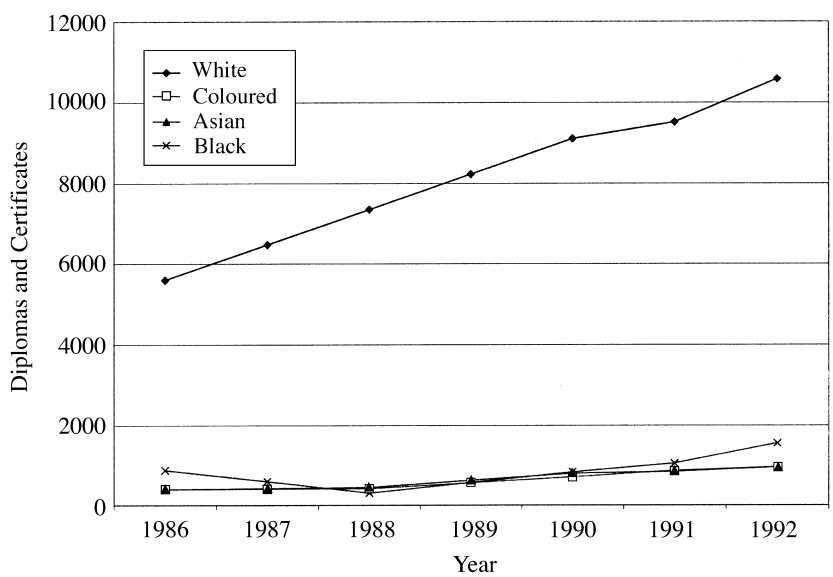

Fig. 10. *Diplomas and certificates—Technikons.*

This conclusion remains in place also in terms of the throughput measures for total diplomas and certificates and the mathematics and science diplomas and certificates. For both throughput measures, the White Technikons are by no means more effective than the Black Technikons. Indeed, in terms of the total diplomas and certificates and the mathematics and science diplomas and certificates, the African Technikons demonstrate better throughput rates than the White.

Only in terms of the real expenditure per degree do White Technikons fare better than the Coloured and Asian Technikons, though again African Technikons were more efficient in their resource use than White Technikons during the early 1990s.[1]

The picture that emerges for applied technical training, in terms of the data series collected for the present study, reveals that it is distinct in terms of its characteristics from other parts of the tertiary training system. First, there is no clear racial discrimination as far as inputs are concerned. Second, a differential between White and Black institutions is difficult to detect on the output side and, if anything, the data suggest that output may be better in the Black institutions. Third, the under-investment and the failure to develop the technical training more forcefully may well have been a particularly severe missed opportunity for a country at South Africa's level of development. Fourth, in this part of the tertiary system, discrimination took a different form from the university form. Poor access, rather than poor output quality limited educational opportunities for Blacks—at least on our measures.

As a final point, note the general measurement difficulties for growth studies concerned with the impact of human capital on long-run development compounds. Quality differentials *within* each human capital category are present, potentially large and difficult to detect. This much we already know from the university system evidence for South Africa. But the form and extent of quality differentials *between* different forms of human capital are also significant, as the comparison between Technikons and universities shows. Taking full account of such differentials, and controlling for their impact on growth promises to be a less than trivial undertaking.

4. Teacher training

Historically, the single most accessible form of tertiary education to wide sections of South Africa's population has been teacher training. This is particularly true of the African racial grouping, which was excluded from other forms of tertiary education for much of the twentieth century. As a consequence, teacher training must occupy an important and central role in any attempt to understand the development of tertiary education in South Africa. In more general terms, it is perhaps also the form of tertiary education on which most developing countries embark in the first instance.

4.1 Student–lecturer ratios

Student teacher numbers in South Africa appear to reflect the differential level of socio-economic development of the various race groups in South Africa. While student teacher numbers for the White, Coloured and Asian racial groups appear to have peaked and are now on a downward trend in absolute terms after long periods of expansion,[2] for the African race group, student teacher numbers continued to expand rapidly into the 1990s.

[1] See Fedderke *et al.* (2000A, ERSA Working Paper No.14) for the relevant figures.

[2] This may well be a reflection of high opportunity costs of entering the teaching profession for these racial groups in terms of both earning potential and status.

Once again, the expansion of African teachers in training in the late 1970s and the 1980s reflects the expansion of secondary education on which we have remarked on a number of occasions in this paper. A positive implication of the evidence is that to the extent that the teachers in training obtain an appropriate quality of training, and that such teacher output is actually employed in the public schooling system, pupil–teacher ratios in the formerly African schooling system should over time come to adjust to more acceptable levels than were evident in the early 1990s (see again Fedderke *et al.*, 2000B).

Patterns of development for lecturing staff at teachers' colleges are much the same as they are for student numbers. The most notable features of these are the peaking in the lecturing staff at teachers training colleges particularly for White teacher training colleges in the mid-1980s and a subsequent downward trend, and the rapid expansion in lecturing staff at African teacher training colleges during the 1980s. It is also noteworthy that teacher training in the TBVC[1] territories became an increasingly important component of African student teacher training, particularly during the early 1990s.

The collective implication is thus that the finding on student–teacher ratios for teacher training colleges is likely to diverge from that found for universities, and to conform more closely to the schooling system. This is precisely the finding that emerges from Figure 11. The student–lecturer ratio in White teacher training colleges is less than 10:1 in the early 1990s, while that for African teacher training colleges hovers at the 20:1 level. Indeed, the only racial group that comes close to White student–lecturer ratios is the Asian.

Nevertheless, it is worth noting that the student–lecturer ratio for African teacher training colleges have come off the peaks reached in the early 1980s (of around 25:1), and the student–lecturer ratio for African teacher training colleges is nowhere as disastrous as that for African schooling (which in the early 1980s was still at between 50:1 and 60:1—see Fedderke *et al.*, 2000B). The main cause for concern here is the differential that is present between the White and African teacher training colleges and the implication of both inequity and of inefficient resource usage that this implies.

Trends in the student–lecturer ratio are not difficult to account for. While student numbers in White teacher training colleges have been in relatively long-term decline, lecturing staff has only begun adjusting during the course of the 1980s. The consequence for White teacher training colleges has been a steadily falling student–teacher ratio since the early 1960s. For African teacher training colleges, it is the surge in school leavers that translates into higher student numbers for all tertiary education in the 1980s and a lagged response in the lecturing staff at teacher training colleges that drives the ratio for African teacher training colleges.

4.2 Real per student expenditure

We have already noted that, in terms of student–lecturer ratios, teacher training colleges show greater similarity with South Africa's schooling system than with South Africa's university system. This pattern is continued for real per student expenditure (see Figure 12).

Real per student expenditure for Whites shows a steady upward trend through to the 1970s, though it subsequently demonstrates a downward trend from the early 1980s. The only race group that has been able to match this real per student expenditure is the Coloured & Asian composite racial category. By contrast, real per student expenditure on African student teachers continued to be approximately at a third of the expenditure for

[1] The Transkei, Bophutatswana, Venda, Ciskei Bantustan 'independent' entities created under Apartheid.

White student teachers—even in the early 1990s. Moreover, in the 1970s the divergence was more extreme: with real per student expenditure for Whites standing in a ratio of approximately 10:1 to that for African students.

Again, this pattern is strongly reminiscent of that found for schooling in South Africa. The strongest approach of real per student expenditure to White levels takes place during the course of the 1980s, suggesting that the limited self-rule afforded by the tri-cameral

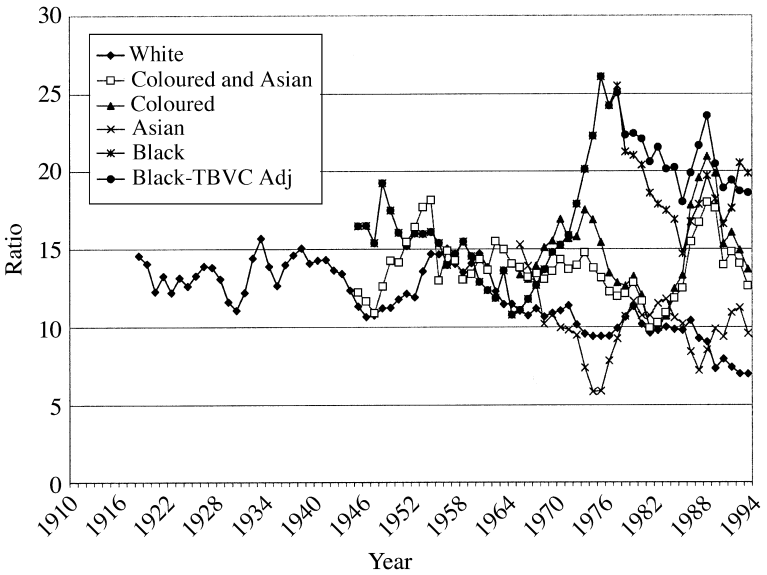

Fig. 11. *Student–lecturer ratio—teacher training colleges.*

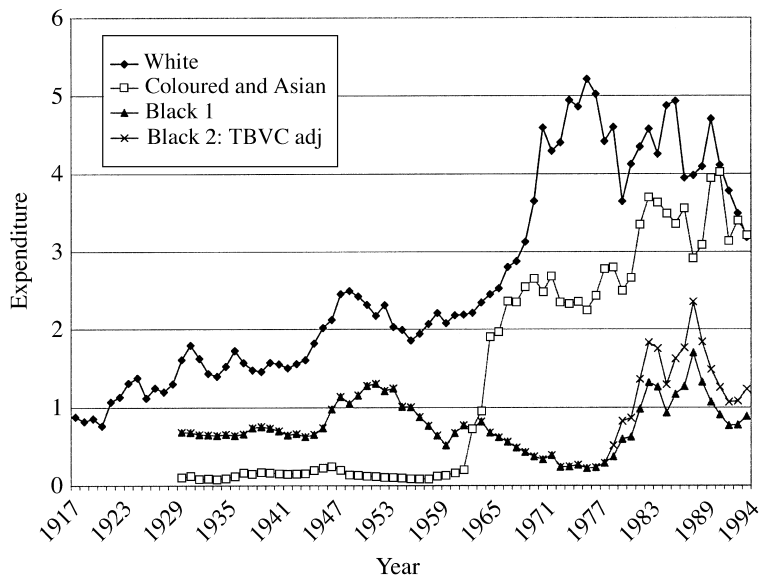

Fig. 12. *Real per student expenditure—teacher training colleges.*

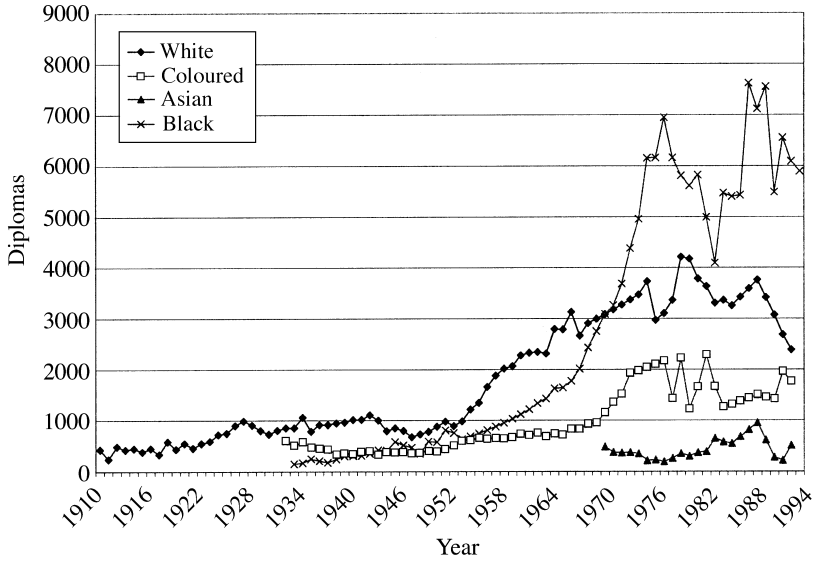

Fig. 13. *Teachers diplomas.*

parliamentary constitutional system does appear to have resulted in a more equitable allocation of expenditure between at least some racial groupings.[1]

4.3 Measurement of output: teachers diplomas issued

Output of teacher diplomas shows the same differential between African and other race groups as was found for student enrolments. For Whites, Coloureds and Asians, the pattern is one of a plateauing of diploma output during the course of the 1970s, and in the case of Whites, a declining level of teacher diploma output through the course of the 1990s. By contrast, the output of teachers diplomas from African teacher training colleges shows a strong increase through the course of the 1970s, though there is some evidence to suggest that the output of diplomas reached (a somewhat volatile) steady state during the course of the 1980s (see Figure 13).

It is noteworthy that the distinction between universities and teacher training colleges already commented on continues to emerge with respect to the output of teacher training colleges. In terms of real expenditure per diploma in teacher training colleges, for Coloureds & Asians expenditure adjusted to White levels during the course of the late 1970s and the 1980s. By contrast, the real expenditure per diploma for African teachers lagged behind, with the ratio of real expenditure per diploma for Whites and Coloureds & Asians in 1993 standing in a ratio of approximately 2:1 to that for African teachers' diplomas. Contrast this with the higher real expenditure per degree maintained by African universities relative to White universities.

Unfortunately, no data are available to control for the quality of the output of the racially classified types of teacher training colleges. The only additional measure at our

[1] The state attempted during the 1980s to stabilise the political system through the cooption of members of an emerging new middle class. Note that this hypothesis is also consistent with the finding of Fedderke and Luiz (1999) that the institutional capacity of users of educational systems to influence policy-makers is of significance in determining the quality or effectiveness of inputs into the educational process.

disposal is given by the ratio of diplomas conferred to the total student body in teacher training colleges. The ratio serves as a proxy for the throughput of the relevant teacher college system, viz., the ability of the teacher training colleges to translate its intake of students into graduands. Again what proves noteworthy is the divergence between White and Coloured & Asian teacher training colleges on the one hand, and African teacher training colleges on the other. For both the White and Coloured & Asian categories, the throughput of students into graduands appears to have stabilised at the 30% level since the 1950s. Given the three-year teacher diploma structure, this suggests a very high throughput rate for teacher training colleges—and one that is approximately twice that of the university system.

By contrast, African teacher training colleges proved to have a low throughput during the course of the 1950s, suggesting that African teacher training colleges were in start-up mode during this period. While the 1960s and 1970s saw throughput rates in African teacher training colleges of similar magnitudes to the White colleges, the trend in the African throughput rate has been steadily downward since 1976, and since the late 1980s has fallen sharply below that of White colleges. African teacher training colleges have thus shown a declining capacity to translate the rapidly expanding student intake into rising diploma output.

Again, therefore, it is arguable that the African teacher training colleges have represented a use of resources associated with relatively high opportunity cost. The duplicate teacher training colleges for African students have simply been less effective in translating their inputs into outputs than the established White teacher training colleges. Inequality in teacher training colleges follows a different pattern from that found for universities and technical training. Poor inputs translating into poor output suggests the 'cheap and nasty' pattern that attached to African schooling.

5. Conclusions

Our analysis rests on data collected for South Africa's tertiary education system over the 1910–93 period. This dataset is more comprehensive than any other we have encountered in the literature, in terms of both the time period that it covers and the range of variables collected on inputs and outputs into tertiary education.

It is important to remain mindful of the institutional context presented by South Africa's unique experimentation with racial segregation which has played a deterministic role in the formation of human capital. We have highlighted these throughout the paper. They include that the Apartheid State purposefully limited the education and opportunities of Africans, believing that they would not need these skills nor would it be desirable for them to compete with Whites and allocated resources accordingly. This provides the context of this study. That Apartheid restricted the professional opportunities available to the African population which may have influenced their investment decisions in human capital.[1] Also that the African population received poor basic schooling, particularly with regards to mathematics and science, which would have presented a supply-side constraint on NES degrees. And finally that the economy was relatively closed

[1] However, we see the problem primarily as a supply-side rather than as a demand-side problem. Furthermore, the legal constraints would seem to exert more of an impact in the earlier phases of the Apartheid era than they did in the latter phases. Thus, as the Apartheid order crumbled, NES opportunities opened up to a somewhat greater extent.

and stagnant, which checked the exchange of ideas and academic competition, thereby limiting the quality of educational outputs.

The result of the state formulating education policy with political rather than economic aims is that it led to an inefficient education system formed along racial lines. The findings confirm the presence of strong inequalities between race groups in South Africa's tertiary education. In the case of South Africa's universities, such inequalities emerged not in the form of the quantity of inputs, but simply in terms of the incapacity of African universities to transform inputs into appropriate quality outputs in the form of either degrees or research. By contrast, quality technical education was simply denied to Africans. Only teacher-training colleges reproduce the patterns we observed for schooling: poor inputs translating into poor output in African teacher training colleges.

The conclusions of this paper also carry more general import. We have seen that the patterns of discrimination in South Africa have assumed differentiated format across the different tertiary educational sectors. This has been closely associated with diverse and sometimes difficult to measure differences in the quality of education on offer to different sections of South Africa's population. As we have remarked throughout the paper, this carries significant measurement problems for any growth study wishing to isolate the impact of human capital on economic growth on the basis of a single aggregate human capital measure.

South Africa faces a legacy of poor human capital production not only at primary and secondary levels, but in its tertiary educational institutions as well. Addressing such problems requires a searching examination not only of the nature of the present educational structures South Africa has inherited from its past, but the will to grapple with the problems that such institutions carry within them. This might require a careful audit of universities to establish which are genuine candidates for world-class university status, which might better serve the region as first-rate or at least good Technikons or middle-rank state universities or liberal arts colleges, and which might best serve as good quality community colleges. Any policy that attempts to address such issues will need to engage not only with an examination of data. It will need also to address structures of expectation. University-based research is expensive and demands economies of scale and concentrations of expertise and resources. Not all tertiary institutions need to aspire to become, or need to remain, research universities. For some, the glamour is necessarily false. Indeed, the importance and value of good Technikons and excellent undergraduate liberal arts colleges needs to be re-affirmed. After all, the USA has dozens of genuinely outstanding liberal arts colleges, such as Amherst, Smith and Haverford, to name only a few. And its good community colleges are legion.[1] To this end, the wider politics and cultural assumptions that have come to characterise the South African tertiary system will need to be engaged with and, in many instances, challenged. For the tertiary system currently is a dead-weight structure, rather than a capstone to South Africa's educational system.

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[1] Whilst the American example may seem inappropriate, the reality is that Nelson and Wright (1992) indicate that this framework of investing in differentiated tertiary education was already in place by the late nineteenth century, during the US's developmental phase.

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Appendix 1: Methods, sources and classificatory conventions

For purposes of precision and consistency, we have followed the classificatory conventions deployed by the South African authorities during both the pre-Apartheid and Apartheid periods. We consider it important to record the information under these contrived rubrics, since the system of racial estates and statutory race classification had profound implications for the administration of educational matters and for the distribution of educational resources and opportunities. The post-Apartheid dispensation formally ushered in by the 1994 elections marks a significant regime-type transition. and the material that we have assembled in this way should enable one to gain a better descriptive and analytical purchase on current and future educational developments.

With respect to White education, many of the data go back to 1910, and our principal source until 1960 has been the *Union Statistics for 50 Years* and subsequently the Central Statistical Services Reports. For other race groups, data are of more limited coverage. While on occasion the series run through to the early 1930s, often coverage is more limited. Again, the initial source for the data was the *Union Statistics for 50 Years*, though in this instance the source required substantial supplementation. Sources included *Reports of the Auditor General*, sources published by the Department of Bantu Education (DBE)—later Department of Education and Training (DET)—Annual Reports from 1953 to 1993, and the Departments of Coloured and Rehoboth Affairs and Indian Affairs, later the reports of the Houses of Representatives and Delegates. Statistics for the TBVC[1] administrative instances disappear and then sometimes re-enter the DBE and DET data series. For purposes of coherence and continuity, we have reconstructed these data to cover all those territories which originally fell under the jurisdiction of the governments of first the Union and then the Republic of South African and which have, since 1994, been reincorporated. Our data are thus comprehensive and cover the Republic of South Africa, the non-independent ('self-governing') administrative entities as well as the TBVC 'states' during the Apartheid period.[2] Note that the statistical records kept by these latter instances were of an uneven and often appallingly bad quality.

The latter point is a general one that applies to many of the data sources we employed. The data quality is variable at best, and state institutions did little to maintain the consistency and quality of data publication over long stretches of South Africa's history since Union. In this context, several general sources proved to be of considerable value to our endeavour. These included the *Annual Surveys* published by the Institute of Race Relations, and E. G. Malherbe's *Education in South Africa* (Malherbe, 1977).

Considerable measurement difficulties were encountered in the study. A more detailed exposition of these can be found in the Working Paper No. 14. More detailed discussion of the behaviour of individual time series can again be found in the Working Paper.

[1] We follow the standard acronym for the Transkei, Boputhatswana, Venda, Ciskei set of territories, recognised as 'independent' by the South African state.

[2] Where adjustment for the TBVC states was not possible, we note this in the discussion that follows.