PERFORMANCE MEASUREMENT IN NOT-FOR-PROFIT PUBLIC ORGANISATIONS: RELATIVE EFFICIENCY AMONG SOUTH AFRICAN PUBLIC UNIVERSITIES

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DEDICATION

To the cherished memory of the Taylor family: Geoffrey 1915-50, Cynthia 1915-99 and David 1945-79.

CERTIFICATION

I declare that this thesis is my own work, except where acknowledged in the text, and has not been submitted for the award of a degree in any other university.

B.K. Taylor.

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ABSTRACT

This interdisciplinary thesis has two principal objectives: to measure the relative efficiency of South Africa's public universities between 1994-97 and to provide explanations for levels of efficiency observed.

Two methods – Data Envelopment Analysis (DEA) and analytical review – were used to measure relative efficiency and to attempt to explain efficiency amongst the ten universities for which comparable data were available, covering the years 1994 to 1997. Three DEA models – academic, research and consolidated – were estimated and this analysis was supplemented by the analytical review method, which confirmed the results from the DEA computations. Institutions were grouped according to their relative efficiency measures within three suggested apparent levels of efficiency. An attempt was made to explain efficiency across various dimensions and the issue of quality was also addressed.

Finally, some benchmarks of 'best practice' for the university sector were suggested. These findings have important implications for policy in higher education, particularly in respect of university rationalisation and governance.

PREFACE AND ACKNOWLEDGEMENTS

My interest in this area of research was inspired by the opportunities that I have had to study in various institutions of higher learning and across a broad spectrum of disciplines. Further motivation was provided by a lifelong working experience that has taken me into many organisations where performance measurement – of one kind or another – assumed prominence in organisation control and provided a cogent reminder of the need to continuously assess objectives and goals being pursued.

The knowledge – both theoretical and practical – that I have gained in life has been hard won and it is perhaps apt to quote *Bodenstede* in this regard:

'The seed of knowledge ripens but slowly in the mind, but the flowers grow quickly'.

My appreciation is extended to the many people who have contributed to my life's education: to my parents; to my family – Susan, Lynne and Claire; to my educators at various levels of learning and in the institutions of my attendance; to those colleagues that I have worked with and for; and to the many authors of articles and books that I have read.

Special thanks are due to my supervisor – Prof. Geoff Harris – for his enthusiastic support, his wise council and insight, his knowledgeable direction and his timely responses. Grateful thanks are due to Mr. H. De Beer of the Department of National Education for his assistance with the electronic transmission of SAPSE data and to my wife Susan for her support and for proofreading the manuscript.

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GLOSSARY OF TERMS AND ACRONYMS

AVE	Arithmetic average
CHE	Council of Higher Education
CNAA	Council for Academic Awards
CVCP	Committee of Vice-Chancellors and Principals
DEA	Data Envelopment Analysis
DES	Department of Education and Science
DMU	Decision making unit
DWV	University of Durban-Westville
FTE	Full-time equivalent
HBU	Historically black university
HE	Higher Education
HEFCE	Higher Education Funding Council for England
HSRC	Human Sciences Research Council
MED	Median
OFS	University of the Orange Free State
PAAB	Public Accountants' and Auditors' Board
PCFC	Polytechnics and Colleges Funding Council
PCH	Potchefstroom University for Christian Higher Education
PTA	University of Pretoria
RAU	Rand Afrikaans University
RHU	Rhodes University
SAPSE	South African Post-secondary Education
SAUVCA	South African Universities' Vice-Chancellors' Association
SCII	Social Sciences Citation Index
SDV	Standard deviation
STL	University of Stellenbosch
UCT	University of Cape Town
UFC	Universities Funding Council
UGC	University Grants Committee
UNIV	University
UPE	University of Port Elizabeth
ZLD	University of Zululand

CHAPTER ONE

INTRODUCTION

1.0 Introduction.

This interdisciplinary thesis sets out to measure the relative efficiency in South African universities and offers explanations for the different efficiency scores observed amongst these institutions. More generally, and with particular reference to the measurement of university performance, the theory of performance measurement in not-for-profit public organisations is reviewed. To provide a context for the review of relevant literature (Chapters 2 and 3) and in particular for the ensuing analytical chapters (Chapters 5, 6, 7 and 8), this first chapter considers the objectives, discusses the importance of the topic and provides a brief overview of the institutional setting. It then outlines the methods used in the research and summarises the limitations and assumptions of the analysis.

1.1 The objectives of this thesis.

The research described in this thesis has two primary objectives:

- First, it aims to measure the relative efficiency of a sample of South Africa's public universities between 1994-97 and to examine the changes in these efficiency levels.
- Second, it attempts to provide explanations for the levels of relative efficiency observed in these institutions.

A secondary objective, which mainly concerns the relatively inefficient institutions, is to assess the possible effect their financial structure has on measures of relative efficiency.

With respect to the second primary objective, certain questions are raised, of which the more important include the following:

1. To what extent does the number and growth of student numbers affect a university's relative efficiency?
2. What influence do student entrance criteria have on relative efficiency?
3. To what extent does the highest qualification level of academic staff influence a university's graduate and research output?
4. Are there differences in the distribution of personnel across the various staff categories and how does this affect efficiency measures?
5. How significant is cost structure to the achievement of institutional efficiency?
6. Is there evidence of a common pattern of recurrent expenditure across the eleven programmes of the Programme Classification Structure[1] and in the different personnel cost centres and how does this affect efficiency measures?
7. What changes – in real terms – in recurrent expenditure have occurred over the period 1994-97 and how has this influenced efficiency?
8. What influence does size – measured on a number of dimensions – of an institution have on its relative efficiency measure?
9. What proportions of financial resources do the relatively efficient institutions allocate to the various educational investment centres?
10. Has relative efficiency been achieved to the detriment of quality standards in higher education (HE), including the maintenance of graduate equivalence?
11. How important are the various dimensions of a university – undergraduate/post-graduate distribution, science/humanities orientation, cultural heritage, institution residential structure and age – in determining relative efficiency?

From the perspective of the community at large, the answers to these questions may go some way towards informing interested parties how efficiently or otherwise financial

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[1] The SAPSE framework that allows for the classification of an institution's resources and programmes/ activities.

resources are being used to achieve the objectives of government's HE policy and to guide consumer choice. At the level of the National Department of Education, the report of a Council on Higher Education (CHE) Task Team (2000), which has been asked to recommend a new structure for HE in South Africa, has accepted that some institutions are not viable and recommends that this problem be addressed by merging institutions rather than closing them. The findings from this research could contribute to the restructuring of the university sector. At institutional level, under general financial pressure from decreasing government subsidies, fewer enrolments and student debt, many institutions are rationalising their operations (by reducing the number of faculties; decreasing staff levels; out-sourcing services; deferring new capital projects) so as to reduce their operating cost levels and to restrain the depletion of capital reserves. Again, the answers to these previous questions may assist the management of each university to address the forces of change confronting their own particular environments.

These wide-ranging questions, amongst possible others, collectively suggest that it is difficult to determine precisely what aspects of institutional efficiency are of importance. As one author puts it:

> I have still another and deeper problem: the conflict between the idea of a selective university, and the ideas of equality and democracy. Efficiency, properly understood, is a fairly non-controversial position. It has been and is challenged in many specific contexts, currently very much with respect to environmental values but also and, perhaps, more fundamentally with respect to moral values ... In education, however, the problem is more what we should be efficient about than whether we should be efficient. (Arrow, 1993. 6-7)

Various authors maintain that any definition of efficiency has to be linked with an assessment of effectiveness – the extent to which output achieves stated objectives – and these, amongst others, includes quality issues in education. Put differently, an institution that is technically efficient, but fails to perform in terms of its objectives, will be of limited value to society. The view of Birch (1985) expresses the assertion succinctly:

> Effectiveness and efficiency are major concerns of management. An organisation is effective if it achieves objectives which are appropriate to the needs of society: it is efficient if it achieves these objectives with the minimal use of resources. Thus it is possible to be effective without being efficient, but it is not possible to be efficient without also being effective. (Birch, 1985.97)

1.2 The institutional context.

An overview of the HE institutional landscape provides a contextual background to the research undertaken for this thesis[1]. In 1997/98, the National Education budget amounted to R5.56bn of which R3.84bn (69 per cent), comprising R3.59bn for current expenditure and R0.25bn for *ad hoc* expenses, was allocated to the university sector. Expenditure per student across all institutions averaged R9 750 (based on the current expenditure budget), although at most residential universities this was between R13 000 and R16 500 per student. In terms of the subsidy formula, universities on average received 66 per cent of what they should have received.

This sector consists of twenty-one separate, autonomously managed but publicly controlled institutions. For the academic year 1997, there were about 368 000 registered students in South Africa's universities – 52 per cent black; 36 per cent white; 7 per cent Indian; and 5 per cent coloured. Of the total student population, 82 per cent studied at undergraduate level and, while the majority of students were female (54 per cent), more males than females are registered for post-graduate studies. At the formerly 'white' residential universities, white student registration ranged from 30 per cent at the University of Natal to 82 per cent at Stellenbosch University. Student enrolment increased by about 13 per cent between 1993 and 1996 but declined in each successive year between 1996 and 1999 by an overall 14 per cent. The historically disadvantaged universities have suffered from the migration of black students to the better-established and more widely recognised institutions. Although black

[1] Otherwise than where indicated, data in this section is compiled from the Department of National Education, Annual Reports 1997-99, Pretoria.

student registration at Afrikaans universities has grown more than in the English universities, much of this growth can be attributed to distance learning. The composition of the total student population is now beginning to reflect the demographics of the country.

The Tertiary Education Fund of South Africa financed over 52 000 student packages to a value of some R264m in 1997. Foreign donors contributed R84m, which accounted for 28 per cent of the government's projected fund target of R300m and government contributed 68 per cent of actual funding[1]. Income from student fees[2] in 1997 amounted to a total of R1.6bn, while student debt[1] at the end of that year totalled R451m – most of which was owed to the historically disadvantaged institutions. There is a general consensus that government subsidies are not sufficient to meet capital expenditures and operating costs, but certain institutions have been singled out for their injudicious use of financial resources.

In 1997, there were 36 470 permanently appointed personnel across all staff categories in the university sector. Of the total, 57 per cent were male and 43 per cent female; within the academic and professional staff category, about 30 per cent were female; while the academic staff was mainly male and white. Total personnel numbers decreased by 7 per cent between 1995 and 1998.

Between 1995 and the end of 1999, then, the sector had experienced financial pressures at individual institutional level; a high degree of rationalisation – for the sector as a whole and at most institutions; an overall decline in student registration; cut-backs in staff numbers; and demographic changes in the student population. The importance of improving efficiency in institutions of HE is therefore unequivocal.

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[1] Edusource Data News No. 22/October 1998
[2] Edusource Data News No. 27/November 1999

1.3 The importance of the topic.

In the absence of the profit motive which underlies the essence of private sector business objectives, performance measurement in not-for-profit organisations presents a unique set of difficulties. Where performance is based on the profit measure, the traditional debate is between short-term profit and ways of taking a longer-term view such as shareholder value. No such overall financial measure is available in not-for-profit organisations and while operating within the constraints of the budget process is essential, it provides little information about performance. Furthermore, performance in terms of achieving agreed objectives is difficult to evaluate. Frequently there are multiple objectives which change through political process and may not be precise, objectives may be paired with political and contradictory constraints e.g. 'cut costs and provide a better service, but don't declare redundancies' and resources may not be sufficient to permit the achievement of objectives.

For the university sector it is particularly difficult to determine appropriate performance measures of the education process. There are few measures of teaching performance that would enable a systematic external assessment of teaching quality and there are various key technical and political factors, which give rise to this. The development of valid performance measures depends on determining the goals and objectives of university institutions. In South Africa over recent years, these have become contentious and political, with the competing ideologies of HE reflecting conflict between economic and social values.

The objective of this research is specifically to measure the relative efficiency of South Africa's public universities. In December 1997, the new Higher Education Act was promulgated marking the beginning of changes which have had far reaching implications for all universities. This involved the establishment of a unified, nationally co-ordinated system providing for programme-based education, which would be planned, governed and funded to ensure maximum use of existing resources and to meet national education priorities. Central to the Act is a new funding system: reduced block grants plus a range of 'earmarked funds' for specific programmes (e.g. to address inequities in HE access) and financial assistance for students, curriculum and research development based on forecasts of student numbers. Overall the government has indicated its intention of reducing its levels of subsidy. Institutions will be required to formulate three-year strategic plans – outlining their missions, targets and performance indicators.

Further, the basis of the report of the CHE (2000) is that South Africa must have stable, excellent institutions, which produce graduates capable of competing internationally. An important recommendation of the report is the suggested reclassification of public universities into three separate categories – bedrock, selected and comprehensive – differentiated according to student numbers, the range of post-graduate studies offered and the extent of research areas. This all suggests that further rationalisation can be expected in the short-term and that this process will be both inter- and intra-institutional.

Universities have responded to their changing environment by entering into intensive, high-level academic and administrative planning processes, as a result of which a degree of rationalisation (referred to in section 1.1) has already occurred in most universities. Quality issues are addressed by setting objectives for strengthening existing and designing new academic programmes and increasing post-graduate research student enrolment and research output.

University management has recognised that their institutions have to survive and progress in an environment in which market forces and the demands of policy-makers are growing more powerful. Increasingly, it is important for universities to establish strategies to deal with change and to know how they are performing in relation to their own objectives as well as to the performance of other entities across the sector. Recognition of the economic imperatives of HE policies towards enhanced efficiency and quality has necessitated more internal evaluation. Efficiency measures which enable top management to raise questions about institutional strengths and weaknesses are vital in terms of optimising the use of resources and ultimately for improving performance.

A comparative analysis of results obtained across institutions will highlight the degrees of efficiency which are to be found within this sector and indicate the different factors that contribute to performance amongst the relatively efficient universities. The assessment of efficiencies will enable administrators to refine their operations by addressing excesses or deficiencies on the input side and optimising output in terms of a balance of inputs. The research should yield some benchmarks of best practice for institutions, linking financial and non-financial efficiency measures. A better understanding of institutional efficiency – of how the different input resources relate to each other and how they collectively give rise to improved levels of output – could enable universities to refocus their attention on quality of service; on the competitive environment in which they offer their service; on strategic issues; and on the overall control of their business operations.

1.4 Research methods.

This thesis involves the utilisation of concepts and techniques from a number of disciplines, including: management, finance, management accounting, economics and computing; therefore the thesis can be described as multi-disciplinary. Before proceeding to the methods used in this research, it is appropriate to define its central concept – efficiency.

Briefly, economists are interested in the functional relationship between inputs and outputs; this linkage gives rise to a key economic concept – efficiency – which in its basic form measures output per unit of input. The orientation may be towards output maximisation for a given quantity of inputs, or towards minimising the inputs required to produce a defined level of output. Inefficiency in producing output arises in two possible ways: by output being less than the maximum level attainable given the level of inputs available or excessive inputs being used to produce a given output (technical efficiency). By introducing input prices, it is possible to extend the concept of economic efficiency by examining whether output is being produced at its minimum cost. Allocative efficiency concerns society as a whole and requires that the allocation of all resources – between products, between entities in the same industry and between different industries – is such as to produce maximum output. The term X-inefficiency, while difficult to define, relates to insufficient managerial motivation needed to optimise an organisation's potential. In this thesis we are specifically concerned with technical efficiency; this is measured in relative as opposed to absolute terms, because there are no standard efficiency measures against which to judge university efficiency.

Frontier assessment methodology is one of two techniques used in this research to measure the relative efficiency of HE institutions. Methods for assessing efficiency can broadly be classified as being parametric or non-parametric – the former demands a quantifiable statement of the function that relates inputs to outputs while the latter does not (see Lovell, 1993). At a lower level of distinction in this classification, stochastic and deterministic methods are used to observe the reaction of a function to empirical data. The use of a non-parametric and deterministic method for measuring efficiency known as Data Envelopment Analysis (DEA), proposed by Farrell (1957) and further promoted by Charnes *et al* (1978), is employed in this research. The principal characteristic of DEA is the transformation of a multiple-input, multiple-output decision-making unit (DMU) into a single 'virtual input' and 'virtual output' value for all DMU's. The ratio of this single virtual input to virtual output provides a measure of technical efficiency. DEA maximises the efficiency of each unit relative to all other DMU's, such that those units not on the efficient frontier are scaled against a convex combination of the DMU's on the frontier. The efficiency of a unit will either be measured as unitary – 100 per cent efficient – or will be less than unitary, in which case it is inefficient.

The approach adopted to measure relative efficiency for each university commences with the development of two preliminary models, which separately consider the most important measurable outputs – academic teaching and research results – of the university sector. A selection of input variables is tested in each model, leading to the development of a series of phase or interim models. After these two preliminary models are developed, they are merged into one consolidated model to provide an overall assessment of relative efficiency. A preferred model (referred to as DEA6 – see section 5.3) is selected from one of the consolidated phase models. It is used for further DEA efficiency measurement and specifically to measure efficiency over a four-year period and to assess the effects of financial gearing on efficiency. All models are developed with an input minimisation orientation, where input levels are assessed for their efficiency, given the level of output.

While DEA is useful for providing an overall measure of relative efficiency for each institution and provides for other observations concerning efficiency measurement, there are limitations to its use (discussed in Chapter 5). For example, it is not possible to include in the DEA computations, all the many and appropriate variables that represent an institution's operations. In order to substantiate the DEA results, expand and add depth to the analysis of institutional performance, a second method – the accounting technique known as analytical review – is employed to further assess efficiency. Analytical review can be defined as the examination of ratios, trends and changes in balances from one period to the next in order to obtain an understanding of the financial position and results of operations of an entity. The computation of ratios will normalise the data set, remove the effect of scale from the data and allow for comparative analysis across all institutions. Using this technique, it is possible to delve into the quantitative dimensions of institutional input resources and output results and determine various linkages between these in ratio form. This will identify specific measures of efficiency rather than overall institution efficiency. In combination these two methods provide a balance to the analysis and measurement of overall efficiency.

The majority of the raw data used in the DEA computations and in the analytical review analysis, has been sourced from the South African Post-secondary Education (SAPSE) information system in electronic format. Managed and administered by the Department of National Education, Pretoria, this extensive and detailed information system contains the annual returns of operating information from South Africa's HE institutions. The following broad data categories which largely make up the SAPSE system, provide an indication of the different types of data that are used in the research:

- Details of qualifications, fields of study and credits.
- Student statistics.
- Personpower resource reporting statistics.
- Financial statements.
- Fixed assets statements.
- Building and space inventory statistics.

Other sources of data include the South African Universities' Vice-Chancellors' Association (SAUVCA) for research output, the Human Sciences Research Council (HSRC) for survey data on the first employment experiences of new graduates and the Public Accountants' and Auditors' Board's (PAAB) qualifying examination results for assessing institutional graduate quality. Data for the years 1994-97 are processed, analysed and reported on in this thesis. The year 1997 is here referred to as the 'base year' and is the year for which data is most recently available. Of the country's twenty-one public university institutions, ten are included in the analysis.

1.5 Limitations and key assumptions.

The limits of the thesis work are noted as follows:

- Educational and academic policies, practices and methods in HE will not be included in the research, nor will the study extend to issues of academic judgement.
- Measurement of quality in HE will not be specifically addressed, as this is a major research topic in itself. However, in the interests of effectiveness, the measurement of efficiency should not overlook the quality dimension and therefore this factor will be discussed at several points in the analysis.
- Institution financial strategy and policy – sources of finance, investment decisions, working capital, budget process and control – will not be investigated *per se* although, recognising that this business function may impact on efficiency measures, the research findings can be expected to provide some insight in this regard.

The following assumptions have been made in this research:

- DEA provides methods for estimating production frontiers and measuring efficiency that require a minimum extrapolation from observed data and does not require assumptions regarding cost minimisation or equivalence between technologies across the different institutions.
- DEA is assumed to provide a particularly robust methodology for use in research involving production frontiers in organisations where operating and business strategies are difficult to capture empirically and in competitive and regulated environments.
- The research will not evaluate the DEA model in terms of its mathematical or technical foundation. However, the thesis will validate the use of DEA as an appropriate methodology in the context of this research work.
- It is assumed that there is uniformity within the SAPSE data set and that data have been returned in a standardised comparable format by all institutions.

Other points, which should be noted, include:

- The research and analysis will focus on the overall performance of each university, viewed as an individual decision-making entity. Faculty performance will not be evaluated – either within an institution or collectively across the HE sector.
- University strategic planning processes, i.e. the formulation, evaluation and selection of strategies for the purpose of preparing a long-term business plan to attain goals and objectives, will not be considered in this thesis.
- Incomplete data from eleven universities have, to a certain extent, limited the scope of this study. This has technically precluded the use of a greater number of different input variables in the DEA computations (see section 4.2.3).

1.6 Overview.

The thesis is structured in the following manner. In Chapters Two and Three, literature is reviewed, focusing on approaches, structures and problems of performance measurement, on some conceptual frameworks and the various techniques to appraise efficiency and on the theory and practice of performance measurement of university teaching and research. The two methodologies used in this study are described and examined in Chapter Four.

In Chapter Five, three DEA models – academic, research and consolidated – are estimated. The efficiency measures resulting from these three DEA models are analysed in Chapter Seven, where further DEA technical analysis is reported. Analytical review is used in Chapter Six to compute various relevant measures (ratios and trends) of university performance. These results are analysed in Chapter Eight; three apparent levels of efficiency are suggested and an attempt is made to explain efficiency overall. Finally, in Chapter Nine, the main research findings are summarised, benchmarks of 'best practice' for the university sector are suggested and conclusions are formulated.

CHAPTER TWO

GENERAL THEORETICAL CONSIDERATIONS OF PERFORMANCE MEASUREMENT

2.0 Essential elements of a performance measurement system.

The global pursuit of improved performance in the management and delivery of services in the public sector has received and continues to receive priority. Numerous Government White Papers, Initiatives and Scrutinies on the subject have been published in many industrialised countries. The central theme in these publications is that performance should be improved and that such improvement must be measured in non-monetary as well as in monetary terms.

The recognition of the importance of public sector organisations focusing on performance is well-documented. The Trueblood Report (American Institute of Certified Public Accountants, 1973), suggests that an objective of the public sector including not-for-profit organisations' annual reports is to provide information useful for evaluating the effectiveness of the management of resources in achieving the organisation's goals and that performance measures should be quantified in terms of identified goals.

The Financial Management initiative (Her Majesty's Government, 1982) called for managers at all levels in central government in the United Kingdom to have a clear view of their objectives, and means to assess, and where possible measure outputs or performance in relation to those objectives. Likewise, the Next Steps initiative (Efficiency Unit, 1988), in calling for the establishment of agencies to carry out executive functions of government, indicated there was a need for greater precision about the results expected of people and of organisations and a need to focus attention on outputs as well as inputs. Government may require performance information to decide how much to spend in the public sector and where within the sector funds should be allocated. In particular, it will be of interest to know what results will be achieved as a consequence of a particular level of funding, or to decide whether or not a service could be delivered more effectively and efficiently in the private sector.

Anthony and Young (1988) argue that effectiveness and efficiency are the two criteria for assessing performance in any organisation. They define effectiveness as the relationship between an organisation's outputs and its goals and objectives, and efficiency as the ratio of inputs (costs) to outputs or the amount of output per unit of input. Each of these criteria is invariably used in a comparative rather than an absolute sense. It is not normally said that an organisation is eighty per cent efficient, but rather that it is more (or less) efficient than a comparable organisation, or that it is more (or less) efficient than it was last year, or that it is more (or less) efficient than budgeted for.

The need to measure performance pervades all public sector management and accounting systems. Hyndman and Anderson (1991) discuss why it is important to measure performance. Without information about what is being achieved (outputs) and what it is costing (inputs), it is impossible to make efficient resource allocations within the public sector. These allocation decisions rely on a range of performance measures, which, if unavailable, may lead managers to allocate resources based on subjective judgement, personal notion or in response to political pressure. Without performance measures managers will not know the extent to which operations are contributing to effectiveness and efficiency, when diagnostic interventions are necessary, how performance compares with similar units elsewhere and how performance has changed over time.

In reviewing the potential roles of performance measures in the decision-making and monitoring processes, Mayston (1985) suggested a number of other specific areas of use.

These include the clarification of organisational objectives, as an input to managerial incentive schemes and to indicate performance standards in the outsourcing of privatised services.

A possible classification of output measures that could be used by public sector organisations has been suggested by Anthony and Young (1988). They provide three terms by which to classify output measures. *Results measures* are those measures that are related to an organisation's objectives, *process measures* are those measures of activity carried on by an organisation and *social indicators* are broad measures of output that significantly reflect the work of the organisation.

Results measures are 'ends orientated' while process measures are 'means orientated'. The greater the correlation between a particular process measure and the furtherance of the organisation's objectives, then the more useful the process measure is as a measure of output. Social indicators tend to be of limited use because most are affected by exogenous factors. In an ideal situation, the objectives of a public sector organisation would be stated in measurable and time-oriented terms and the output would be measured in those same terms.

In order to measure organisation performance, it is first necessary to establish what the organisation's objectives are. As an organisation's objectives are multiple, partially conflicting and subject to change over time, appropriate measures of performance will have similar characteristics (Berry *et al*, 1995). Research work carried out by Pickle and Friedlander (1967) has demonstrated the conflicting nature of many organisations' objectives and, in particular, the conflict between short-run and long-run performance on virtually every dimension.

There is no single best set of performance measures, no unique basis for setting standards for those measures, and no universal reward mechanism that constitutes some perfect performance measurement system, applicable in all organisational contexts. However, emerging from the research of Fitzgerald and Moon (1996) are several themes, which together represent common characteristics of measurement systems used in practice. These include: knowing what the organisation's mission is, adopting a range of measures, extracting comparative measures to assess performance outcomes, reporting results regularly and driving the system top-down. They suggest that these characteristics serve as necessary preconditions for the attainment of best practice and in their view, these characteristics should be key ingredients within any organisation if a performance measurement system is to be an effective management tool.

It is also important that measurement be directed to help to influence and forecast future performance rather than merely to record and understand past results. A wide variety of literary sources point out that the traditional, all-inclusive financial measures are inadequate for capturing the complexity of modern organisation operations. Measurements will therefore need to be both financial and non-financial in nature reflecting the adoption of a range of measures. Also they must be balanced to ensure that one objective is not pursued to the detriment of others and collectively, should focus on the critical success factors identified within the organisation. The philosophy should be to simplify information and focus management attention on those things that really matter to the organisation.

Performance measures are necessary for public sector organisations to discharge accountability to government and the public. Accountability can be viewed as the requirement to be answerable for one's conduct and responsibilities. Public sector organisations must be held accountable not only for the finances entrusted to them, but also for results. The public will be interested in how public funds have been used to achieve public benefit and thereby to call selected representatives to account. In a like manner, government will require information on what has been achieved with the resources entrusted to public sector organisations. This will enable operational stewardship to be assessed and may well affect future funding decisions.

A commonly held view (Fitzgerald and Moon, 1996; Brignall *et al*, 1991) is that performance measurement is central to organisational control. However, it must be stressed that performance measurement is only one stage in the overall control process; it is also necessary to set standards, generate apt control systems and take appropriate action to ensure that such standards are attained.

2.1 Approaches to performance measurement.

The evaluation of an organisation's performance as a whole is frequently viewed more as the emergent property of the management accounting information system than as a subject worthy of concern in its own right (Le Saint-Grant, 1992). In consequence, this leads to a measurement system that only considers quantitative aspects. A further effect of this view is that profit achievement, despite its weaknesses, is given prominence. Peters and Waterman (1982) found companies that seemed the most focused – those with the most quantified statements of mission, with the most precise financial targets – had done less well financially than those with broader, less precise and with more qualitative statements of corporate purpose.

Five approaches to performance measurement have been suggested by Le Saint-Grant (1992). In order to compare and contrast these approaches, a frame of reference is required, incorporating four main dimensions by which performance measurement systems can be assessed.

The focus of performance measurement can converge on various *levels of hierarchy*. Some levels are appropriate for examining the performance of the organisation as a whole, others are more suited to appraising sub-units such as faculties or functions and finally, certain levels may concentrate on individual performance.

Organisational perspective concerns the position from which performance is evaluated, that is, who decides not only what constitutes good or bad performance, but also what constitutes performance *per se*. At the one end of the spectrum there are perspectives that are virtually based on the views of a single interest group such as investors, managers or government. These are termed 'uni-rational', in contrast to 'multi-rational' where performance is viewed from multiple perspectives. With a multi-rational perspective, the aim would be to accommodate the views of various interest groups equally and therefore equitably, thereby achieving a consensus on what constitutes good performance. In practice, many perspectives lie somewhere between the two.

The next dimension on which the various approaches to performance measurement differ is in the *model of the organisation*. For example, a behavioural model would concentrate on engineering the behaviour of an individual or group to gain desired results such as increasing output. Alternatively, a systems model can be used to engineer the transformation process of converting inputs of resources into outputs of finished goods or services.

The final dimension concerns the *categorisation of measures*. Traditionally, measures of performance are categorised as qualitative or quantitative. A systems-based, goal-seeking approach, for example, tends to lean heavily towards quantitative measures. Goals are translated into targets, such as return on investment or productivity, which facilitate quantitative indicators of progress. Other categories of measures include the audit commission's terms of effectiveness, efficiency and economy and the soft-systems approach categories of effectiveness, efficiency, efficacy, ethicality and elegance (Checkland and Scholes, 1990).

Having established a reference framework, the five approaches to performance measurement can now be set out and contrasted:

Audit Commission:

Inherent in this approach is a model of the organisation as a simple production system, where the organisation is seen in terms of a transforming process, converting resources (inputs) into finished goods or services (outputs). Types of measure favoured, fall into categories often referred to as the 'three E's' - economy, efficiency and effectiveness. This approach is therefore primarily concerned with quantitative measures, setting targets and appraising performance in relation to these (McSweeney, 1988).

Soft systems methodology:

This is a multi-rational approach. The perceptions of interest groups or stakeholders are sought with the aim of achieving a consensus on issues of concern. Interest groups could include management, staff, customers, investors and pressure groups. Although the systems model is used in this approach, it is used quite differently to the audit commission approach. Measures can be defined as the 'five E's'. Both effectiveness and efficiency are defined similarly to the audit commission's definition. However, in regard to effectiveness, consideration of multiple perspectives of the organisation leads to the ongoing debate regarding organisational aims and values. Efficacy relates to the accomplishment of tasks, and measures help to ensure that the task is actually carried out. Ethicality draws attention to the ethics of the organisation's operations. This could range from staff welfare, to student selection criteria and to credit control policy. Finally, elegance refers to more aesthetic considerations, for example, the attractiveness of the organisation's visual imagery. The measures considered are thus both quantitative and qualitative (Checkland and Scholes, 1990).

Service sector approach:

The viewpoint adopted is predominantly uni-rational, in accord with the financial requirements of investors, but modified to take into account the views of customers and competitors. The approach uses the systems model, viewing an organisation in terms of simple input-process-output functions. The service sector approach represents a determined effort to balance and integrate qualitative and quantitative measures. Six dimensions of performance were proposed by Brignall *et al* (1991): competitiveness, financial performance, quality, innovation, flexibility and resource utilisation.

Behavioural approach:

A traditional behavioural approach to performance appraisal focuses on the individual. This attempts to assist superiors in managing the performance of subordinates at any level in the organisation. The approach is uni-rational, being manager orientated. The performance measurement structure should provide a recognisably fair balance between effort and reward amongst co-workers and promote commitment towards clear organisational goals. Objective and subjective categories of measures are considered. Examples of the objective type are given as output-quantity measures and output-quality measures. Subjective measures can involve comparison of performance with that of other people or with an absolute standard (Moizer, 1991).

Systems resource approach:

The systems resource approach is primarily concerned with effectiveness, which is assessed by analysing the relationship between an organisation and its environment. A common feature of all organisations is that they compete for some scarce and valued resources, such as the recruitment of high-calibre staff and graduates, and funding in universities. The focus of the approach is placed midway along the uni-rational/multi-rational spectrum. For an organisation to be successful in competing for resources, arguably it must be pleasing some interest groups. The approach is not overtly multi-rational though, as it does not deliberately aim at accommodating the views of all interest groups. Types of measures advocated are those that assess the bargaining position of the organisation. The potential ability to control resources is considered in terms of energy, stability, relevance, universality and substitution. Energy refers to human activity in terms of the proportion of an employee's personality that is involved with the organisation. Stability refers to how transient the resources are, such as the rate of staff turnover. Relevance focuses on the degree of relevance of a particular resource to an organisation. Thus a university's ability to attract a high level of donor funding would be indicative of relevance. Universality refers to how well an organisation can attract commonly used resources such as unskilled labour, physical facilities or liquid resources. And finally, substitution denotes the versatility of the resource in terms of its value as a substitute in another application (Seashore and Yuchtman, 1967).

Which approach to performance measurement is appropriate within non-profit organisation parameters will therefore depend on several factors. The viewpoint from which performance is judged is important. The more dependent an organisation is on the co-operation and goodwill of others, the stronger the argument for a multi-rational approach. This is likely to include a focus on more soft, qualitative factors, such as the ethical posture of organisational policy, as well as the more quantitative measures of traditional management accounting. The soft systems methodology would appear to be appropriate for assessing performance in the public, not-for-profit organisation. To decide which type of approach to use is however both difficult and problematical for managers and organisational groups.

It is essential to have a robust process for developing performance measures. A four-stage process based on systems thinking has been suggested by Davis and O'Donnell (1997). The stages outlined below provide a systematic method of creating a set of integrated performance measures, an approach that according to them is proven in a number of organisations.

Initially, a clear statement of organisation objectives needs to be established. The Royal Society for the Encouragement of Arts (1995) concluded that sustainable success can only be achieved through the maintenance of confidence and support of all stakeholders. This suggests that traditional objectives, which benefit the providers of capital, may not be sufficient in the future, underlining the importance of a range of objectives.

In the next stage, the dynamic links between organisation activities and objectives are established, using the tools and techniques of systems analysis and design, to formulate the various relationships. Measures must focus on the factors that lead to success, in addition to the measurement of success itself.

A diagram showing the dynamic organisational links is used to identify which activities are critical. This gives rise to the so-called key performance drivers. Many of these will be expected but almost certainly there will be some surprises. The creation of a computer model showing the dynamic organizational links will be useful, particularly if these are complex.

In the final stage, methods of measuring key performance drivers are developed. Sometimes one can measure the driver itself, but often this is not possible and one or two proxies can be measured instead. The essential tool in this work is the 'influence diagram', which shows how all activities and objectives affect one another. Influence diagrams are particularly useful when there are important success criteria that cannot be measured directly, such as student satisfaction and staff morale.

2.2 The structure of a performance measurement system.

There is broad agreement that some form of performance measurement system is an important component of organisational control. Organisations will be pursuing different strategic objectives, operating in different environments with varying technologies, providing different products or services, and therefore will require different measures of performance. However, Otley (1987) suggests that common to all systems is the need to answer three basic questions. These are: what are the dimensions of good performance that the organisation is seeking to promote; what are the appropriate standards of performance in each of these dimensions, both for the organisation as a whole and for the segments which make it up; and what rewards (or penalties) are to be associated with the achievement (or non-achievement) of performance targets?

Dimensions of good performance concern the underlying purpose of an organisation. At one level this relates to corporate strategy, where long-term objectives and plans are developed and refined in order to achieve required performance. There are also the more detailed plans for parts of the organisation and for short-term horizons that have to be considered. It is here that overall corporate strategy merges into issues of management control and performance measurement.

At the level of the overall organisation and in terms of the pursuit of its goals, there is usually no single criterion that defines what good performance should be. The overall goals that are developed have to be analysed into subsidiary goals relating to such matters as marketing mix, quality issues, customer service, financial position and so on. In addition, goals need to be defined for each part of the organisation and for all of the business functions contained therein. Thus the dimensions of performance that are defined for an organisation are likely to be multiple and probably partially conflicting.

Although some aspects of performance can be quantified, others are less quantifiable, for example, organisation image and employee morale. Whether a goal can be quantified or not, the way in which it is achieved may not be precisely known. Therefore, any programme of action designed to achieve these goals is likely to be analysed in terms of its effectiveness and its overall acceptability.

Ambiguities in the collective goals and the problems of formulating appropriate plans to achieve them in a complex and uncertain environment, make this process one that demands considerable managerial insight and judgement. It is a process that is continually being reflected upon in many organisations because of the need to respond to, or pre-empt a continuously changing environment. Changes to the dimensions of performance being pursued are likely, in order that any new goals arising will be achieved.

When an acceptable set of dimensions of required performance has been established, standards of achievement on each of these dimensions need to be set. Emmanuel *et al* (1990) point out that there is an immediate conflict between what is desirable and what is achievable, with both being subject to considerable ambiguity. Executive management will consider the demands made by the various stakeholders associated with the organisation, most of all from customers and fund providers. They may have limited knowledge about how feasible it is to achieve the required standards of performance and the detailed actions necessary to implement them. This problem is exacerbated by the fact that those in the best position to express opinions about the feasibility of proposed performance are also the managers who will be held accountable for meeting the standards that are set. In such circumstances, managers may be less than unprejudiced in their assessments.

The conflict between what is desirable and what is achievable extends throughout the organisation, with senior managers focusing more on desirability and lower-level managers more on feasibility. According to Emmanuel *et al* (1990), the basic issue is one of information asymmetry, where senior managers are better informed as to what is necessary for overall organisational survival and success, while lower-level managers are better positioned to determine what actually could be achieved.

The association between reward structures and the achievement of performance needs to be considered. The setting of quantitative performance levels for managers will only be effective to the extent that managers observe acceptable rewards flowing from their achievement (or penalties from their lack of achievement). This requires the setting-up of formulae that link target achievement to valued rewards, although not necessarily financial. These can take a variety of forms, ranging from the encouragement of cohesive peer groups to the explicit linking of significant monetary rewards to target achievement, inherent in all incentive payment schemes.

There is no doubt that incentives can be formulated that will encourage managers to achieve, or at least report, a high level of performance. However, the manner in which performance is achieved may not be that which was intended or desired. In particular, such schemes tend to stress the independence of one organisational unit from another, and encourage a high level of competition between managers. This behaviour may be harmful where co-operation between managers is necessary for successful, overall organisational performance. These incentive schemes may encourage the distortion and manipulation of management information, such that senior managers become increasingly misinformed about what is actually happening, while believing all is in order.

This linkage of results with rewards is essentially part of an organisation's accountability function, which is at the centre of sound management. It includes not only the use of short-term rewards, but also overall assessments concerning managerial performance that may influence long-term promotion prospects. However, this is an area in which there is a tendency constantly to rearrange the precise links between performance and remuneration. Emmanuel *et al* (1990) suggest it links with the setting of performance standards, but the stage at which incentives are awarded and the points at which they rise incrementally with increasing performance, are also likely to affect motivation.

2.3 Problems that attend performance measurement and measures.

Although the need to develop appropriate performance measures is well-founded, many difficulties attend the development of a system that provides for performance measurement and the ensuing measures. According to Hyndman (1991), the major difficulties relate to a number of factors. In many cases, objectives are so vaguely documented that they prevent useful performance measures from being developed. Williams (1985) argues that this is the most difficult part of the whole process. Often objectives are defined in terms of activity (process) measures rather than specific, results measures, related to the strategic mission of the organisation. The problem with this is that more activity is not necessarily desirable, particularly where more activity (and expense), does not lead to improved results. As far as possible, the objectives should be stated quantitatively and in a time-constrained manner.

It is critical for the co-ordination of the measurement system that there is a sound relationship established between the low-level measures and the high-level objectives of the organisation. The low-level measures should, as far as possible, motivate managers and decision makers to behave in a way that furthers the overall strategic mission of the organisation. Establishing such co-ordination is often a difficult activity. The development of high-level measures requires much thought and experimentation because it is often at this level in the organisation that there is the greatest vagueness about objectives.

There is an inherent danger that quantity rather than quality will be emphasised. Measures of performance that do not adequately address the question of quality may be misleading. Quality in certain circumstances can be measured in terms of freedom from error. In other circumstances and usually in the case with higher-level measures, user surveys, professional judgement and peer-group reviews may be needed to assess quality. These measures therefore introduce the problem of subjectivity.

Because quantity is almost always easier to measure than quality, there is the danger of the measurable displacing the unmeasurable. This may lead to a distorted view of performance being provided. Given this difficulty, it is imperative that the measurement system is constructed to identify quality differences in outputs, such that these become an integral component of the reporting mechanism.

Measures of performance are normally relative rather than absolute and therefore some basis of comparison is required. The most usual comparisons are: comparisons with previous periods, comparisons with similar organisations and comparisons of actual with budget. To make these comparisons meaningful there is a need to match like with like wherever possible. When this is not possible it is important to interpret the measures in the light of any differences that exist.

Another potential area of difficulty relates to the treatment of joint costs. This is needed to derive measures of efficiency. The apportionment of these costs by organisations, often on a fairly arbitrary basis, may make it difficult to compare measures across organisations. To discourage inappropriate comparisons of efficiency it may be useful if, as far as is practicable, the method of apportioning joint costs is disclosed. Furthermore, if comparisons over time are made of a particular organisation, then a consistent basis of apportionment should be used.

External influences may also make comparisons difficult. Differences in socio-economic variables affecting populations from various geographic areas may render comparisons of performance meaningless unless interpreted in the light of such differences. Where socio-economic variables are needed to interpret performance measures, these should be provided together with an explanation of their significance.

Without some discipline and standardisation regarding the choice of measures, management may engage in 'gaming' whereby they choose measures that show up their own or their organisation's performance in a favourable light. This is especially the case when they have the power to change measures from time to time. A definition of measures appropriate to a particular area of activity would reduce the opportunity for manipulation.

Simplistic approaches, arising from whatever sources and for whatever reasons, are unlikely to contribute much to the improvement of financial management in the not-for-profit sector. In developing performance systems, it is important that the correct relationship between high-level and low-level outputs, the weight to be attached to various objectives and the problems in the interpretation of performance measures, all receive careful consideration. High-level performance measures are often the most difficult to establish because many costs and benefits arise over the long-term, difficulties exist regarding the separation of the impact of environmental factors from organisation inputs and outputs and it is particularly difficult to capture the quality dimension of such measures. These factors encourage a concentration on the low-level objectives that are significantly removed from the strategic issues. This may result in the production of an excess of low-level performance measures and a dearth of vital measures that reflect the most important outcomes. Williams (1985) argues that in complex organisations where ambitious objectives are pursued, one cannot expect simple-minded approaches to play more than a minor contributory role. An organisation can have too few measures resulting in a system that does not adequately reflect its whole range of social and economic impact.

It is important therefore that the higher-level outputs are focused on. Anthony and Young (1988), stress this need by suggesting that in most not-for-profit organisations there are a few key measures that are important indicators of success. They take the view that opinions may differ as to what these are, but it is usually worthwhile to give careful thought to identifying them. They also suggest that due to the multiple and complex objectives of most public-sector organisations, it is impossible to develop defect-free measurement systems.

According to Binnersley (1996), the underlying value of performance measures can only be realised through comparison, either against past performance, which normally provides no true indication of the future or competitive position, against budget or through the benchmark process. He points out that these measures often rely on labour intensive, internal accounting systems that fulfil reporting requirements of regulators and accounting bodies, with the result that accounting measures play a limited role in management decision- making.

The use and development of performance measures is not straightforward (Emmanuel *et al*, 1990). Organisations often require that co-operative action be taken, but trying to measure individual performance will not necessarily reflect co-operative aspects of performance and may be dysfunctional, in that individuals may pursue actions that enhance their own positions at the expense of the organisation's best interests. The specification of tasks and targets in advance may be of little use because of the ambiguous nature of managerial responsibilities and the measurement of results may not be adequate to reward effort, especially if the environment does not materialize as was expected when targets were set.

According to Berry *et al* (1995), a major problem is that reward systems reward reported performance and not behaviour. This leads to the situation where managerial behaviour is geared towards the achievement of reported results.

In a study of cost centre managers, Hopwood (1972) argues that three diverse orientations to performance measurement can be identified and in each case there are different approaches to the linkage of performance and rewards. In a budget-constrained style, a rigid insistence upon the short-term achievement of the budget is the central feature, while in a profit-conscious style the general effectiveness of the unit's operations is the central feature. Finally, there is a non-accounting style in which budgetary data are seen as relatively unimportant and other measures of performance are used. One can immediately see the problems that arise in measuring performance. Managers evaluated in a non-accounting style are less cost-conscious than those evaluated using accounting-based styles. Those managers evaluated using the budget-constrained style reported higher levels of stress, poorer working relationships and a greater tendency to manipulate financial reports.

Otley (1978) also found that performance influenced the choice of management style, with higher achieving managers more likely to be assessed under the more flexible style. The option of the way in which budgetary outcome is used in performance measurement is a complicated process, offering the prospect of some unexpected secondary effects.

The effects of different environmental influences on performance measurement were studied by Hirst (1981). His research indicated that in a highly uncertain environment, accounting measures are seen as providing a less complete measure of performance than in a more stable environment. This finding was supported by Govindarajan (1984), who suggested that in a highly uncertain environment more subjective performance measures are likely to be adopted.

Other problems relating to the use of traditional measures include contentions that there should be more consideration given to what drives the numbers rather than the numbers themselves, they tend to reflect functions rather than processes, they are structured to fit the organisation rather than to shape it and they generate too much information and provide the wrong level of information to inappropriate personnel.

2.4 Performance measurement in not-for-profit, public organisations.

2.4.1 Distinguishing characteristics of not-for-profit, public organisations.

The public sector is different to the private sector in a variety of ways. Some of these differences are inevitable, possibly because of the nature of services provided. Many of the differences are highly desirable, projecting a rather different set of values and staff dedication to ideals of duty, which may be difficult to preserve. Others may be highly undesirable; the lack of innovative management is often cited, and comparison is often made with the private sector that is believed to be more efficient (Williams, 1997).

Drucker (1990) claims that one of the most basic differences between public, not-for-profit organisations and private sector organisations is that the typical not-for-profit organisation has so many more relationships that are vitally important. In all but the very large private organisations, the key relationships are fewer, involving employees, customers and owners. Each not-for-profit organisation has a multitude of constituencies and has to work out the relationships with every one of these groups. This will influence the way that these organisations are managed and measured.

One aspect of not-for-profit sector management that distinguishes it clearly from management in the private sector is that identification of objectives may be difficult or even futile (Smith, 1993). Various stakeholders have different expectations of public organisations, for example, students, staff, the community at large and government, may wish to emphasise very different outputs from the secondary education sector. Within a specific group of stakeholders there may be a broad mix of requirements, whilst over the course of time the priorities of the groups may change. In the end though, secondary educational institutions must reconcile the possibly conflicting demands made on them. To set explicit statements of objectives might indicate that educational institutions are favouring one group of stakeholders to the detriment of another group, and preclude the flexibility needed to adapt to changing demands.

According to Williams (1997), in principle there are two fundamental objectives – either provide a 'defined' service and somehow obtain the funds to support it or provide the 'best' service possible for the given level of funding. Invariably professional employees, rather than professional managers, have pursued the former, which creates a need for increased funding. On the other hand, politicians and administrators are inclined to the latter, but they will have to elect which services to omit. Given these unclear objectives and that all the groups involved have their own objectives, Williams (1997) suggests that this will be an indeterminate political process. A specific outcome of this is that every change in funding leads to a reassessment of objectives. It is therefore important to stress that identifying objectives is not a trivial process.

The not-for-profit organisations have always posed particular problems concerning organisational control. According to Smith (1993), the problems that are the most difficult to solve are: the difficulty in securing agreement on what the output (and objectives) of such organisations should be, the difficulty of measuring such output and the eventual outcome of public sector intervention, the difficulty of interpreting any output and outcome measures that can be developed and the difficulty of persuading the community to take an interest in performance measures and their interpretation.

There are not only contrasting differences between the control systems found in the public and private sectors, there is also a pronounced distinction between central and local control systems within the public sector. These differences have a major bearing on performance measurement. Central control is characterised on the one hand by cash allocation through formulae and political process, based on assessed need, but not local efficiency. This is being changed in the UK, for example, by establishing 'quasi-markets' and 'internal markets'. On the other hand, there is no clear link between funding and efficiency measurement. When there is a perceived need, an inefficient unit will nevertheless be funded and local management or local political pressure may improve efficiency. Finally, there is measurement of relative efficiency using various performance indicators (noting there is no 'engineering approach' to determine a theoretically possible efficiency). Essentially, there is a complete separation of control from performance measurement in the public sector. In the private sector, control over multiple units has been established using simple techniques. Units are viewed as investment centres, where managers have only limited authority and return on capital employed is measured. A detailed comparison of key ratios is made and this approach proves effective because all units are aiming to offer very similar services.

The public sector experiences the problems of being a service provider. Brignall *et al* (1991) suggest four key characteristics differentiate a service organisation and influence its approaches to control and performance measurement. First, *simultaneity*, where the customer is present during production and consumption of the service – most services cannot be measured, inspected or verified in advance of their delivery. Second, *perishability* refers to services that cannot be stored. Controlling quality and matching supply to demand are key management problems, often exacerbated by the presence of customers during the delivery process. Third, *heterogeneity* reflects service having a high labour component and places particular pressure on the measurement control system to ensure some consistency of quality from the same employee and to obtain comparable performance between all employees. Fourth, *intangibility* refers to service output that cannot be precisely measured, for example the helpfulness, dedication and responsiveness of staff that influence levels of customer satisfaction. Identifying what a customer values from a complex mix of intangible services makes the process difficult to measure and control. These four characteristics pose additional problems in terms of identifying what to measure and in particular, when and how to measure performance.

The next major distinguishing characteristic lies in the funding of public, not-for-profit organisations. In the private sector, revenues are generated from the customer base. However, in the public sector, funds are provided by government through taxation and not generally by charging customers, as in the case of university student fees. Obtaining funds, or additional funds, can be a complex political process, for there is no automatic logic that equates additional service provision with more funds.

There are significant underlying differences between the budgeting process in the public and private sectors. The first factor to be considered is that of motivation, for a profit-responsible manager in the private sector is often rewarded for achieving budget and is motivated to maximum achievement when budget limits are extended. A public sector cost-centre manager responsible for delivering an array of services within a budget is presumably motivated to achieve the service delivery. The budget limits must be adhered to, even if this leads to a reduced service level.

Within the public sector the budget authorisation decision is all-important. Once approved, clear authority has been given to act within its limits and in the manner specified by the detail in the budget. Little flexibility, technically referred to as 'virement', is permitted in moving funds from one budget head to another. The funds will emanate from taxation and can be assumed to be certain. This does not apply in the private sector for income is not certain, because it arises from trading in markets, and however stable the market and precise the budgeting, the exact income is not known in advance.

In the private sector the budget can often be varied for good reason and with prior management approval, but in the public sector this is only possible in quite exceptional circumstances. Expenditure increases are almost invariably balanced by expenditure cuts. It is more appropriate in the private sector to regard budget review as a process of performance evaluation, rather than a process of control. In the public sector, due to the difficulty of increasing the budget, there is a significantly greater element of control.

The budget negotiation is also quite different. In the public sector, the agreed budget will be a commitment for the whole budget period and it will be possible to closely control actual against the original plan. In the private sector, there is always the possibility of change, small in a large corporation within a stable environment, but very considerable in smaller organisations. This difference is explained by Jonsson (1984), who suggests that resources are allocated to activities via the budget in the public sector. It is a fundamental difference between private and public organisations, that the public organisation is related to its source of finance by a budget, while private organisation finance is related to market forces.

In the public sector, budgeting will inevitably be political, and is often described in this way. Wildavsky (1975) refers to this as an attempt to allocate financial resources through political processes to serve human needs. This is not to say that political manoeuvring is unknown or even unusual in the private sector, but that it is limited by the market system.

2.4.2 A review of a conceptual framework for performance measurement.

In 1979, Parker put forward an argument for a balanced assessment of performance to be measured by a composite mix of qualitative and quantitative indices. The main assertion was that, as there is a plurality of organisational objectives, there must be a balanced view of performance and the indicators used to appraise it. This idea of a balanced view has been further developed by Kaplan and Norton (1992), who introduced the concept of a balanced scorecard that represents a set of measures aimed at providing executive managers with a quick but comprehensive view of the organisation. The balanced scorecard forces managers to look at the organisation from four important perspectives. These are: customer perspective – the way customers view the organisation; internal business perspective – those factors that the organisation must excel at; innovation and learning perspective – the organisation's ability to continually improve and create value; and financial perspective – the assessment by fund providers.

It is argued that the financial measures show the results of actions already taken. These financial measures are then complemented with operational measures on customer satisfaction, internal processes and the organisation's innovation and improvement activities. Important features of this approach are that they consider both internal and external matters that concern the organisation and that the goals and performance measures are related to the key elements of organisation strategy. The fact that financial and non-financial measures are linked is a further important feature. The scorecard limits information overload by limiting the number of measures used and places emphasis on strategy and vision rather than on control. Their work is underpinned by the notion that this approach is consistent with the recent trends towards cross-functional integration, global competitiveness, continuous improvement and team rather than individual accountability. By combining the financial, customer, internal process and innovation, and organisational learning perspectives, the balanced scorecard assists managers in understanding implicitly the many relationships within the organisation. This understanding can help managers to overcome the usual views about functional barriers. The balanced scorecard is regarded as a system for keeping organisations looking and moving forward, rather than backwards.

The conceptual thinking behind the balanced scorecard was further developed by Kaplan and Norton (1993), who point out that managers may introduce new strategies and innovative operating processes but fail to match these new initiatives with new measures of performance. There is emphasis on the fact that the balanced scorecard is not a template that can be applied to organisations in general. It is important to recognise that different market situations, product strategies and competitive environments require different scorecards. This aligns with the concept of the contingency theory of management accounting; the scorecard must be devised with an understanding of the contingent factors facing the organisation. An aspect that is continually emphasised is the need for the scorecard to be more than just a measurement system. It is suggested that the scorecard has its greatest impact when used to drive a change process. It is argued that the scorecard is a management system aimed at focusing strategy so as to create a break-through in competitive performance. This important link between an organisation's strategy and its management control systems was further developed by Kaplan and Norton (1996), who see the scorecard as the foundation of an iterative and integrated management system, which allows strategy to evolve in response to changes in the organisations' competitive, market and technological environments.

Although Kaplan and Norton's work has tended to focus on manufacturing organisations, their ideas are just as appropriate in service organisations. There are significant similarities between their work and that of Brignall *et al* (1991), who in recognising the unique characteristics of service organisations, advocated the measurement of service across six generic dimensions. The six dimensions are: competitiveness, financial performance, quality of service, flexibility, resource utilisation and innovation. They emphasise that these dimensions fall into two conceptually different categories. The first two dimensions are results orientated which reflect the success of the chosen strategy, while the other four factors are determinants of competitive success. They suggest that the design of a balanced range of performance measures should be structured in relation to an organisation's service type, competitive environment and chosen strategy.

Similarities between the work of Kaplan and Norton (1992) and Brignall *et al* (1991) show that there is a need to balance the approach to performance measurement, to consider possible trade-offs between different parts of the performance scorecard, to link financial and non-financial performance measures together and to link performance measurement to the organisation's strategy.

2.4.3 Measurement problems and the effect of profit motive absence.

An obvious additional problem in public sector performance measurement is the absence of the profit measure. Only when this measure is absent, is it possible to appreciate all its uses, for it provides a single criterion of measurement, reducing all organisational debate to the effect on profit. In the public sector, arguments become debates about an organisation's objectives. Quantitative analysis in terms of relevant costs and revenues is possible and evaluations can be made to assess the effects on future profit. This can be compared with the indeterminate cost-benefit analysis done in the public sector.

Profit provides a broad measure of performance because managing profit assumes an ability to balance costs with revenue, and not only technical excellence in functional management. It assumes that profit incorporates all other relevant measures and if a measure does not affect profit it can be ignored. According to Ezzamel (1992), profit enables decentralisation, where managers can have delegated powers to trade-off costs and revenues to achieve profit. Without a clear profit objective, delegation and the cost/revenue trade-off is limited.

Comparison between unlike units is possible using profit as a measure. Profitability measures allow all profit-making organisations to be compared, whereas efficiency measures only allow entities that are identical or very similar to be compared. Profit is also an important factor in motivation and education within an organisational setting. Managers need to be educated about the corporate profit objective and then programmes and systems set out to motivate managers so as to achieve these corporate objectives.

The private sector organisation can, in principle, measure performance by sales and profit. It will be concerned with other factors though, including public satisfaction, because they affect profitability, but these are intermediate measures. It is profit that is the final measure of achievement of objectives. The measure of ultimate success is not dependent upon the product concerned; there are universally accepted, abstract performance measures, such as return on investment (incorporating profit). These simple, unequivocal measures are neither available nor appropriate in the public sector. A range of measures is required to deal with the multi-dimensional nature of public service.

According to Stewart and Walsh (1994), 'the dilemma of performance management in the public sector is to secure effective performance when the meaning to be given to it can never be completely defined and the criteria by which it is judged can never be finally established' (p.45). The elusive nature of performance makes it difficult to capture and measure. Performance measures for services are inherently more difficult to establish than measures for products, because the output of service is determined through interaction with the customer, who contributes to and determines the quality of output. The nature of performance in the public sector is inherently uncertain, posing a more fundamental difficulty. Weisbrod (1988) has argued that certain activities are in the public or not-for-profit sector largely because of the complexity of assessing them. As these activities are not easily monitored and therefore rewarded (the strength of the private sector), society turns to other sectors to perform them. Often measures used do not measure outcome and impact, but rather intermediate output. The relationship between input, output and outcome is also not necessarily clear, and there are also problems about the manner in which these measures interact. When discussing performance measures in the public sector, it is generally recognised that there are limits to the extent to which adequate performance measures have been developed. The assessment of performance in this sector necessarily involves comparison of variables that are unalike and cannot be reduced to a common denominator.

An appropriate performance measure can itself be the subject of political argument, and often is, for example, when there is debate about the extent to which social factors should be factored into the assessment of educational performance. An apt performance measure will, in any event, vary according to who is concerned with performance and there can be no boundaries excluding the community from a concern about the performance of a particular service. The assessment of the contribution of the public sector to the well-being of a community will, as Hirschman (1982) has argued, be constantly shifting.

There are many aspects to performance in the public sector and Dalton and Dalton (1988) have suggested that the criteria of performance are wider than in the private sector. They propose that an organisation's implementation of public policy may be characterised as just or unjust, equitable or non-equitable, coercive or non-coercive and representative or non-representative. The values realised in the public sector are therefore different from those in the private sector and add to the problems of measurement.

The political process gives rise to trade-offs between different factors; it is possible to trade-off one element of performance against another. For example, short-term gains in economy (budget cuts) can be 'purchased' at the expense of longer-term effectiveness and excellence and extending the scope of equity is often traded off against a reduction in efficiency. These trade-offs are, according to Jackson (1990), the substance of public sector management.

Trade-offs are not measurable but are a matter of judgement and political decision, where one value is weighed against another. The reason why adequate performance measures cannot be easily established in the public sector is therefore not only a matter of technical difficulty, it is inherent in its nature. Given that performance has many dimensions and is inherently contested, then measures can be viewed as competing or reflecting different value systems. Arvidsson (1986) distinguishes between the following aspects of performance: economic, democratic, legal and professional, and alludes to the difficulty of finding indicators which are both relevant and operational. It is further held that performance can seldom be expressed in a meaningful way by quantitative data only; analysis of performance has to be based on qualitative descriptions and statements. Stewart and Walsh (1994) go further by suggesting that it is the absence of an ultimate measure that makes 'judgement' crucial to performance measurement. Imperfect or uncertain measures should be used in full awareness of their limitations and seen as a means of supporting judgement.

The following chapter considers some performance measurement studies of HE, examines a conceptual framework for performance measurement and various techniques to measure efficiency and reviews the theory and practice of performance measurement of university teaching and research.

CHAPTER THREE

MEASUREMENT OF UNIVERSITY PERFORMANCE

3.0 An overview of performance measurement studies in higher education.

The assessment of performance in HE has historically been based on statistical methods and the development of performance indicators, which have drawn criticism from both academics and administrators. Different techniques, which vary from simple financial reporting of accounting standards to the use of sophisticated frontier analysis methodologies, are used in the measurement of performance in HE. An evaluation by Johnes (1992) of individual indicators raised doubts about their relevance and validity as measures in isolation, while comparisons have shown that different indicators produce widely differing assessments of the same institution (Johnes and Taylor, 1990). According to Dyson *et al* (1994), performance measures are sought to address diverse objectives such as public accountability and management control.

The importance of extending the concept of efficiency from simple unit costs to a systematic approach that aims to integrate multiple inputs and outputs was recognised earlier on by econometricians. Layard and Verry (1975) used aggregate linear cost functions for teaching and research and tested the use of explanatory inputs to examine outcome efficiency in HE although, by their own admission, their work was not wholly successful. Cohn *et al* (1989) extended this work with a more detailed consideration of scale and scope economies by using a multiple-output cost function for various outputs in US universities. In their cost-efficiency study of US universities at institutional level, De Groot *et al* (1991) formulated a multiple input and output model that utilized a wide range of recurrent expenditure data. They experimented with dependent variables, using full-time equivalent undergraduate and graduate student numbers and the number of degrees earned, finding the results similar.

Cost-efficiency research was extended by Glass *et al* (1995), with the consideration of capital input, which previous studies had found too variable to include. In the light of their results on the economies of scale and scope, they go on to examine the UK government's policy of expanding undergraduate numbers while driving unit cost down. Johnes (1995) considered synergies between outputs split between sciences and non-sciences, using a stochastic frontier estimation to fit a multi-product cost function.

Two recent studies published in 1997 are of particular interest in terms of methodology to this thesis. According to Athanassopoulos and Shale (1997), DEA is the most recent methodology used to examine the problems of performance measurement of HE institutions. Wilkinson (1993) examined effectiveness (outcome efficiency) in the process of university education, while Beasley (1995) used DEA methodology to assess the trade-offs between the resources used by departments in the production of teaching and research outputs. Doyle *et al* (1995), in the light of considerable recent emphasis on research performance measurement, focused on the 1992 UK Research Assessment Exercise data for business and management studies. Following the transfer of resources from established Australian universities to former colleges of advanced education, Madden *et al* (1997) compared the initial and subsequent performances of economics departments by applying survey data to a DEA model. A summary of the objectives, methodology and variables and results of selected performance measurement studies are shown in Table 3.1.

Table 3.1 Summary of selected performance measurement studies in higher education.

Coverage	Objectives	Methodology and variables	Results	Reference
United Kingdom, 1968-69.	To estimate the cost of undergraduate/ post-graduate teaching and research (outputs) in all UK universities using an econometric approach.	1. The main approach uses these three outputs in an aggregate linear cost function to explain total cost (salaries, wages, consumables, equipment and maintenance costs), extended and supported by; 2. An alternative time-allocated departmental cost function, using the same input – output array.	1. Absence of substantial economies of scale, high marginal costs for post-graduates, undergraduate and post-graduate marginal costs rise/progress from arts → science → engineering. 2. Higher departmental set-up costs, approximately similar undergraduate costs and much lower post-graduate marginal costs.	Layard *et al* (1975)
United States, 1981-82.	To estimate a multiple-output cost function and to calculate the degree of scale and scope economies for various output bundles in higher education.	The basic specification of the model is a flexible, fixed cost quadratic equation. Inputs = cost of average faculty salaries. Outputs = undergraduate and graduate teaching costs, research grants.	A multiple-output cost function is preferable to the conventional single-output cost function. Economies of scale and scope exist in public and private institutions. Product-specific economies observed in the public sector. Scope economies suggest that institutions involving undergraduate/ graduate teaching and research may be more efficient than those specialising.	Cohn *et al* (1989)
United States, 1982-83.	To study the sensitivity of cost function estimates to different output measures and the impact of state regulation of personnel and financial practices on production efficiency in 147 doctorate granting universities.	A general translog specification is used to approximate the cost function for multi-product output, for total cost and various different cost components. Inputs = total variable costs (education and general expenditure) Output = undergraduate and graduate FTE enrolment (alternatively earned degrees), research publications.	Evidence is found of economies of scale for an average institution, as well as scope. Institutional ownership (public or private) is not significant for the explanation of variable cost. The intensity of state regulation in the public sector does not significantly impact on production efficiency.	De Groot *et al* (1991)

Table 3.1 Summary of selected performance measurement studies in higher education (continued).

Coverage	Objectives	Methodology and variables	Results	Reference
United Kingdom, 1989-90.	To examine the cost efficiency of UK universities as producers of teaching and research output and; to estimate the product and input-specific economies of scale, product-specific economies of scope, marginal costs and cost complementarities.	A two input, three output general cost function model is employed. Inputs = capital and labour expense. Outputs = number of FTE undergraduate (UG) and post-graduate students (PG), units of research output (R) including a peer review of quality.	In a sample of 61 universities, overall and product-specific scale results indicate considerable increasing returns, while scope results suggest neither economies nor diseconomies. For PG and R output in all universities no cost complementarity found; cost anti-complementarity found between R and UG and between PG and UG outputs.	Glass *et al* (1995)
Australia, 1987 and 1991.	To analyse the effect of the higher education systems' funding policy changes on the efficiency of Australian economics departments, by comparing initial and subsequent performance.	The analysis applies survey data to a non-parametric input-minimisation DEA model. Inputs = academic staff numbers. Outputs = teaching (undergraduate and post-graduate numbers), research (core journals, other journals and books).	Of the 24 economics departments, 7 were input efficient in 1987 while 11 achieved an input efficiency score of unity in 1991. Mean inefficiency scores show substantial reductions and suggest overall productivity improvement across all economic departments post policy reform.	Madden *et al* (1997)
United Kingdom, 1993	To gain further insights into university operations by applying concepts of cost and outcome efficiency.	DEA and its recent advances are used. In the cost efficiency model: inputs = general academic expenditure, research income; outputs = number of graduates, number of higher degrees awarded and weighted research rating. In the outcome efficiency model: inputs = number of undergraduates, post-graduates and academic staff, mean A-level scores, research income, library and computing expenditure; outputs = same as above.	Application of the DEA methodology revealed a subset of 6 universities out of 45 that showed satisfactory performance across both alternative efficiency tests.	Athanassopoulos *et al* (1997)

3.1 A conceptual framework for university performance measurement.

The development of a performance measurement system for universities requires a framework for the analysis, evaluation, choice and application of these measures. Mayston (1985) showed that if measures lack decision relevance, they are ignored. The introduction of measures may, in unforeseen ways, affect the pattern of working relationships between decision-making units and individuals, the relationships with funding bodies, the responsiveness to demands made upon it and the discretion in the use of resources. The partial nature of measures provides an opportunity for dysfunctional behaviour in departments or institutions where their input and output mix is largely discretionary, and where student degree classes or the completion rate of research degrees are determined. Furthermore, there are difficulties in using measures as an input to the resource allocation process. The interpretation and use of measures is as complex as measurement itself.

These problems can be alleviated by developing a framework showing the production function represented by the measures and showing how the measures can be applied to university objectives and policy. An overlapping range of classifications and frameworks in the literature can be referred to: Moravcsik (1986) has proposed a methodology for finding a methodology for the assessment of science, although its application is potentially wider. Similarly, and to accommodate the need for measures to be decision relevant, Jesson and Mayston (1990) identified three conditions for the use of performance measures. Banta and Borden (1994) provided a list of criteria for judging performance measures for HE that could also be used to form a framework for applying them.

A framework proposed by Cave *et al* (1997) suggests that there are three different levels of analysis that should be applied. Firstly, they proposed a classificatory schema within which individual measures relating to teaching and research can be assessed for their usefulness. These measures can be classified and evaluated according to a number of criteria which are:

type of indicator (input, output, final outcome), relevance (accuracy of measurement relative to university objectives), ambiguity (identifying a high or low value of a measure as unambiguously favourable or unfavourable), manipulability (manipulated measures have reduced value), cost of collection (the return on developing measures is not the summation of returns on individual measures but rather the overall effect of the whole process), level of aggregation (each measure has its own natural level and collectively the measures may be difficult to bring together or weight) and relation to other indicators (the existence of multiple measures to measure the same aspect of performance is a useful consistency check but they should not be regarded as independent variables).

Secondly, they focus on key conceptual and structural issues that must be considered by those who develop and use performance measures. Measures are used at several levels in the HE system and attention may be on the performance of the education system as a whole, on various parts of the system or on specific universities, faculties, departments, programmes or individuals. Measures are used by responsible persons and representative groups (participants) both internally and externally to the institution concerned. The framework needs to integrate all levels, the participants and purpose and modes of use. Various authors (Sizer *et al*, 1992; Nedwek and Neal, 1994) have identified certain categories of use and Cave *et al* (1997) have proposed four modes of use linked with four kinds of purpose. Measures may be used summatively with a view to making decisions, formatively with a view to challenging or diagnosing, as a monitor with a view to maintaining a system and as an instrument of presentation with a view to marketing, attracting investment or recruitment.

The authority with which measures are used depends on their validity, theoretical and empirical soundness and their development. The development of measures is dominated by a production model that links input, process and output, reflecting a strong conceptual link with the objectives of economy and efficiency.

The relationship between measures and the use of judgement is complex, but is an important component in using performance measures. However, using measures in support of judgement, focuses on the weighting problem, which requires apportioning weight between the performance numbers and the judgement and which is especially difficult where the two diverge. The weight to be given to expert judgement and the importance of errors and ambiguities in the measures vary with the level at which data are used.

Thirdly, they point out how the selection and use of measures are significantly affected by the broader policy context, the nature of the State and the resource allocation mechanisms embodied within these. According to Cave *et al* (1997), HE funding is in transition all over the world and this tends to be towards systems that are more reliant upon private funding and less on government grants, and towards systems that are market orientated. In their analysis of the role of measures they refer to the polar resource allocation models – the administered system (predominantly or entirely state funded) and the market-based system (exclusively privately funded). Measures can play a role in support of both systems. In the former case, the role of measures is essentially regulatory, largely passive and is there to identify inadequate performance. In the latter case, the collection and publication of comparative performance information can be viewed as a form of consumer protection and therefore has a market and social value.

This transitionary process sees governments moving towards market-based approaches, driven by a desire to increase productivity and reduce public spending in order to expand and improve HE in pursuit of economic competitiveness. Cave *et al* (1997) see this as the emergence of a multiple stakeholder system, in which governments remain substantial investors with incentives to retain considerable control. Given this transition, there is a number of probable consequences for performance measures. Performance measurement will cease to be a centralised immovable system and become a joint product of public funding and private sector organisations. Information about universities will be required in different forms and research financiers will be interested in more detailed information on the capacities of individual research groups, rather than that of departments or faculties.

3.2 A review of techniques to appraise university efficiency.

An understanding of efficiency in a theoretical framework is based on the economic concepts of cost and production functions. Inefficiency in producing output is revealed in two ways: by output being less than the maximum level attainable for the given level of inputs (technical inefficiency), or because the proportions of input have been incorrectly chosen to produce the output (allocative or price inefficiency). The redress for each type is different. Overcoming technical inefficiency requires greater productivity from all inputs, while allocative inefficiency requires adjustment to input proportions. Estimating a production function from actual data implies that only technical inefficiency can be measured because inputs are treated as exogenous and therefore no inefficiency is attributed to the input mix. Estimating the cost function gives a measure of total inefficiency as input proportions are assumed to be endogenous. The division of efficiency into its technical and allocative components is however not possible (Barrow, 1990).

Various techniques have been used to measure the efficiency of public institutions and these can be applied to HE. In principle the techniques require establishing some relationship between university inputs and outputs. They differ in respect of the points at which input and output is measured, the units of their measurement and the level of aggregation. The techniques can be categorised according to whether the method is parametric or non-parametric, deterministic (non-statistical) or stochastic (statistical).

Cost-benefit analysis has been used to measure the rate of return on investment in HE, either for the student or for the economy as a whole. Costs are established by aggregating teaching related costs, while benefits are estimated as the discounted value of the increments in earnings associated with HE, although it is difficult to separate these from the environmental effects. This technique is most suited to the study of groups of disciplines or levels of degrees, but due to problems of sample size, it is not normally possible to distinguish performance between different universities.

A less complicated technique is cost-effectiveness analysis, which is a type of productivity measure, where inputs are measured in cost terms and outputs are measured in physical units. The main difficulty is to ensure that the attributes of output are adequately reflected in the physical unit. For homogeneous output this is possible, but the outputs of HE differ substantially in quality. Input and output measures may also be combined to yield partial productivity measures, for example, graduates per staff member or the staff-student ratio. These measures can be computed reasonably quickly and on a disaggregated basis, by department across universities or between departments within a university.

An underlying assumption of cost-benefit and cost-effectiveness analysis is that particular costs in universities can be associated with particular returns. The distinction between teaching and research inputs and outputs raises various difficulties. Many costs on the input side are joint or common to both teaching and research, while on the output side research degrees incorporate both teaching and research output.

Regression analysis (parametric) requires the selection of a particular functional form to fit a data set, for example the Cobb-Douglas formulation[1]. In relating inputs to outputs, the regression model assumes some form of technology to be estimated. The standard model fits an average curve to the data and the frontier may be found by various methods, depending on whether the model is deterministic or stochastic. Regression offers the

[1] The specification of a production function that determines the description of the input-output relationship.

possibility of testing hypotheses concerning factors that affect the production process in HE and it provides a more refined basis for measuring the performance of an individual department.

The final technique is DEA, which is one methodology employed in this research and which is fully discussed in Chapter 4.

3.3 Categories of university performance measures.

The literature provides evidence of a variety of attempts to categorise performance measures. The Jarratt Report (1985) refers to three main categories of measure, which are internal, external and operating measures. Internal measures include variables that possess the common attributes of showing either inputs into the university (share of undergraduate applications) or valuations internal to the university (graduation rates, teaching quality). External measures reflect the value of a university's output (acceptability of graduates in the market place, research publications produced by staff). Operating measures focus on productivity ratios such as the staff/student ratio and reflect variables such as course options available or library stock availability.

The more conventional categories of input, process and output measures were distinguished in the report of the CVCP/UGC Working Group (1986). Input measures concern resources employed by a university, process measures refer to the efficiency of resource use and the effort applied to the inputs and the operation of the organisation. Outputs reflect the products of the university system.

According to Cullen (1987), a conventional categorisation based on management principles, distinguishes three types of measures: economy, efficiency and effectiveness. The UK's Department of Education and Science White Paper (1987), in supporting the use of performance indicators, noted that the CVCP/UGC's (1986) list of measures covered both efficiency and effectiveness measures, and serves to illustrate this distinction.

The input-process-output approach has generally been associated with the categorisation of performance measures and is increasingly being used in discussions regarding performance measurement. Richardson (1994) sets out a slightly different terminology of inputs-outputs-outcomes, which again are quite often referred to in the literature. Over two hundred and fifty performance measures for HE were identified by Bottrill and Borden (1994), who classified each as an input, a process or an output measure.

Within the university sector, the two main subcategories of output are generated by the activities of teaching and research. A monetary measure of the value added by teaching can in principle be found, based on the notion that a more highly qualified employee receives greater lifetime earnings. However, such data is not available by institution and interpretation is difficult. The output of teaching is therefore normally measured in terms of the number of graduates, possibly qualified by some quality adjustment. Placing a monetary value on research output is possibly even more difficult, with the result that the best approach is to find some qualitative or quantitative indicator of output, and this is likely only to be partial (Cave *et al*, 1989).

Performance may also be categorised according to: measures that quantify fairly precisely some attribute of interest; indicators that are less accurate or view the relevant variable obliquely; and management statistics that record the level of an intermediate variable, rather than the measure of final output.

3.4 Performance measures of university teaching and learning.

3.4.1 Problems of measurement and application.

It is generally accepted that it is more difficult to establish measures of teaching than of research performance. The UK's University Grants Committee (1985) pointed out that there are few indicators of teaching performance that would enable a systematic external assessment of teaching quality to be made. The reasons for this are both technical and political. Educational goals of HE have become disputed and political. Nedwek and Neal (1994) suggest that 'goals are multiple and contested, within a HE system that has conceptually moved from being a public utility to becoming a strategic investment' (p.75). Opposing thought and ideas on HE are inspired by different ideas of knowledge and conflicting economic and social values. The focus on the instrumental importance of HE has resulted in individual consumption benefits becoming increasingly tied to the requirements of the economy and the make-up of personnel required to meet these. Greater support has been received by government and employers rather than by the institutions of higher learning, in defining these requirements. Given this situation, the challenge of identifying relevant and acceptable measures becomes increasingly intense at institutional level.

A definition of what it is that teaching performance measures are required to present, is a further problem and one that is linked to levels of aggregation. Within the university sector and the universities themselves, teaching represents their educational function or more technically, the conversion of inputs into graduate outputs. With respect to the faculty, the department, the discipline and the individual, attention is focused on teaching, teaching activities, teaching and learning and on students. At all levels though, there is an increasing appreciation of the spread of activities and provisions, apart from teaching, that constitutes education and of the problem of determining the main variables affecting educational output.

A combination of political pressure and deficiency in technical expertise, gives rise to the formulation of measures that are data driven and that can be easily quantified. Political response to pressures and intensified technical analysis may in turn, redirect concerns towards issues of validity and the need to have a conceptually defensible measurement system (Nedwek and Neal, 1994). Sizer *et al* (1992) point out that where measures are used for selective funding decisions, the debate on these measures turns to issues of their validity and reliability. There is then, a requirement for evidence and theoretical consideration about the relationship between education outputs and the inputs, processes and objectives of the HE system.

An additional factor that adds to the problems of determining the measures for teaching is that the purposes for which they are used are proliferating. Sizer *et al* (1992) suggest uses for 'monitoring, evaluation, dialogue, rationalisation and resource allocation' (p.137). Nedwek and Neal (1994) refer to uses for 'monitoring conditions, measuring progress, forecasting and diagnosing problems, allocation decision-making and political symbolism' (p.89). The use of measures in image management and protection of interests is apparent at all levels, but particularly so at the institutional level, including the university sector as a whole. A main issue relates to the distinction between the use of measures for internal and external purposes.

Finally, there are two further factors that affect, in particular, the development and use of performance measures. These are the relative status of policy and practice in teaching and research and the development of quality policies. The Department of Education and Science White Paper (1987) suggests that the quality of teaching needs to be assessed by reference mainly to students' achievements, some measures of which are difficult and costly to make (first destinations of new graduates, for example). There is general agreement that defining point-of-entry standards for undergraduate degrees is difficult to establish across the university sector, and that explicit standards are hard to separate, both from the disciplinary practice of academics and from the processes by which students learn to become proficient in their subjects of study.

3.4.2 Quality and performance measures.

The subject of quality raises the question of its relationship with performance measures. They may provide background information, be used singularly or in combination with other information to assess quality or be the main component of judgements. The fact that there are multiple concepts of quality and that the relevance of a particular measure may vary according to the concept focused on within the quality assessment system, poses a further difficulty for the relationship. Harvey (1995) discussed the relationship between quality and standards in HE and identified various perceptions of quality: quality as exceptional, as perfection or consistency, as fitness for purpose, as value for money and as the 'enhancement or empowerment of students or the development of new knowledge' (p.9).

The use of outcome measures to reflect quality of teaching and learning, such as degree classifications, numbers of firsts, non-completion rates and examination performance, was criticised by the UK's Higher Education Quality Council (1994) on the grounds that these 'might be regarded as narrow, failing to capture the overall quality of learning' (p.15). Barnett's (1994) criticisms of quality assessment in the UK concern the problem of defining quality in a system that is committed to diversity and the maintenance of some core standards and principles. He argued that these core criteria needed to be more clearly stated, as institutions were forming their own perceptions of emphases and values in the assessment process. 'Our enquiries lead us to conclude that the greatest weighting is given to teaching performance, [followed by] the student experience and physical resources' (para.5.12.). Attention may be drawn to three particular issues that emerge from the analysis prepared by the Higher Education Funding Council for England (HEFCE, 1995) and Barnett (1994) on quality assessment. They are all relevant to performance measures.

The first relates to the extent that it is possible to construct a clear framework of criteria that is neither narrowly prescriptive nor vulnerable to manipulation and does not constrain university distinctiveness. The second concerns the evidence, theories and values that inform evaluative processes or performance measures and the nature of their authority. The third is in respect of six core dimensions of educational quality identified by the HEFCE: curriculum design, content and organisation; teaching, learning and assessment; student progression and achievement; student support and guidance; learning resources; quality assurance and enhancement. Performance measures therefore need to capture and reflect the essence of these core dimensions of educational quality. Should this be possible, then a sound relationship may be established between quality and university performance measures.

3.4.3 The use of cost measures in performance evaluation.

A traditional cost measure is the average cost per student, per graduate or per completed credit unit. It combines measures of inputs and outputs and lends itself to comparative analysis, either against a national average or across individual universities. Although average cost per student is generally used, average cost per graduate is technically a more appropriate variable, as it is a pure output (as opposed to process) measure. The staff-student ratio is a basic variant of the cost measure and as it only includes labour supplied by lecturers, it may therefore encourage inefficient substitution of other inputs (for example, equipment and administrative time) for inputs from lecturers. The ratio makes no allowance for the seniority or income levels of lecturers.

Average cost measures are subject to various problems in the measurement of both inputs and outputs. For inputs, the allocation of a university's total costs to its cost centres, raises practical difficulties (cost allocation, apportionment and overhead absorption) and if conclusions are to be drawn from comparative data, then consistency of treatment must be achieved. It is important to recognise that teaching costs are a component of total university cost and that this proportion is likely to vary between universities for a variety of reasons. The aggregation of undergraduate and post-graduate (research and taught) students into a single measure, poses difficulties for measuring output. There is also the question of whether output standards are similar across all universities (whether a degree in a given class is of uniform value).

There are conflicting interpretations of a high cost per student. On the one hand, it may reflect a high quality of the educational process, although in the absence of empirical evidence on the quality of degrees of the same class across universities, it is difficult to draw conclusions about the relationship between teaching inputs and student quality. On the other hand, if degrees of the same class are of the same quality and if the value-added to a student on obtaining a degree of similar class is the same for all universities, then average cost may under certain conditions be used to measure efficiency.

Comparisons of cost-effectiveness between universities require that they have similar production technologies (capacity to convert inputs into outputs) and face identical prices (equivalent cost function for the same production in all universities). This means that a university should not be penalised because of its infrastructure, location, staff configuration, research capacity or other relevant factor. However, these conditions are unlikely to hold, as each university is unique and portrays various structural differences. Funding policies will affect the availability of resources and a university with insufficient resources may be constrained to an output level that does not maximise output efficiency. Cost-effectiveness will also depend on the quality of inputs (student quality) to the production process. Where universities have varying qualities of student intake, average cost may vary due to factors unrelated to overall cost-effectiveness in university cost centres. This relationship is not precisely understood. If there is no difference in whether high quality students benefit more or less from a given level of teaching than students of a lower quality, then variations in student quality do not affect average cost. Average cost may therefore be an appropriate measure of cost-effectiveness (Cave *et al*, 1997).

Research carried out by Johnes and Taylor (1990) shows that cost per student varies considerably between universities in the UK. These differences were attributed largely to subject mix (70 per cent of variation), the staff-student ratio (10 per cent of variation), while the remaining difference was unexplained. They state that 'this is not to argue that universities should not take a cold, hard look at their unit costs compared to other universities, but exactly how they respond to an apparently inferior cost position, is something which must be very carefully considered' (p.79). They suggest there is a need for better output measures before conclusions about efficiency can be drawn.

Unit costs have received support from the UK's Joint Performance Indicators Working Group (CVCP, 1995a), who recommended that a unit cost model should be developed to promote self-assessment and inter-university comparisons. They view unit costs as a more relevant and robust measure, than for example, student-staff ratios. Limited unit cost data are also included in the list of management statistics proposed by the Higher Education Management Statistics Group (1995) for the UK from 1996 (selected items from this list and from the management statistics and performance indicators proposed by the CVCP (1995b), are shown in appendix Table A.1 to illustrate the nature of these cost measures).

3.4.4 The value-added measure.

According to Astin (1982), 'the basic argument underlying the value-added approach is that true quality resides in the institution's ability to affect its students favourably, to make a positive difference in their intellectual and personal development' (p.11). Education is of value to a person in respect of personal development and the prospect of increased earnings potential. The value-added in terms of an individual with a degree as opposed to one without a degree, is the difference in the contributions made to the welfare of society by these two persons, normally measured by their earnings capacities. The importance of the need to measure value-added is seen in the information that it could provide on the efficiency of the education process. More efficient universities produce greater value-added at the same or lower cost and the efficiency of one university relative to another can be roughly measured by the ratio of average value-added to average cost. The returns to scale in HE may be better understood through the use of value-added. In order to allocate resources efficiently, information is required on the way outputs change in response to marginal changes in inputs.

An ideal measure of value-added by HE would enable a relationship to be established between all the benefits of HE and all relevant costs. The outputs (benefits) would be measured as the difference between a person's productivity as a graduate and the productivity of an identical non-graduate. This difference would then be related to inputs specific to a university's teaching process.

Research by Johnes and Taylor (1990) found that 'over 80 per cent of the variation between universities in degree results can be explained (statistically) by a set of plausible explanatory variables, the main one being the mean A-level score of each university's student entrants' (p.117). Their main finding was that after inter-university differences in inputs available are taken into account, the remaining unexplained variation between universities is relatively small, especially for the teaching measures of non-completion rates, degree results and first destinations of new graduates. They argue that 'with less than 20 per cent of the variation remaining unexplained ... this raises the question as to whether the unexplained variation is itself a useful indicator of performance' (p.183). Cave *et al* (1997) suggest that this may serve as a quantitative indicator of comparative university value-added.

In the UK, the main emphasis in devising methods for calculating value-added has been on finding a way to measure the difference between entry and exit qualifications. The work of the Polytechnics and Colleges Funding Council and Council for Academic Awards (1990), which has been the most significant, focused on various index methods and a comparative method, the results of which were reported by McGeevor *et al* (1990). They concluded that none of the results obtained from the use of indices was wholly satisfactory. Hadley and Winn (1992) pointed out that the comparative value-added approach is not as objective as it is claimed.

Another approach to implementing the value-added measure was made by Mallier and Rodgers (1995), who set out to establish the incremental earnings value of different classes of degrees (compared with the earnings of an employee with A-levels). They contend that whereas it is impossible to have a precise measurement of value-added in education – because of the large number of variables involved and the difficulties of definition – their approach does provide a benchmark as a performance indicator in the resource allocation process.

The various approaches to value-added have attracted a range of criticisms. Given the difficulty of measuring this concept, this is to be expected. Cave *et al* (1997) state that:

> If we were able to measure value-added, the efficiency of institutions could be explored and the usefulness or otherwise of investment in higher education demonstrated. Additionally, we could examine the relationship between inputs and outputs at the margin and go some way towards estimating the optimal size of institutions assessed. (Cave *et al*, 1997.136)

3.4.5 The non-completion rate measure.

The non-completion rate of undergraduate students in a university can be defined as the proportion of students who do not complete their degree. The rate may be calculated either by the entry cohort method or the percentage of leaving cohort method. The difference between these two methods is that the entry approach measures the non-completion rate of students entering a university at a specific point in time whereas the leaving approach measures the non-completion rate of students who entered university over several years. According to Johnes and Taylor (1990), the two methods produce similar estimates of the non-completion rate.

Student non-completion occurs for reasons other than failing to meet the academic requirements of a university. As Tinto (1982) points out, some attrition is therefore inevitable (and indeed desirable) as students realise that their goals and aspirations are more likely to be met by switching courses and institutions. Inter-university differences in the non-completion rate may be required as a measure by groups that fund HE or by universities themselves. The factors that influence a university's non-completion rate can be divided into two broad categories. Firstly, there are student related factors that are likely to influence the probability of a student leaving university prematurely. These include gender mix, academic ability and socio-economic background (type of school attended prior to university and parental education). Secondly, there are university related factors that affect the rate and these include the subject mix of each university as well as the non-completion rate for each subject group in the university sector as a whole (Johnes, 1990).

There are in addition other factors that may have an effect on the rate and these are: the staff-student ratio, the length of the course and the type of accommodation used by students. As certain university related factors (that may affect the non-completion rate) are not easily measurable, Johnes and Taylor (1990) suggest that it is useful to allow for differences in the characteristics of universities by grouping them into separate broad categories (all campus, vocationally oriented) in a statistical analysis. They further suggest that in order for inter-university comparisons of non-completion rates to be of value (either to the universities themselves or to policy makers interested in institutional efficiency), 'each university's non-completion rate would first need to be corrected for at least some of the factors responsible for causing inter-university disparities in this variable' (p.99).

3.4.6 First destinations of graduates.

The extent to which a graduate is found to be employable is of interest to the state, universities, employers and students. Although first destination data may be classified into various categories of measure, attention is generally focused on three measures: the percentage of a university's graduates entering permanent employment, the percentage proceeding to further education and the percentage unemployed six months after graduation.

A wide range of factors may be expected to influence the first destination of a university's graduates. According to Johnes and Taylor (1990), subject mix is the most significant explanatory variable. Graduates in vocationally related subjects generally find employment more quickly than graduates in non-vocationally related subjects. Student related factors that are known to vary between universities and may be expected to affect first destinations are: academic ability, social background and gender. The university related factors that may be expected to have an influence are: age, size, type and location of a university, research reputation, staff-student ratio and its careers advisory service.

The performance of students after graduation is seen as an important aspect of the shift from input and process to output and outcome measures. However, the use of first destination measures has attracted a varying response. Boys and Kirkland (1988) found these measures to be moderate predictors of success in the labour market over the longer term, but Johnes and Taylor (1989) were less than enthusiastic about the use of first destination measures. Brennan *et al* (1993) found that after five years the main variables affecting graduates' financial reward from employment, were the subject studied and the university attended.

The wider issues about the range and types of indicators that may be assembled in order to obtain a more robust set of measures, was raised by Brennan *et al* (1994). They suggested that three main categories of information should be collected: objective indicators of income and proportions of unemployed graduates; subjective indicators such as graduates' career paths and their aspirations; and the match between work tasks and the content of HE. Based on their research into graduate employment, they concluded that the most appropriate time to study aspects of the link between HE and employment was two years after graduating.

3.5 Performance measures of university research.

3.5.1 Evaluating research performance.

The relationship between quality and quantitative measures of research performance has been the subject of considerable and fluctuating debate. The perceived quality of a university's research is linked to the allocation of resources within the university sector. Methods for the evaluation of research output and performance are however, not significantly advanced and their assessment remains highly controversial (Johnes and Taylor, 1990). The UK's Joint Performance Indicators Working Group's main concern was stated as being 'to ensure that indicators of research are available to institutions to assist them in the management of their research output' (CVCP, 1995a. para.3.1). The full list of its proposed research indicators is given in appendix Table A.2. Harris (1994) suggests that 'one of the requirements for greater efficiency are appropriate performance indicators so that progress, or lack of it, can be identified, and appropriate incentives applied' (p.1).

Four aspects of research performance were proposed by Phillimore (1989), who matched these with relevant measures: output (publications); impact (citations); quality (research grants, research studentships, committee memberships, journal editorships, peer judgement, reputation, awards); and utility (external income, patents, licences, contracts).

3.5.2 Measures of research input.

The main input measures of research performance are numbers of research students and research income. The number of research students is a measure of the attractiveness of an institution or department to potential research students. It will depend upon the availability of financial support and will vary considerably across the disciplines. The number of research students is also linked, as an input measure, with completion rates of research degrees. It is recognised that the submission rate for doctoral and other research degrees, measures not only student input, but also the institution's admission policy, the quality of its supervisory practices and the level of research activity within its departments. The emphasis on submission rather than completion must also be noted, as this can create a skewed impression of performance. There has been argument against the use of non-completion rates as a measure, because success in training post-graduates leads to wastage when students are attracted to private sector positions prior to completing their degrees. The use of submission rates has been reviewed by Collinson and Hockey (1995).

The measure of research income per full-time equivalent staff member raises a number of issues. More abstract and theoretical work, that has greater influence and respect, is not as dependent on research income as work requiring experiment or collection and analysis of large amounts of data. The process of securing research contracts can direct academic attention away from more traditional academic research activities. Research income is an input to the research production process and should be considered when evaluating research productivity. The level of research income allocated to an institution or department may be taken as a measure of its relative competitiveness. However, there are important qualifications to this contention. Large departments can produce much research and are likely to attract a larger share of total research income. Therefore, it is important to measure success in attracting research income on a *per capita* basis, by relating income to centrally funded full-time equivalent staff in a department. A related factor concerns economies of scale in the production of research, as unit costs may vary with department size. Economies of scale imply that large departments have a relative cost advantage over smaller departments and may appear to be performing more efficiently. It is also important to distinguish between sources of income as well as the aggregate amount. Research grants from funding bodies are viewed as prestigious, having the potential to produce publishable results that can be reflected in research output indicators. Research contracts often lead to reports that may not be openly disclosed. The assessment process therefore concentrates on the academic quality of pure research as opposed to applied research, as noted in the report of the Universities Funding Council (1989).

The inclusion of patents, licences and copyrights is therefore important for giving recognition to research that is largely practical in orientation and for providing a balance to assessment. The use of research income as a measure of performance has however, attracted criticism. Gillett (1989) pointed out a number of defects in measures based on research income. On both *a priori* and empirical grounds, indices based on grant-giver peer review and impressionistic peer review was shown to yield unsatisfactory measures of research.

3.5.3 Measures of research output.

The main output measures of research performance are publications and research quality. There are two broad approaches to the types of publications that may be included in an assessment; either a range of printed media is analysed or the analysis is restricted to journals. Twenty categories of publications used in the CVCP's (1993) first annual survey for the year 1991 are shown in appendix Table A.3, to illustrate this range.

Different subjects seem to be associated with different forms of publication and this reflects the underlying nature of a subject. Many assessments of publications, particularly in science, engineering and some social sciences are compiled from journal articles only. Regardless of whether a range of publications or journals alone is examined, the analysis of journals can involve wide and various techniques, some examples of which are noted in Crewe (1987) and in Spaapen and Sylvain (1994). There are many technical problems that underpin the development of a sound method for assessing publications. Using a broad range of publications poses difficulties in scoring the many types of publications and infers that all journal articles are of equal value. When a narrow range of noted journals is used, this may mean that books are excluded and researchers in specific fields are disadvantaged.

In order to weight the various contributions found in publications, a scoring mechanism has to be established, examples of which are noted in Crewe (1987) and Harris (1989). The importance of the weighting issue is demonstrated by Johnes (1990), who highlights the importance of weight choices and the potential for their manipulation. The counting of publications on a per capita basis is a generally accepted approach, although who should be included raises further issues (more than one author, authors in different institutions, time frame over which measurement occurs). However, focusing on the number of publications produced may lead to a proliferation of lesser quality articles. Johnes (1986) argued that the value of publications as a measure is that they highlight those factors (optimal staffing levels, library stocks and staff-student ratios) that enhance research productivity.

In an assessment of the individual productivity of researchers, Harris and Kaine (1994) suggested that research performance is influenced more by individual motivation than by resource support. Harris (1994a) concluded that in addition to the influence of motivation, productivity could also be influenced by extrinsic rewards and by the environments in which researchers work.

The use of a quantity index as a measure of research performance (number of articles published), raises the objection that issues about the quality of articles are largely ignored. The quantity factor therefore, needs to be adjusted for its relative quality or impact, and this can be achieved through the use of citation counts. Based on the annual Social Sciences Citation Index (SCCI), the use of citations as a measure of research quality has been used in a number of North American studies. Graves *et al* (1982) and Laband (1985) argue that citations provide an objective approach to assessing the quality, impact or influence of research output. Quality may be seen as the extent to which cited articles have made an impact on and improved the understanding in the subject area. Nederhof and Van Raan (1989) concluded from their review work that when sufficiently large numbers of articles are examined, citation counts may provide a useful partial indicator of quality and can be used to monitor scientific research. A number of approaches to weighting output can be sited in the literature. The method of citation indexing, for example, is provided by Jones *et al* (1982). Influential journals are likely to have higher impact factors, indicating that articles selected for publication in these journals are generally of a higher quality.

The use and value of citations analysis has provoked considerable and highly technical debate. Cozzens (1989) sets out various factors that may inflate or reduce citations. A number of theoretical and practical difficulties attend the use of citations. While their economic viability (time and cost factors) is questionable and as it is difficult to weight citations in an objective way, their interpretation must be viewed carefully.

Research output may also be adjusted for quality through peer review, which is difficult to define precisely and can include a variety of activities. Gillett (1989) suggests that peer review – including journal, grant-giver and impressionistic peer review – is a generic term that reflects a common understanding of the term. He found that only journal peer review, measured by number of publications *per capita* or cost per publication, provides a true performance measure, as it links inputs to outputs. The CVCP/UGC Working Group (1986) defined peer review as being 'assessments of departments by individuals or groups who are acknowledged experts in their field of study' (Appendix 2, p.9). It is questionable however, whether peer review should be included in a group of performance measures, as it describes a judgemental process rather than being a measure as such.

In the next chapter, the two methodologies – DEA and analytical review – used in this study to measure efficiency, are described and examined. Data sources and the selection of universities are discussed.

CHAPTER FOUR

DESCRIPTION OF THE RESEARCH METHODOLOGY

4.0 Two methodologies for the analysis of performance.

It is acknowledged that there are some limitations to the use of analytical review and DEA, although this is more apparent when these techniques are applied separately than when used together to measure relative efficiency. Whereas DEA provides an overall assessment of relative efficiency, the full use of the many variables arising from a university's database that reflect measures of efficiency is not possible. This is because there are limitations to the number of variables that can be used in the DEA computations at any one time. On the other hand, while ratio analysis permits the computation of a limited range of efficiency factors, these are individual measures that cannot be conveniently combined into one overall measure of relative efficiency. These two analytical techniques will therefore be used in combination in this research. Such use will not only complement mutual strengths of the two techniques, but will importantly enhance the analysis.

4.1 The technique of analytical review.

The official terminology of The Chartered Institute of Management Accountants (1991) defines analytical review as 'the examination of ratios, trends and changes in balances from one period to the next, to obtain a broad understanding of the financial position and results of operations; and to identify unusual fluctuations and other items requiring further investigation' (p.4). This technique will incorporate both financial and non-financial measures of inputs, outputs and outcomes of the university education process. Analytical review may be performed differently in different organisations because of their nature of operations, management style and objectives.

The starting point of the analytical review is the use of ratio analysis. Ratios will be required to normalise the data and to measure efficiency. Normalisation will remove the effect of scale from the data (both non-financial and financial) and the normalisation process will be particularly important where ratios are compared across the universities selected for research. Time series analysis will be facilitated through this approach. The measures of inputs and outputs of university operations in ratio form will identify specific efficiency rather than overall university efficiency. The concept of ratio pyramids[1] may possibly be explored, noting that there are two particular ratio pyramids – one links the financing ratios and is mainly the concern of the finance discipline while the other consists of all the operating ratios. The computation of standard financial ratios will depend on the availability of suitable financial data. In order to assess non-financial operating outputs, other ratios will need to be introduced and explored within the overall analytical framework. In the review of the various ratios determined, cognisance will be given to the likelihood that within the university environment, a unique set of ratios is likely to be yielded.

4.2 An overview of Data Envelopment Analysis.

4.2.1 Use of DEA for decision-making unit efficiency.

The concept of DEA dates back to Farrell (1957). However, the current interest seems to have been initiated by Charnes *et al*, (1978), who proposed DEA as a way of measuring performance in not-for-profit and public sector organisations, the success of which cannot be measured by a single factor such as profit.

Thus DEA began as a new management science tool for technical efficiency analysis of public-sector decision-making units (DMUs). The emergence of DEA was an extension of the historical focus on operations research/management science methodologies in the

[1] Defined as the analysis of a primary ratio into mathematically linked secondary ratios.

development and application of optimisation techniques in resource allocation problems. It provides a new approach to organising and analysing data, to uncovering new production relationships in the data and to revealing new insights in the analytical process. It has become an alternative and complement to central-tendency analyses and provides a new approach to traditional cost-benefit analysis and for obtaining information about outliers.

DEA evaluates the relative efficiency of homogeneous DMUs where the efficiency production function is not known or easily specified. In most cases there is no known relationship between the transformation of inputs used by an organisational unit and the outputs that it produces. The efficiency frontier is therefore not known. It can however be estimated by using the available data on the actual achieved performance of the DMUs under consideration, in terms of the outputs that they produce for the level of inputs that they use.

The essential characteristic of DEA is the transformation of the multiple-input, multiple-output DMU into a single 'virtual input' and 'virtual output' value for all DMUs. The ratio of this single virtual input to virtual output provides a measure of technical efficiency. DEA utilises a mathematical programming technique that maximises the efficiency of a unit subject to the efficiency of all other units in the set having an upper limit of 1. A notable feature is that the weights applied to inputs and outputs are chosen so as to maximise the efficiency of the individual unit. The efficiency of the unit will either equal 1 (100 per cent efficient) or will be less than 1, in which case the unit is inefficient. The relative efficiency score of a unit represents the maximum proportion of its inputs that the unit should have been using, if efficient, in order to secure at least its current output levels.

Relative homogeneity of organisational units, such as universities, provides an opportunity for applying DEA methodology. The efficiency of a DMU K_0 operating in a homogeneous set of N DMUs, utilising multiple inputs I to produce multiple outputs R, can be defined as follows:

Model (M1):

Maximise $E_{K_0} = \frac{\sum_{r=1}^{R} u_{rK_0} y_{rK_0}}{\sum_{i=1}^{I} v_{iK_0} x_{iK_0}}$ subject to: $\frac{\sum_{r=1}^{R} u_{rK_0} y_{rj}}{\sum_{i=1}^{I} v_{iK_0} x_{ij}} \leq 1$ for all j target units = 1,…,N,

$u_{rK_0}, v_{iK_0} \geq 0$ for all r = 1,…,R, and i = 1,…,I, where,

E_{K_0} = efficiency of unit K_0,

y_{rK_0} = amount of output r = 1,…R produced by DMU K_0,

x_{iK_0} = amount of input i =1,…,I consumed by DMU K_0,

u_{rK_0} = weight given to output r,

v_{iK_0} = weight given to input i,

y_{rj} = amount of output r from unit j; x_{ij} = amount of input i from unit j,

I = number of inputs; R = number of outputs.

Each DMU K_0 analysed will specify the particular input and output weights (u and v respectively), which maximises its own ratio of weighted output to weighted input, subject to the constraint that no other unit utilising the same weights could exceed an efficiency rating of 1. A DMU with an efficiency rating of 1 will be designated efficient relative to other DMUs. Conversely, an efficiency rating of less than one will result in a specific unit being described as inefficient, relative to others.

This model is a linear fractional model and needs to be transformed to an ordinary linear programme in order to be solved. This can be achieved by scaling either the denominator or the numerator of the objective function by a constant. The equivalent linear programming models are as follows:

Model (M2) – output maximisation:

$$E_{K_0} = \max \sum_{r=1}^{R} u_{rK_0} y_{rK_0} ,$$

subject to $\sum_{i=1}^{I} v_{iK_0} x_{iK_0} = 1$ and $\sum_{r=1}^{R} u_{rK_0} y_{rj} - \sum_{i=1}^{I} v_{iK_0} x_{ij} \leq 0$ for all j units

$u_{rK_0}, v_{iK_0} \geq 0$ for all j units

Model (M3) – input minimisation:

$$\frac{1}{E_{K_0}} = \min \sum_{i=1}^{I} v_{iK_0} x_{iK_0} ,$$

subject to $\sum_{r=1}^{R} u_{rK_0} y_{rK_0} = 1$ and $\sum_{i=1}^{I} v_{iK_0} x_{ij} - \sum_{r=1}^{R} u_{rK_0} y_{rj} \geq 0$ for all j units

$u_{rK_0}, v_{iK_0} \geq 0$ for all j units

(see Sarrico *et al*, 1997 and Soteriou *et al*, 1998).

4.2.2 A non-parametric approach to data analysis.

An alternative principle for extracting information about a data set, as shown for example in Figure 4.1, is embodied in DEA. In contrast to parametric approaches where the objective is to estimate a single regression line through the data (broken straight line), DEA optimises on each individual observation with the objective of determining a discrete piecewise frontier determined by the Pareto-efficient DMUs. The single optimised regression equation in parametric analysis is assumed to apply to each DMU. In contrast, DEA optimises the performance measure of each DMU and results in a revealed understanding about each DMU rather than depicting an assumed 'average' DMU. In other words, the focus of DEA is on the individual observations as represented by each optimisation (one for each observation) required in DEA analysis, in contrast to the focus on the 'averages' and estimation of parameters that are associated with single optimisation statistical approaches.

DEA does not require any assumption about the functional form (for example, a production function, regression equation) relating the independent variable(s) to the dependent variable(s) and nor does it require specific assumptions about the error terms (for example, data distribution qualities). DEA calculates a maximum measure for each DMU relative to all other DMUs in the data set with the requirement that each DMU lies on or below the extremal frontier. Any DMU not on the frontier is scaled against a convex combination of the DMUs on the frontier facet closest to it.

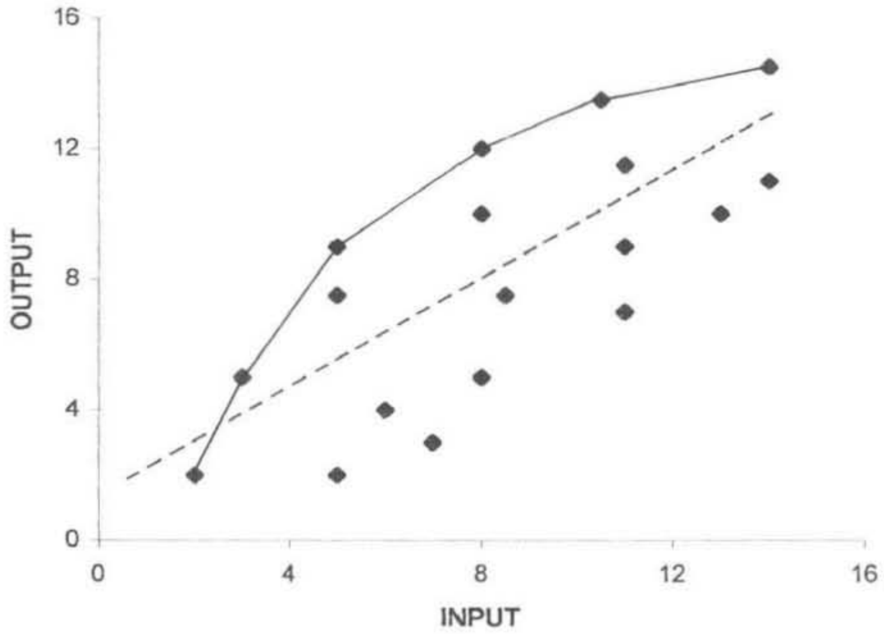

Figure 4.1. Comparison between DEA and Regression

The solid line in Figure 4.1 represents a discrete piecewise frontier developed by DEA from data on a group of DMUs, each using different amounts of a single input to produce various amounts of a single output. It must be noted that DEA formulates only relative efficiency measures. The relative efficiency of each DMU is calculated in relation to all other DMUs, using the actual measured values for the inputs and outputs of each DMU. The calculations aim to maximise the relative efficiency score of each DMU, subject to the requirement that the set of weights obtained in this way for each DMU must also be feasible for all the other

DMUs included in the calculations. DEA produces a piecewise empirical extremal production surface, which in economic terms represents the revealed best practice production frontier.

For each inefficient DMU, the source and level of inefficiency for each input and output is identified. This level of inefficiency is determined by comparison to a single referent DMU or a convex combination of other referent DMUs located on the efficient frontier that uses the same level of inputs and produces the same or a higher level of outputs. This is achieved by satisfying inequality constraints that can increase some outputs or decrease some inputs without negatively affecting other inputs/outputs. The required improvement for each inefficient DMU does not necessarily coincide with the performance of any actual DMU featured on the efficient frontier or to a deterministic projection of an inefficient DMU on to this frontier. Input and output improvements of inefficient DMUs are indicative of potential improvements possible because the projections are based on revealed best practice performance of comparable DMUs that are located on the efficient frontier.

4.2.3 The description, orientations and application of DEA models for efficiency computations.

Charnes *et al* (1994) allude to a basic subset of four DEA models, which embody the concepts and methodologies of DEA. The attributes of these models are discussed briefly:

CCR ratio model[1]: results in a piecewise linear, constant returns-to-scale envelopment surface and gives an objective evaluation of overall efficiency by identifying the sources and estimating the amounts of the identified inefficiencies. The model provides for both input and output orientations.

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[1] Formulated by Charnes, Cooper and Rhodes (CCR) - see Charnes *et al* (1978).

BCC model[1]: results in a piecewise linear, variable returns-to-scale envelopment surface and distinguishes between technical and scale inefficiencies, by estimating pure technical efficiency at the given scale of operation and by identifying whether increasing, decreasing or constant returns to scale possibilities are present for further enhancement. The model accommodates both input and output orientations.

Multiplicative models: in contrast to the piecewise linear envelopment afforded by the majority of DEA models, the variant multiplicative model allows a piecewise log-linear envelopment surface while the invariant multiplicative model allows a piecewise Cobb-Douglas interpretation of the production process. The model has natural extensions to multiple inputs/outputs and accommodates constant and variable returns to scale (see Charnes *et al*, 1994).

Additive model: results in a piecewise linear, variable returns to scale envelopment surface. This model relates DEA to the earlier Charnes and Cooper (1957) inefficiency analysis and further, relates inefficiency results to the economic concept of Pareto optimality[2].

Managerial and economic issues are considered in each of these models and while useful results may be provided, their orientations are different. Importantly, they generalise and provide a linkage with the features and concepts inherent in the models. Fundamentally, the various models each set out to establish which subsets of an observed group of DMUs determine part of an envelopment surface.

Different results may be achieved not only in the selection of a specific model, but also with the different orientations featured within a model. The important choices for the basic models outlined are the envelopment surface and its geometry and the 'projection path' to

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[1] Formulated by Banker, Charnes and Cooper (BCC) - see Banker *et al* (1984).

[2] For a given set of all possible states of the economy, such as A, B…E, a state E is Pareto optimal if there does not exist a single state of the economy that is Pareto superior to E (see Sher and Pinola, 1986).

the envelopment surface for inefficient DMUs. The term projection path refers to the calculation of potential improvements in each of the inputs and outputs for an inefficient DMU, based on observable referent revealed best-practice DMUs located on the efficient frontier. A choice must be made between the piecewise constant returns to scale surface or the variable returns to scale surface. For a given envelopment, the projection path to a point on the efficient frontier is determined in the selection of an appropriate model and its specific orientations and will differ according to this choice. Considerable flexibility is afforded by the array of options available within these basic models. Incorporating certain refinements and extensions to the underlying theory of DEA can further enhance this flexibility. These allow one to fine-tune the analysis by incorporating organisation and managerial factors, refining efficiency estimates and dealing with inconsistencies.

According to Charnes *et al* (1994), probably the most significant of these refinements to DEA is the concept of restricting the possible range for the weights. In the basic models, a specification of the weights, derived from experience, is not required and each DMU is valuated in the best possible view. However, this total flexibility can allow a DMU to appear efficient in ways that may be difficult to account for. The model could assign rather low or high values to the weights so as to drive the efficiency measure for a DMU as high as possible. Imposing restrictions on the values of the weights gives a more precise efficiency measure and is appropriate under the following conditions: certain information cannot be directly included in the model or may contradict expert opinion, management may have entrenched perceptions about the relative importance of certain factors and what constitutes best practice and where the sample of DMUs is small, the model cannot discriminate and all units may be deemed efficient.

A second refinement deals with the implicit assumption of the basic model, that all inputs and outputs are controlled and varied by the management of each DMU (that is, discretionary). In reality though, there may be exogenously determined or non-discretionary inputs or outputs that are beyond the control of a DMU's management (for example, the age of facilities in different universities). In effect, the non-discretionary input excesses and output slacks are omitted from the objective function when efficiencies are measured. However, they are included in the constraints so that their presence is taken into account.

A further refinement considers the possibility that input and output variables are not all continuous and that ordinal variables do arise in realistic situations. In this case, certain inputs or outputs may reveal the presence or absence of a particular characteristic (for example, universities with a medical faculty) or may have a more natural representation at discrete levels (for example, the division of a student population by ethnic group). A specific DMU should be compared only with DMUs that are in the same category or are in more disadvantaged categories. If the categories are not comparable, a separate analysis should be undertaken for each category.

The use of DEA methodology in this research requires the selection of N DMUs, the I inputs, the R outputs and a DEA model that is appropriate for the elements of the research area. Consideration needs to be given to the computational characteristics of the DEA methodology that impact numerical stability and accuracy. A wide range in the values of the input and output variables (ill-conditioning) can give rise to computational difficulties. While scaling of the data can alleviate this, lower-order digits in the data may be affected with the result that the ability to accurately differentiate between DMUs is potentially removed. A further problem is that scaling does not overcome all sources of ill-conditioning. Wide variations in the values of a specific input or output variable across the N DMUs are another source of ill-conditioning that cannot be overcome by scaling.

In those models with either an input or output orientation, the values of the weights are inversely proportional to the values of the input/output variables. Consequently, the larger the input/output values, the smaller the values for the weights, and vice-versa. Where there is an imbalance between the values of the weights, the potential for confusing the testing of optimality, is brought into contention. The most common approach to overcoming this problem is to restate the normalising constraint within the model.

Consideration needs to be given to the matter of degeneracy (cycling or slow convergence to a solution) in DEA models. In linear programming, a basis corresponding to a feasible solution is deemed degenerate when at least one of the basic variables has a value of zero. For each DEA model, when the mathematical programme is solved for an efficient DMU, each feasible basis is degenerate. Models that show degeneracy may need a considerable amount of computation before optimality requirements are verified and an optimal outcome achieved. While this may not be a problem with an analysis of small data sets, degeneracy presents itself when the number of inputs and outputs ($I + R$) is greater than 10. Although the combined data set used for computations in this analysis will be less than 10, anticycling mechanisms are incorporated in the DEA software to deal with degeneracy.

The use of DEA requires an awareness of the sensitivity of the method to various issues. It is important to establish the presence of a relationship between the inputs and outputs. This may be assessed theoretically, empirically or from experience and should at least reflect a modest relationship. This requirement will be established not only theoretically, but also empirically by calculating appropriate correlation coefficients. There is also a need to minimise redundancies in the inputs and outputs by eliminating inter-correlations between the inputs and between the outputs. As DEA requires only one observation for each variable, it can be sensitive to errors in the data. This will be monitored and checked throughout the data retrieval and preparation phase. There may be situations where the DEA application will not be able to differentiate amongst the DMUs and they are all calculated as being efficient. This mainly occurs when the number of DMUs relative to the combined number of inputs and outputs is too small. Charnes *et al* (1989) suggested a heuristic that recommends that the minimum number of DMUs be equal to or greater than three times the sum of inputs and outputs.

Where DEA results are to be used as a guide to managerial action or policy-making, it is important to acknowledge that the calculated increases in the inputs and outputs are indicative of the potential performance improvements by DMUs positioned below the efficient frontier. DEA solutions can be used to focus attention towards gaining a better understanding of the reasons for the location of certain DMUs on the efficient frontier while others are deemed as being inefficient. From a managerial and organisation effectiveness perspective, the attention of management will need to focus on identifying the various organisational factors (policies, processes, structures, etc.) that account for the observed differences. In the final analysis, the objective will be to determine the organisational changes that inefficient universities will need to make in order to become efficient.

4.2.4 Characteristics, advantages and limitations of DEA.

While DEA permits new ways of organising and analysing data, it should be recognised that the inherent features in DEA give rise to various characteristics in the calculations required to derive the efficient frontier. Specifically, the calculations:

1. Centre on revealed best-practice frontiers as opposed to the central tendency of frontiers;
2. Meet precise equity criteria in the relative evaluation of each DMU;
3. Determine specific estimates for required changes in a variable(s) for projecting DMUs below the efficient frontier on to the frontier;
4. Place no restriction on the functional form of the university production relationship;
5. Centre on individual observations as opposed to population averages;

6. Produce a single aggregate measure for each university in respect of its consumption of input factors (independent variable) to produce planned outputs (dependent variable);
7. Can use multiple inputs and outputs at the same time with each being stated in different units of measurement;
8. Are able to accommodate exogenous and categorical variables;
9. Are value free and do not require specification of *a priori* weights or prices of the variables;
10. Can permit judgement when necessary; and
11. Are Pareto optimal.

A single measure of relative efficiency for dispersed DMUs can, up to a point, be a substitute for a single profit criterion. DEA can accommodate a range of measures of input and output variables and can be flexible on the number of inputs and outputs and their weighting. The technique of DEA will group similar universities when computing DMU efficiencies. This exposes a greater understanding of an underlying similarity of these university groupings.

DEA analysis has certain technical limitations:

1. DEA measures relative efficiency rather than absolute efficiency. Comparison is with the best units even if these are not notably efficient. In terms of university performance, there is no absolute standard such as theoretical machine efficiency.
2. The validity of the analysis depends on the specification of all relevant inputs and outputs, where relevance is a matter of judgement.
3. It is assumed that each unit of a given input and output variable is identical in all universities. Quality differences are difficult to specify and measure and DEA will be

biased towards the low quality/low cost unit, as will any other method of evaluation based on the non-quality-sensitive data normally available for comparisons.

4. Interpreting the results can be difficult as the input and output weights cannot be regarded as values in the economic sense.

4.2.5 Selection of a DEA model and input-output variables for efficiency computations.

The application of DEA in this research requires the consideration of various factors. The first concerns the choice of a basic model and its suitability for the analysis. The scale/ orientation heuristic provides an appropriate basis for selecting models for most applications. In this regard, the problem formulation justifies an assumption of constant returns to scale. Examining the relationship between student numbers and the levels of fixed investment and annual recurrent expenditure tested this assumption. Student numbers as one variable was plotted against the two expenditures (separately) as the other variable. These variables were found to be reasonably well-correlated with data points fairly evenly distributed above and below the line of best fit (see appendix Figures F.1-F.3). Furthermore, as suggested by Bates (1997), although it may not be the fault of a university's management, failure to achieve the appropriate scale of operation is a form of inefficiency.

The problem formulation is orientated towards input minimisation rather than output maximisation, because levels of input (for example, investment and current expenditures, staffing levels, selection criteria, etc.) are largely subject to the discretionary control of university management. It is here that efficiency is focused upon. The levels of output are ultimately dependent upon the input variables and their underlying quantitative and qualitative characteristics.

The selection of relevant inputs and outputs is critical to the success of a DEA efficiency assessment. Sherman (1984) argues that when relevant inputs and outputs are excluded because they were overlooked, too difficult to measure or immeasurable, the DEA results can be biased or possibly misleading. However, unlike in econometric model building where variables are eliminated from consideration by using hypothesis tests, there is no standard method for selecting input and output variables in a DEA model. Various suggestions have been made in the literature as to how to select the most relevant variables for a particular set of DMUs. Ganley and Cubbin (1992) point out that the selection of inputs and outputs remains essentially a subjective exercise, which at best is based on expert opinion. They suggest that the credibility of DEA models would be increased if more formal, less disputable selection criteria were developed.

Without a formal method for variable selection there is concern that it will be easier for DMUs to 'manipulate' their efficiency score. DMUs can be expected to 'aim' for the inclusion in the model those variables that make them appear as efficient as possible. DMUs may 'argue' for the maximum number of variables to be included in the model, as this will increase the likelihood that a DMU will be found to be efficient (these figurative descriptions refer to the processes inherent in DEA).

In order to identify those factors that are most significant in their influence on university performance, an approach suggested by Norman and Stoker (1991) and referred to as the stepwise approach, will be used for selecting variables. This approach begins with an accepted measure of efficiency to obtain an initial relative efficiency score. In this case, the expenditure/graduate ratio has been used – the lower the value of this ratio, the more efficient the university is considered to be. However, the aim of DEA is to take account of as many factors that influence efficiency. The second stage is to identify these additional factors by looking at the correlations between output and other input variables from the data set. A high (positive or negative) correlation indicates that the variables in question are related to performance. If it is felt that there is a causal relationship between a variable and performance, then it is a candidate for inclusion in the DEA model.

The next stage is to run the DEA model with the addition of this variable(s). This is an iterative process, which at each stage measures efficiency in terms of the important factors identified up to that stage. This process is repeated until no further factors emerge.

4.2.6 The elements of DEA computer software.

The process of applying DEA can be broken down into four steps by using a suitable software package:

1. Data management permits the preparation of data files, with the facility to edit files as required. When data files have been created and loaded into the programme, the DEA analysis may be carried out.
2. Model selection refers to the selection of the specific variables that make up the I inputs, the R outputs and the research set of N DMUs. Model selection allows the choice of a specific DEA model to be used in the analysis as well as the option to scale and/or restate the values of a particular variable.
3. After model selection, data and model parameters are selected and the analysis performed by running the optimiser.
4. Various types of reports are produced by the programme and these depend on the options selected when setting-up the parameters of any one model. There is no standard format for report generation, although they are essentially tabular with descriptive notes and deal either with a collective set of DMUs or with a specific DMU.

For this analysis, Warwick Windows software (version 1.02) will be used. This software features the following capabilities:

Optimisation models:

1. The radial improvement model attempts a radial (or parallel) improvement. With input minimisation, the radial improvement is sought in the inputs, whilst ensuring that no output reduces in value. By default the gains sought are all of equal priority, although by specifying varying radial priorities these gains can be modified. It may be possible to make further gains in inputs and outputs by performing a secondary optimisation based on a prioritised sum of all inputs and outputs using target priorities. Likewise, the radial model may be run with an orientation that maximises output or with an orientation that combines both input minimisation and output maximisation.
2. The target improvement model attempts to maximise the prioritised sum of the reductions in inputs and improvements in outputs. By default these improvements are taken relative to the DMU's current values and are given equal priority.
3. In the mixed improvement model a percentage limit is specified. If the maximum radial gain is less than this limit, the mixed model is the same as the radial model. If the maximum radial gain is greater than this limit, only the percentage radial gain specified is retained when performing the secondary target sum optimisation.

Extra options:

1. Returns to scale: in the constant returns to scale model, no restrictions are placed on the proportions of a unit to be included in the composite comparator unit. In the variable returns to scale model, a restriction is placed on the proportions of units included in the composite comparator unit. This restriction, the BCC constraint, limits the sum of these proportions to be equal to unity.

2. Own unit as comparator: as a default, in determining the optimal composite unit, the unit under comparison is a candidate for inclusion. It is also possible to exclude the unit under comparison from the composite reference set. This will have no effect for units that are inefficient. For units that are efficient, it may however no longer be possible to retain the current levels of the unit. In the input model, for example, it may be necessary for the inputs to increase; the targets will show where this occurs and the efficiency will be greater than 100 percent (super-efficiency).
3. Second phase priorities: for the uniform option all priorities are equal. A set of priority values may be specified for the radial and target options for use in their respective models.
4. Weights: there are restrictions on raw weights as well as virtual inputs and outputs. For efficient DMUs, the maximum weight for each input-output variable is given such that efficiency is not affected. Weights may be incorporated during the radial phase.
5. Assessment: of targets when priorities over specific variables are expressed; of units when a variable(s) is exogenously set and returns to scale are variable; and of the relative contributions of each peer to the targets of an inefficient unit.

The optimisation results are reported in four main types of report tables that focus on efficiencies, peers, targets and virtual input-outputs. The ordering of the units in these tables depends on the sort order selected.

4.3 Data selection and retrieval.

With the exception of the data regarding university research output, the raw data which will been used in the analysis have been retrieved from the South African Post-secondary Education (SAPSE) information system, managed and administered by the Department of National Education in Pretoria. This vast and detailed information system contains the data that is returned annually by South Africa's post-secondary education institutions, including the university sector. Data that have been selected for analysis in this research fall within the following broad information categories. These may be referred to as subsets of the SAPSE information system, where the data are presented in a specifically structured manual format:

- **SAPSE-002: Programme classification structure manual.**

  This refers to a framework that allows for the classification of a university's resources and programmes/activities in accordance with their relationship to the achievement of institutional objectives. Specifically, the structure is a logical framework that enables an institution to order information in a hierarchical set of separate programmes, in which a programme is defined as a collection of activities serving a common set of objectives.

- **SAPSE-003: Classification of educational subject matter.**

  It provides a single, coherent system for classifying subject matter regardless of the level of instruction, type of institution or source of support.

- **SAPSE-004: Formal degree, diploma and certificate programme classification structure manual.**

  The classification scheme used includes the qualification type, course level, and fields of study and credit values of instructional offerings.

- **SAPSE-005: Student statistics manual.**

  Broadly, the statistics cover admissions, enrolments, students exiting the institution and numbers of students who have fulfilled the requirements for degrees, diplomas and certificates. A wide spectrum of demographic detail is reflected in the statistical tabulations.

- **SAPSE-006: Finance manual.**

  This describes the principles and practices associated with post-secondary fund accounting, provides uniform definitions and procedures for reporting financial data, emphasises the relationship with other sections of the SAPSE information system and describes formats for the reporting of university financial data. The financial statements have been designed to form part of an integrated reporting system that provides data on all aspects of university operations which are required for planning and management.

- **SAPSE-007: Personpower resources reporting manual.**

  Terms are defined for the reporting of personnel resources. This includes a classification scheme for personnel, which provides a comprehensive basis for detailing the uses of a university's personnel resources when used in line with the programme classification structure.

- **SAPSE-008: Fixed assets manual.**

  A system for the classification and valuation of fixed assets (movable property, immovable property and construction in progress) is set out in this manual. This reflects a university's investment in fixed assets and accounts for additions, transfers and deletions. Data are contained in a series of statements that represent a set of balance sheet supporting schedules.

- **SAPSE-009: Building and space inventory and classification manual.**

  The classification systems, codes and definitions necessary for describing and quantifying buildings and building space in terms of statistical aggregations that are appropriate in terms of resource allocation, are dealt with in this manual.

The broad data required for this analysis were downloaded from the SAPSE system and transferred electronically to a home-based personal computer platform. This facilitated the management of a large volume of data that would have been impossible to deal with in printed format. Thereafter, the data were subject to closer scrutiny and specific data were then extracted and transferred to a secondary data base set-up in Microsoft Excel 2000. During this process and where possible, data validation checks were done to ensure consistency and accuracy of the data. It was also possible to cross-check certain data items where these appeared in other different data subsets. The use of worksheet formats facilitated the tabulation and analysis of data, including the use of formulas and graphic presentations.

Information regarding research output for the university sector was made available by the South African Universities' Vice-Chancellors' Association. Data for the years 1994 to 1997 (the most recent available) will be assessed and analysed. In this research, 1997 will be referred to as the base year.

4.4 Selection of universities for research.

There are twenty-one universities in South Africa, each displaying a unique set of characteristics relating to geographic location, size of investment in infrastructure, operating cost structure, faculty and departmental organisation (size/subjects offered), personnel resources, student numbers and composition and academic output. While each university has its own characteristics, the fulfilment of the responsibilities assigned to these institutions by society in creating and disseminating knowledge, is dependent upon a common set of programmes and activities. As these are fundamental to each university, one may therefore be permitted to view these institutions as homogeneous entities. This provides an appropriate starting point to conduct an analysis of efficiency performance in the university sector.

In terms of the requirements of the Charnes *et al* (1989) heuristic for DEA (see section 4.2.3), it would be preferable to include all universities in the research. However, having sought an opinion about the quality of the SAPSE data base, the Department of National Education has advised that as certain information is either outstanding or incomplete for certain universities, they should not be included in the research sample. As a consequence therefore, only the following universities have been included in the research:

Table 4.1. Those universities included in the research sample.

University:	Denoted by:
University of Cape Town	UCT
University of Durban-Westville	DWV
University of the Orange Free State	OFS
University of Port Elizabeth	UPE
Potchefstroom University for CHE	PCH
University of Pretoria	PTA
Rand Afrikaans University	RAU
Rhodes University	RHU
University of Stellenbosch	STL
University of Zululand	ZLD

Although these universities represent a fair cross-section of the university sector in terms of the above list of university characteristics, it would have been desirable to have greater representation of the so-called disadvantaged universities (Fort Hare, Transkei, Western Cape, Venda, etc.) in the sample. The abbreviations for each university shown in Table 4.1 are used throughout the chapters that address results, analyses and conclusions.

4.5 The possible effect of a university's financial structure on its measure of relative efficiency.

As a special study, the effect of the financial structure of each university on its measure of relative efficiency will be analysed using the DEA technique. An analysis of university balance sheets will reveal the financial structures of each entity. The capital employed in each university will be analysed in terms of its long-term debt and equity finance and from these components, the financial gearing ratios will be calculated.

By varying the gearing ratios in a range from 0 to 50 per cent, the effect of a theoretical change in long-term debt on interest expense and its consequential effect on the total cost structure, will be examined. The cost structure appropriate to each level of gearing will be tested in the target improvement DEA model to determine changes (if any) in relative efficiency scores separately for each university. All other variables will be held constant within the model. The analysis will be made using data for 1997 – the base year in this research.

In Chapter Five, testing various input-output variables to measure relative efficiency develops three DEA models – academic, research and consolidated. A 'preferred model' is employed to measure relative efficiency between 1994-97 and to examine the effect of an institution's financial structure on relative efficiency.

CHAPTER FIVE

THE RESULTS OF DATA ENVELOPMENT ANALYSIS

5.0 DEA: relative efficiency measurement of universities.

The most important measurable outputs from the university sector are their academic results (degrees, diplomas and certificates) and their research results (books, articles in approved journals, conference proceedings, patents/licences and research income). As these are the mainstream outputs, relative efficiency has initially been measured for each university using models that consider academic and research results separately. After these preliminary models had been developed, they were then merged into one model to give an overall assessment of relative efficiency. Data for 1997 (the base case) were used in these models.

5.1. A model based on academic results.

Using the stepwise approach (see section 4.2.5), the following model that incorporates various inputs with a single output was developed. Input variables chosen are those that display a conceptually strong relationship (tested by measuring correlation coefficients - r) with expected academic results. A series of seven DEA's was run; working up from a simple analysis involving instructional adjusted expenditure and formal degree results (including diplomas and certificates) to an analysis that includes more aggregated levels of inputs. This was done in order to establish whether, depending on the inputs used, there was any consistency between different DEA model results.

Model summary (academic):

Radial improvement with input minimisation.

Constant returns to scale.

Inclusive of own unit (as a default, in determining the optimal composite unit, the unit under comparison is a candidate for inclusion).

Uniform priorities on inputs (all priorities on inputs are equal).

Related efficiency values (for the radial model, given a possible radial improvement of p, the efficiency is defined as (1 – p) for input minimisation).

Phase 1 optimisation – minimises the input requirement with the output level held.

Phase 2 optimisation – maximises secondary gains relative to the target.

The results of all the DEA's undertaken are shown in Table 5.1. These are referred to as DEA1A to DEA7A respectively and have the following definitions:

DEA1A: OUTPUT: Degree Credits[1] (fixed for all DEA's).

INPUT: Instructional adjusted expenditure[2] ($r = 0.902$).

DEA2A: INPUT: FTE staff numbers ($r = 0.902$).

DEA3A: INPUT: Capital employed ($r = 0.918$).

DEA4A: INPUT: Student numbers ($r = 0.927$).

DEA5A: INPUT: Student numbers + Capital employed.

DEA6A: INPUT: Student numbers + Capital employed + Inst. adj. expenditure.

DEA7A: INPUT: Student numbers + Capital employed + FTE staff numbers.

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[1] Formal credits obtained by students who fulfilled the requirements for a degree, diploma or certificate.

[2] Adjusted recurrent annual expenditure (defined as total annual recurrent expenditure less expenditure that cannot be directly attributed to instruction and research activities i.e. public service, bursaries, student housing/food services, hospitals and independent operations) less annual research programme expenditure.

Table 5.1. Relative efficiencies of 10 universities for selected DEA's (academic).

1997	Exp/Grad	DEA1A		DEA2A	DEA3A	DEA4A	DEA5A	DEA6A	DEA7A
UNIV	Rank	Rank	%	%	%	%	%	%	%
UCT	9	8	50	53	37	93	94	94	94
DWV	7	7	58	73	93	100	100	100	100
OFS	8	9	46	51	49	51	80	80	80
UPE	3	4	66	58	51	66	66	84	75
PCH	5	5	64	68	100	89	100	100	100
PTA	2	2	74	74	53	94	94	100	99
RAU	1	1	100	100	60	62	63	100	100
RHU	4	3	72	35	52	90	90	97	90
STL	6	6	63	70	54	99	99	100	99
ZLD	10	10	39	38	70	46	70	70	70
MEAN EFFICIENCY			63	62	62	79	94	92	91
MEAN INEFFICIENCY[1]			59	58	58	77	83	85	87

Note: [1] Mean inefficiency is calculated for input efficiency scores less than unity.

5.2 A model based on research results.

The following model that incorporates various inputs and a single output was developed using the stepwise approach (see section 4.2.5). Input variables chosen are those that display a conceptually strong relationship (tested by measuring correlation coefficients - r) with research output. A series of five DEA's was run, working up from a simple analysis involving research FTE staff and research output, to an analysis that includes more aggregated levels of inputs. Again, this was done in order to establish whether there was any consistency between different DEA model results depending on the inputs used.

Model summary (research):

Radial improvement with input minimisation.

Constant returns to scale.

Inclusive of own unit.

Uniform priorities on inputs.

Related efficiency values.

Phase 1 optimisation – minimises the input requirement with the output level held.

Phase 2 optimisation – maximises secondary gains relative to the target.

The results of all the DEA's undertaken are shown in Table 5.2 below. These are referred to as DEA1R to DEA5R respectively and have the following definitions:

DEA1R: OUTPUT: Research output in units[1] (fixed for all DEA's).

INPUT: Research FTE staff numbers ($r = 0.882$).

DEA2R: INPUT: Research adjusted expenditure[2] ($r = 0.925$).

DEA3R: INPUT: Capital employed ($r = 0.992$).

DEA4R: INPUT: Capital employed + Research FTE staff numbers.

DEA5R: INPUT: Capital employed + Res. FTE staff numbers + Res.adj. expenditure.

Table 5.2. Relative efficiencies of 10 universities for selected DEA's (research).

1997	Res/Staff [1]	DEA1R		DEA2R	DEA3R	DEA4R	DEA5R
UNIV	Rank	Rank	%	%	%	%	%
UCT	7	7	37	72	75	75	80
DWV	6	6	45	31	56	64	64
OFS	5	5	49	58	72	77	77
UPE	4	4	53	58	50	75	65
PCH	10	10	31	45	75	75	75
PTA	2	2	64	92	78	91	98
RAU	1	1	100	100	68	100	100
RHU	3	3	61	88	100	100	100
STL	8	8	36	69	75	75	78
ZLD	9	9	32	29	56	56	56
MEAN EFFICIENCY			51	64	71	78	79
MEAN INEFFICIENCY [2]			45	60	67	74	74

Note: [1] Research output in units per professional FTE staff member.
[2] Mean inefficiency is calculated for input efficiency scores less than unity.

[1] Unit of research evaluated by the Committee of Universities' and Technicons' Advisory Council (AUT).

[2] Adjusted recurrent annual expenditure less annual instructional programme expenditure (see definition of adjusted expenditure under the consolidated model in section 5.3).

5.3 The consolidated model.

The consolidation of the academic and research models into a unitary model provides for an overall measurement of relative efficiency for each university. Output variables are fixed in this model and focus on academic and research results achieved in each university. Input variables used in the development of the model are those that featured in the initial models, with the exception of the variable for expenditure, which has been adjusted to reflect the joint activities of teaching and research. A stepwise approach has been used to test the input variables selected (see section 4.2.5). These variables have been selected for displaying a conceptually strong causal relationship with academic and research results alike. The development of the model was limited by the requirements of the Charnes *et al* (1989) heuristic for DEA (see section 4.2.3), which in this case, restricted the number of variables to four. This meant that the input variables could not exceed two in number (having already determined the two output variables).

A series of seven DEA's was run, working up from an analysis involving total expenditure to an analysis that included more aggregated levels of inputs. This was done in order to establish whether, depending on the inputs used, there was any consistency between different DEA model results.

Model summary (consolidated):

Radial improvement with input minimisation.

Constant returns to scale.

Inclusive of own unit.

Uniform priorities on inputs.

Related efficiency values.

Phase 1 optimisation – minimises the input requirement with the output level held.

Phase 2 optimisation – maximises secondary gains relative to the target.

The results of all the DEA's undertaken are shown in Table 5.3 below. These are referred to as DEA1 to DEA7 respectively and have the following definitions:

DEA1: OUTPUT: Degree Credits + Research output in units (fixed for all DEA's).

INPUT: Total Expenditure[1] ($r = 0.881$ and 0.925).

DEA2: INPUT: Capital employed ($r = 0.918$ and 0.992).

DEA3: INPUT: Capital employed + Student numbers ($r = 0.927$ and 0.818).

DEA4: INPUT: Capital employed + FTE staff numbers ($r = 0.902$ and 0.970).

DEA5: INPUT: Capital employed + Adjusted expenditure[2] ($r = 0.881$ and 0.928).

DEA6: INPUT: Capital employed + Total Expenditure.

DEA7: INPUT: Student numbers + FTE staff numbers.

Table 5.3. Relative efficiencies of 10 universities for selected DEA's (consolidated).

1997	Exp/Grad	DEA1		DEA2	DEA3	DEA4	DEA5	DEA6		DEA7
UNIV	Rank	Rank	%	%	%	%	%	Rank[1]	%	%
UCT	9	4	70	75	100	97	78	7	79	100
DWV	7	7	57	93	100	100	96	4	100	100
OFS	8	8	57	77	85	87	77	8	79	82
UPE	3	6	60	60	68	71	77	9	75	76
PCH	5	9	53	100	100	100	100	3	100	92
PTA	2	3	81	83	97	100	94	5	93	100
RAU	1	1	100	78	78	100	100	1	100	100
RHU	4	2	87	100	100	100	100	2	100	95
STL	6	5	67	81	100	97	87	6	88	100
ZLD	10	10	41	72	72	72	72	10	74	50
MEAN EFFICIENCY			67	82	90	92	88		89	90
MEAN INEFFICIENCY[2]			64	77	80	85	83		81	79

Note: [1] Ranking is determined by using the technique of super efficiency, where the unit under comparison is excluded from the composite mix. In the input model it will be necessary for inputs to increase; the targets show where this occurs and efficiency will be greater than 100 per cent.
[2] Mean inefficiency is calculated for input efficiency scores less than unity.

[1] Total annual recurrent expenditure in respect of all university expenditure categories (covering all programmes and subprogrammes).

[2] Defined as total annual recurrent expenditure less expenditure not directly attributed to instruction and research activities (public service, bursaries, student housing, hospitals and independent operations).

Following an assessment of the relative efficiency values expressed in the models DEA3 to DEA6 in Table 5.3 above, model DEA6 was selected to be the preferred model for the ongoing DEA analysis. Other features of this model were then further evaluated. Results for peer groupings, target values for inefficient universities and virtual inputs/outputs (weight factors) are set out below. The reasons for the selection of this particular model will be substantiated in Chapter 7, which deals with the analysis of DEA results.

5.3.1 Peer units for each inefficient university.

The DEA computations of relative efficiency for each university indicate those other universities that are peer grouped with an inefficient university. These reference universities are referred to as peer units. Details of the peer units and their groupings are set out in Table 5.4 below. The column 'times cited' indicates the number of times an efficient university has been cited in the reference group of inefficient universities. A large number of citings indicates that a peer group university is not uniquely efficient and consequently is a preferred university by which to analyse best practice. The peer group columns list the efficient universities that comprise the target university's reference group.

Table 5.4. Peer groups for inefficient universities for model DEA6.

1997	EFFICIENCY	PEER GROUPS						TIMES
UNIV	% RADIAL	UNIV	LAMBDA[1]	UNIV	LAMBDA	UNIV	LAMBDA	CITED
ZLD	74.12	PCH	0.317	RAU	0.018	RHU	0.013	0
UPE	75.42	DWV	0.131	PCH	0.032	RAU	0.252	0
OFS	79.11	PCH	0.252	RAU	0.081	RHU	1.081	0
UCT	79.12	RAU	0.246	RHU	2.961	-	-	0
STL	88.27	PCH	0.368	RAU	0.385	RHU	1.507	0
PTA	92.69	PCH	0.137	RAU	0.876	RHU	2.506	0
DWV	100.00	-	-	-	-	-	-	1
PCH	100.00	-	-	-	-	-	-	5
RHU	100.00	-	-	-	-	-	-	5
RAU	100.00	-	-	-	-	-	-	6

Note: [1] A DEA generated factor for apportioning amounts of actual input variables of peer units selected for setting targets for each inefficient DMU. Lambda multiplied by the actual input values of each peer unit added together = the target for each input variable of an inefficient DMU (see Thanassoulis and Emrouznejad, 1996).

5.3.2 Target values for each university.

Following the tabulation of the peer units for each university, the DEA computations indicate the target contributions of the peer grouping required to achieve an optimal mix and an efficient unit. The targets show the improvements required for appropriate variables in an inefficient unit in order for this unit to move on to the efficient frontier. The tabulations in Table 5.5 show the target values for each inefficient university.

Table 5.5. Target values for each inefficient university for model DEA6.

1997 UNIV	EFFICIENCY % RADIAL	VARIABLE	ACTUAL	TARGET	TO GAIN %	ACHIEVED %
ZLD	74.12	-CAPEMP[1]	162.0	120.1	25.9	74.1
		-TOTEXP[2]	144.0	106.7	25.9	74.1
		+RESRCH[3]	59.0	59.0	0.0	100.0
		+DEGCRS[4]	2139.1	2139.1	0.0	100.0
UPE	75.42	-CAPEMP	323.0	243.6	24.6	75.4
		-TOTEXP	141.0	106.3	24.6	75.4
		+RESRCH	104.9	104.9	0.0	100.0
		+DEGCRS	3118.2	3118.2	0.0	100.0
OFS	79.11	-CAPEMP	562.0	444.6	20.9	79.1
		-TOTEXP	324.0	256.3	20.9	79.1
		+RESRCH	264.9	264.9	0.0	100.0
		+DEGCRS	5206.7	5206.7	0.0	100.0
UCT	79.12	-CAPEMP	1280.0	1012.7	20.9	79.1
		-TOTEXP	618.0	488.9	20.9	79.1
		+RESRCH	623.9	623.9	0.0	100.0
		+DEGCRS	8947.6	10229.0	14.3	87.5
STL	88.27	-CAPEMP	939.0	828.8	11.7	88.3
		-TOTEXP	482.0	425.5	11.7	88.3
		+RESRCH	462.3	462.3	0.0	100.0
		+DEGCRS	9661.9	9661.9	0.0	100.0
PTA	92.69	-CAPEMP	1510.0	1399.6	7.3	92.7
		-TOTEXP	659.0	610.8	7.3	92.7
		+RESRCH	770.7	770.7	0.0	100.0
		+DEGCRS	15128.9	15128.9	0.0	100.0
DWV	100.0	-CAPEMP	347.0	347.0	0.0	100.0
		-TOTEXP	292.0	292.0	0.0	100.0
		+RESRCH	126.0	126.0	0.0	100.0
		+DEGCRS	6097.8	6097.8	0.0	100.0
PCH	100.0	-CAPEMP	324.0	324.0	0.0	100.0
		-TOTEXP	317.0	317.0	0.0	100.0
		+RESRCH	159.3	159.3	0.0	100.0
		+DEGCRS	6142.1	6142.1	0.0	100.0
RHU	100.0	-CAPEMP	280.0	280.0	0.0	100.0
		-TOTEXP	146.0	146.0	0.0	100.0
		+RESRCH	183.2	183.2	0.0	100.0
		+DEGCRS	2753.7	2753.7	0.0	100.0
RAU	100.0	-CAPEMP	746.0	746.0	0.0	100.0
		-TOTEXP	230.0	230.0	0.0	100.0
		+RESRCH	330.9	330.9	0.0	100.0
		+DEGCRS	8431.6	8431.6	0.0	100.0

Notes: [1] Capital employed (– denotes an input). [2] Total recurrent expenditure.
[3] Research units (+ denotes an output). [4] Degree credits.

5.3.3 Virtual inputs and outputs for each university.

In establishing whether or not a university is efficient, DEA determines if there is a set of weights for inputs and outputs that locates that university on the efficient frontier. The weights generated by the DEA process to calculate the virtual inputs and outputs and the aggregate relative efficiency scores for universities are shown in Table 5.6.

Table 5.6. Virtual inputs and outputs for each university for model DEA6.

1997 UNIV	EFFICIENCY % RADIAL	VARIABLE	VIRTUAL I/Os[1] %	I/O WEIGHTS
ZLD	74.12	-CAPEMP	58.63	0.00362
		-TOTEXP	41.37	0.00287
		+RESRCH	26.32	0.00446
		+DEGCRS	47.80	0.00022
UPE	75.42	-CAPEMP	62.58	0.00194
		-TOTEXP	37.42	0.00265
		+RESRCH	3.65	0.00035
		+DEGCRS	71.76	0.00023
OFS	79.11	-CAPEMP	68.61	0.00122
		-TOTEXP	31.39	0.00097
		+RESRCH	39.87	0.00151
		+DEGCRS	39.25	0.00008
UCT	79.12	-CAPEMP	22.51	0.00018
		-TOTEXP	77.49	0.00125
		+RESRCH	79.12	0.00127
		+DEGCRS	0.00	0.00000
STL	88.27	-CAPEMP	71.05	0.00076
		-TOTEXP	28.95	0.00060
		+RESRCH	43.13	0.00093
		+DEGCRS	45.14	0.00005
PTA	92.69	-CAPEMP	74.27	0.00049
		-TOTEXP	25.73	0.00039
		+RESRCH	46.74	0.00061
		+DEGCRS	45.95	0.00003
DWV	100.00	-CAPEMP	46.45	0.00134
		-TOTEXP	53.55	0.00183
		+RESRCH	3.03	0.00024
		+DEGCRS	96.97	0.00016
PCH	100.00	-CAPEMP	62.38	0.00193
		-TOTEXP	37.62	0.00119
		+RESRCH	37.62	0.00236
		+DEGCRS	62.38	0.00010
RHU	100.00	-CAPEMP	63.40	0.00226
		-TOTEXP	36.60	0.00251
		+RESRCH	63.40	0.00346
		+DEGCRS	36.60	0.00013
RAU	100.00	-CAPEMP	50.00	0.00067
		-TOTEXP	50.00	0.00217
		+RESRCH	50.00	0.00151
		+DEGCRS	50.00	0.00006

Note: [1] I/O's – denotes virtual inputs and outputs, defined as the weighted value of each original input/output variable expressed as a percentage (computer generated) to obviate the different units of measurement of the original variables (see Charnes *et al*, 1994; Thanassoulis and Emrouznejad, 1996).

These weights are the most balanced values for each university and are as close to equality as possible (the weights for both inputs and outputs must also be feasible for all other universities and are selected in a manner that calculates the Pareto efficiency measure of each university). The term 'virtual' refers to the reduction of the multiple input and multiple output variable situation for each university to that of a 'single virtual input' and a 'single virtual output'. The ratio of this single virtual output to single virtual input provides a measure of efficiency, which is a function of the weights.

Relative technical efficiency of each university is calculated by forming the ratio of a weighted sum of outputs to a weighted sum of inputs using virtual input and output values. For example, from Table 5.6, the relative efficiency of ZLD is given by:

Ratio of virtual output/input = $[(26.32 + 47.80) \div (58.63 + 41.37)] \times 100 = 74.12\%$

and the relative efficiency of DWV is given by:

Ratio of virtual output/input = $[(3.03 + 96.97) \div (46.45 + 53.55)] \times 100 = 100.00\%$

5.3.4 Assessment of relative efficiency with restrictions on output weights.

Model DEA6 assumes uniform priorities for both the input and output variables. However, it may be argued that this is not representative of the actual university model in so far as output is concerned and that the relative importance of university output could be skewed towards academic results (degree/diploma/certificate) rather than research results. In consideration of this possibility, research output has therefore been modified by imposing higher weights in a range from 0.0002 up to 0.01 within model DEA6. There are also the difficulties that exist in quantifying research output. The effect of this restriction on the relative efficiency measures established for the ten universities is shown in Table 5.7.

Table 5.7. Relative efficiency measures (per cent) for various weights in model DEA6.

UNIV	WEIGHTS[1]							
1997	0.0001[2]	0.0002	0.0003	0.0005	0.001	0.0025	0.005	0.01
ZLD	74.12	73.14	73.14	73.14	73.14	73.14	73.14	73.14
UPE	75.42	75.42	75.42	75.42	75.42	75.42	75.36	75.36
OFS	79.11	79.11	79.11	79.11	64.09	64.09	64.09	64.09
UCT	79.12	79.12	79.12	79.12	52.34	52.34	52.34	52.34
STL	88.27	88.27	88.27	75.03	75.03	75.03	75.03	75.03
PTA	92.69	92.69	92.69	92.69	92.69	78.22	78.22	78.22
DWV	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
PCH	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
RHU	100.00	71.22	71.22	71.22	71.22	71.22	71.22	71.22
RAU	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note: [1] The weights from 0.0002 – 0.01impose additional constraints on the research unit variable.
[2] Relative efficiencies initially reported for model DEA6 (see Table 5.3).

5.4 Relative efficiency over time.

The relative efficiencies of the university sector have been examined over time (1994-97). This has shown the extent to which the university sector has demonstrated stability in terms of unit efficiencies. Where this has not been the case, the DEA results have highlighted those units that have been the subject of improvement or decline in their relative efficiencies. The results of the measurement of relative efficiencies for each university over time are reflected in Table 5.8. Model DEA6 is again used as the basis for this time series evaluation.

Table 5.8. The relative efficiencies of universities over the period 1994-97, based on model DEA6 (per cent).

UNIV	EFFICIENCY 1997	EFFICIENCY 1996	EFFICIENCY 1995	EFFICIENCY 1994
ZLD	74.12	76.54	83.38	48.04
UPE	75.42	65.53	59.90	67.76
OFS	79.11	84.52	92.37	100.00
UCT	79.12	90.83	95.62	100.00
STL	88.27	85.33	91.87	92.38
PTA	92.69	87.43	90.75	82.13
DWV	100.00	100.00	99.96	79.76
PCH	100.00	100.00	100.00	100.00
RHU	100.00	100.00	100.00	89.86
RAU	100.00	100.00	100.00	100.00
MEAN EFFICIENCY	88.87	89.02	91.39	85.99
MEAN INEFFICIENCY[1]	81.46	81.70	87.69	76.66

Note [1] Mean inefficiency is calculated for input efficiency scores less than unity.

5.5 The effect of a university's financial structure on relative efficiency.

The financial structure of each university has been analysed in terms of equity finance and long-term debt (borrowing instruments repayable with a term greater than one year). Gearing[1] ratios (long-term debt divided by total capital employed) have been calculated from these two components for each university. Based on the amount of interest paid by a university over the year, assumed interest rates have been calculated using an average of the opening and closing long-term debt balances. This interest rate was then used to calculate the interest expense on long-term debt associated with any particular level of gearing. The relevant figures and computed values are reflected in Table 5.9.

[1] The relationship between long-term debt finance and total capital employed (permanent capital plus debt).

Table 5.9. The financial structure, gearing ratio and interest components for each university.

UNIV 1997	CAPEMP Rm[1]	EQUITY Rm	LONG-TERM DEBT O/BAL[2] Rm	C/BAL[3] Rm	GEARING RATIO[4]	INTEREST PAID Rm	INTEREST RATE[5] %
UCT	1277.8	1030.0	264.9	247.8	0.194	35.10	13.69
DWV	346.9	344.0	4.3	2.9	0.008	0.05	1.40
OFS	561.2	521.0	41.6	40.2	0.072	5.38	13.15
UPE	322.9	292.0	33.6	30.9	0.096	4.27	13.24
PCH	324.1	282.0	45.0	42.1	0.130	5.67	13.02
PTA	1520.4	1460.0	69.9	60.4	0.040	10.1	15.51
RAU	746.4	696.0	53.3	50.4	0.068	5.92	11.42
RHU	280.3	268.0	20.1	12.3	0.044	1.53	9.44
STL	938.7	852.0	87.1	86.7	0.092	9.22	10.61
ZLD	161.4	126.0	35.5	35.4	0.219	0.50	1.41

Notes: [1] Rand million.
[2] Opening balance (prior year end balance sheet figure).
[3] Closing balance (current year end balance sheet figure).
[4] Long-term debt divided by total capital employed.
[5] Calculated as interest paid divided by average long-term debt expressed as a percentage per annum.

By varying the gearing ratios in a range from 0.0 to 0.5, a theoretical restructuring of the financial structure of each university was carried out to assess the possible effect of this on its established measure of relative efficiency already noted in the consolidated model (see section 5.3). The assumed change in the long-term debt component of capital employed resulted in an associated change in the level of interest expense. The impact of this change on the total current cost structure was then computed, the results of which are shown in Table 5.10.

The cost structure appropriate for each level of gearing was then tested separately in the consolidated model DEA6 for each university to determine the changes (if any) in its relative efficiency. All other variables were held constant within the model (including the variable of total expenditure for all other universities not subject to test at any one time).

Table 5.10. The changes in the total cost structure arising from theoretically assumed gearing ratios.

UNIV	CAPEMP	L/TDEBT	T/COST	L/TDEBT	T/COST	L/TDEBT	T/COST	L/TDEBT	T/COST	L/TDEBT	T/COST	L/TDEBT	T/COST
		GEARING = 0.0		GEARING = 0.1		GEARING = 0.2		GEARING = 0.3		GEARING = 0.4		GEARING = 0.5	
1997	Rm	Rm	Rm	Rm	Rm	Rm	Rm	Rm	Rm	Rm	Rm	Rm	Rm
UCT	1277.8	0.00	582.90	127.80	600.39	255.6	617.89	383.34	635.38	511.12	652.87	638.90	670.36
DWV	346.9	0.00	291.95	34.69	292.44	69.38	292.92	104.07	293.41	138.76	293.89	173.45	294.38
OFS	561.2	0.00	318.62	56.12	326.00	112.24	333.38	68.36	340.76	224.48	348.14	280.60	355.52
UPE	322.9	0.00	135.73	32.29	141.01	64.58	145.28	96.87	149.56	129.16	153.83	161.45	158.11
PCH	324.1	0.00	311.33	32.41	315.55	64.82	319.77	97.23	323.99	129.64	328.21	162.05	332.43
PTA	1520.4	0.00	648.90	152.04	672.48	304.08	696.06	456.12	719.64	608.16	743.23	760.20	766.81
RAU	746.4	0.00	224.08	74.64	232.60	149.28	241.13	298.56	249.65	298.56	258.18	373.20	266.17
RHU	280.3	0.00	144.47	28.03	147.12	56.06	149.76	84.09	152.41	112.12	155.05	140.15	157.70
STL	938.7	0.00	472.78	93.87	482.74	187.74	492.70	281.61	502.66	375.48	512.62	469.35	522.58
ZLD	161.4	0.00	143.50	16.14	143.73	32.28	143.96	48.42	144.18	64.56	144.41	80.70	144.64

Notes: CAPEMP – capital employed. T/COST – total annual current expenditure.
L/TDEBT – long-term debt. Rm – Rand million.

Model summary (consolidated):

Radial improvement with input minimisation.

Constant returns to scale.

Inclusive of own unit.

Uniform priorities on inputs.

Related efficiency values.

Phase 1 optimisation – minimises the input requirement with the output level held.

Phase 2 optimisation – maximises secondary gains relative to the target.

DEA6 definition: OUTPUT: Degree Credits + Research output in units.

INPUT: Capital employed + Total Expenditure.

The results of the computations undertaken are shown in Table 5.11.

Table 5.11. Relative efficiencies for various levels of financial gearing based on model DEA6 (per cent).

UNIV 1997	GEAR[1] = 0.0 EFFIC[2] %	GEAR = 0.1 EFFIC %	GEAR = 0.2 EFFIC %	GEAR = 0.3 EFFIC %	GEAR = 0.4 EFFIC %	GEAR = 0.5 EFFIC %
UCT	82.76	80.90	79.13	77.43	75.80	74.50
DWV	100.00	100.00	100.00	100.00	100.00	100.00
OFS	79.53	79.11	78.40	77.85	77.31	76.77
UPE	76.29	75.41	74.57	73.74	72.93	72.14
PCH	100.00	100.00	100.00	100.00	100.00	100.00
PTA	93.06	92.2	91.37	90.54	89.74	88.94
RAU	100.00	100.00	100.00	100.00	100.00	100.00
RHU	100.00	100.00	100.00	100.00	100.00	100.00
STL	88.76	88.23	87.71	87.19	86.67	86.17
ZLD	74.23	74.18	74.13	74.08	74.03	73.99

Note: [1] GEAR – financial gearing ratio. [2] EFFIC – efficiency.

The DEA computations associated with the theoretically different levels of financial gearing for each university demonstrate that the four unitary efficient universities (DWV, PCH, RAU and RHU) measured in the consolidated model DEA6, remain unitary efficient over the gearing range 0.0 to 0.5. The changes in relative efficiency of the inefficient universities and the relationship of this change to each university's interest rate level is summarised in Table 5.12.

Table 5.12. The changes in relative efficiency of universities over the gearing range 0.0 to 0.5 and the relationship of this change to interest rate levels.

UNIV 1997	CHANGE IN EFFIC LEVEL (% POINTS)	PERCENTAGE CHANGE IN EFFICIENCY	INTEREST RATE % PER ANNUM	MODEL DEA6 EFFICIENCY[1] %
ZLD	0.24	0.32	01.41	74.12
UPE	4.15	5.44	13.24	75.42
OFS	2.76	3.47	13.15	79.11
UCT	8.26	9.98	13.69	79.12
STL	2.59	2.92	10.61	88.27
PTA	4.12	4.43	15.51	92.69
DWV	0.00	0.00	01.46	100.00
PCH	0.00	0.00	13.02	100.00
RHU	0.00	0.00	09.44	100.00
RAU	0.00	0.00	11.42	100.00

Note: [1] Relative efficiency computed in the consolidated model DEA6 (see Table 5.3).

As could be expected, the low interest rates evident in DWV and ZLD have no significant effect on their respective cost structures and consequently even less of an impact on their relative efficiency measures. For those inefficient universities subject to more normal interest rate levels, their relative efficiencies change within a range from about 3 per cent (STL) to 10 per cent (UCT) across the gearing range.

DEA results are analysed in Chapter Seven. In Chapter Six, analytical review is used to compute various performance measures of the university process; individual efficiency measures are computed and compared with the DEA measure using a ranking approach.

CHAPTER SIX

THE RESULTS OF ANALYTICAL REVIEW

6.0 Overview of input, output and efficiency measures.

In this chapter, the results of the analytical review will focus on the base year 1997 – the year for which the most recent and complete data set is available. Results will be categorised according to whether they are input measures, which reflect the resources available to each university or output measures, which reveal the results of each institution applying its processes to its input factors of production. The full computations of ratios, percentages and values and their statistical outcomes in respect of university student populations, personpower inputs and financial resources have been tabulated for the years 1994-97 and appear in the appendices Tables B.1 – D.10 (see section 4.3 for data sources).

In order to provide an overview to the detailed results that follow, the inputs and outputs selected for this research will be briefly discussed, as will be some of the limitations of simple comparisons between universities. The principal inputs broadly include students, personpower and financial resource. Students are considered in terms of academic status, which includes the levels of undergraduate, lower post-graduate (post-graduate diploma/certificate, post-graduate bachelor and honours) and higher post-graduate (master's and doctoral) and their distribution across these three levels for each university. The criterion for the admission of students is examined according to the type of school leaving certificate (matriculation exemption in this case) and the aggregate symbol achieved at this level, which provide an indication of the quality of student intake at a university.

Institutional personpower (skills, capabilities, interests and attitudes of individuals) represents a resource that is fundamental to its operations and the importance of this resource extends well beyond a significance expressed in financial terms. Without individuals who are intellectually qualified and motivated towards teaching, the instructional process would cease to function efficiently and without those that are personally interested in scholarly pursuits, there would be no research.

Personnel employed in a university are grouped into four main categories, which are:

- Instruction/research professionals (staff employed for the primary purposes of performing teaching and research activities),
- Administration (executive, administrative and management professionals and non-professional administrative staff),
- Specialist/support professionals (professional staff engaged in academic support, institutional support and student service), and
- Technical services (technical, craft, trade and service activities).

Particular attention is given to the category of instruction/research professionals and the manner in which this resource is allocated and used in the main programmes of teaching, research and academic administration within universities. Viewed from another perspective, an assessment is made of how this input is allocated according to student status. It is also analysed in terms of level of appointment (professor, lecturer and below junior lecturer) and within these categories, the quality of staff is measured by reference to their highest qualification obtained. A problem in this regard is that there is no guarantee on the equivalence of higher degrees conferred by different universities. Since the better-recognised universities will be able to attract a higher calibre staff from those institutions with an acknowledged high academic rating, a quality differential amongst teaching and research staff probably exists within the university sector although the *de facto* existence of this remains indeterminate.

Student and staff inputs are combined to determine the measures that provide an understanding of the approach taken in each university to their instruction/research staffing levels and importantly, the trade-off between the desire to provide a quality driven service and the need to maintain a high level of operational efficiency. This is viewed in terms of students, graduates and the full-time equivalent staff. Instructional time is measured for both undergraduates and post-graduates based on student class contact time.

The DEA computations are largely underpinned by financial parameters and therefore in the analytical review considerable attention is devoted to the manner in which this resource is used in universities. Annual recurrent expenditure is analysed within the SAPSE-defined programme classification structure, a framework that allows for the classification of university resources and activities in accordance with the achievement of institutional objectives. This framework allows a determination of where financial resources are focused and, by using inter-university comparisons, to determine the efficiency of their use.

Cost structures are briefly examined to provide an estimate of the fixed cost component of total cost in order to determine the ability of each university to respond to changes in annual student intake numbers. The lower the level of fixed cost, the greater is the flexibility to deal with any decline in student numbers (and *vice versa*) and hence the likelihood of maintaining an acceptable level of efficiency. As personnel expenditure accounts for a high percentage of total annual recurrent expenditure (fixed and variable), it has been analysed in detail and within the same categories referred to previously. Recurrent expenditure in each institution is normalised by percentage and on a per student and graduate basis for ease of comparison and measurements.

The capital employed in an institution comprises the elements of tangible fixed assets, long-term investments and net working capital. This is the financial resource available to the managers of an institution and may aptly be referred to as the operations management capital employed. In this research, an attempt is made to determine the degree to which capital is efficiently used. More specifically, investment in fixed assets (the largest component of capital employed) is examined by SAPSE programme, which comprises the following categories:

- Educational and general investment (instruction, research, academic support, student service, bursaries, institutional support and operations/maintenance of plant),
- Auxiliary enterprises (student and staff accommodation and catering services), and
- Other investments (teaching hospital, independent operations – institutional, external, and operations/maintenance of plant).

The primary category of educational and general fixed asset investment is further analysed to establish the allocation of financial resources between educational land and buildings, educational equipment, library collections and other educational investment. The focus here is to determine the patterns of investment across the institutions and whether this translates into the efficient use of limited capital.

The principal outputs from the university process are graduates at various academic levels and research in its different forms. Graduate output is measured by reference to academic status (undergraduate, lower post-graduate and higher post-graduate) and is further assessed in terms of whether institutions have a leaning towards natural science or the humanities or have a balance between these two. The rate at which students are transformed into graduates provides a basic measure of university efficiency and is set out in terms of graduates per 1000 students, by academic status. An immediate difficulty arises here in that graduation rates may reflect different academic standards in certain universities; for example, a graduate from university X may not be equivalent to a graduate from university Y (particularly at post-graduate level). This difficulty may be explored by analysing the first employment experiences of graduates on leaving a university and by observing graduate progression in the early years of a career. Conversely, the percentage of students who leave a university without completing a formal qualification gives rise to the non-completion rate, which will be used in the analysis of overall institutional graduation efficiency.

In comparing university graduate outputs, then, recognition has to be given to the fact that the raw material inputs differ to a certain but ill-defined extent between institutions and this creates a problem for measurement and the interpretation of results. The differences in the quality of student intake amongst universities can be measured by the percentage of students with a matriculation exemption and, within this criterion, by the levels of aggregate matriculation symbol. One may therefore need to group universities with similar entry profiles and then assess the relative efficiencies separately for each group. As the pass rate is lower for natural science degree courses than for the humanities, universities may need to be grouped by this profile and relative efficiency assessed accordingly. The differences that are apparent amongst instructional and research staff, particularly their academic qualification base, have already been referred to. There are also differences regarding the physical infrastructure of each institution – its buildings, facilities, equipment, library collections, computer networks, and student/institutional support – both in terms of quality and amounts of capital invested.

A major measure of efficiency will be the total expenditure incurred in producing a graduate in each university. However, it must be noted that in pure expenditure terms the problem of graduate non-equivalency arises, that is, the cost of 'producing' a science or engineering graduate is greater than that of an arts or commerce graduate (due allowance being made for different course durations). Research output (articles in approved journals, published books, conference proceedings and patents) will be measured in terms of research units produced per instructional/research staff member (academic professional) and in terms of research expenditure per research unit. The profiles of universities may also be seen from the perspective of being mainly research or teaching oriented. Research output will therefore be viewed against a background of these two profiles and analysed to see the effect of this orientation on relative efficiency measures. In making comparisons of research output between universities, allowance will need to be made for the fact that research in certain areas – particularly the sciences - attracts greater expense. Output may also be related to the composition and quality of academic staff and some universities may have a smaller percentage of academic staff actively doing research.

The following tabulations represent a synthesis of the information contained in the appendices. In order to add a further dimension to this research, universities will be categorised according to their cultural heritage, that is, whether they were historically English, Afrikaans or Black universities. The time-series aspect of the analytical review will be incorporated within the analysis and discussed in Chapter 8.

6.1 Input measures.

Table 6.1. The classification of registered students by academic status in 1997 (per cent).

	UNIVERSITIES									
	ENGLISH			AFRIKAANS					BLACK	
%	UCT	UPE[1]	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
UGRAD[2] TOTAL	69.2	87.4	79.3	73.0	70.6	73.1	79.4	68.5	83.8	91.1
PGRAD LOWER[3]	13.1	6.9	10.4	12.6	11.4	9.4	10.1	12.8	8.9	7.0
PGRAD HIGHER[4]	17.7	5.7	10.3	14.4	18.0	17.5	10.5	18.7	7.3	1.9
PGRAD TOTAL[5]	30.8	12.6	20.7	27.0	29.4	26.9	20.6	31.5	16.2	8.9

Note: [1] UPE has a multi-lingual language policy. [2] Undergraduate. [3] Post-graduate degree (bachelor, honours), diploma or certificate. [4] Post-graduate master's and doctoral degree. [5] Post-graduate total.

The classification of registered university students, according to whether they are at undergraduate or post-graduate level, is shown in Table 6.1. Some universities may be regarded as strongly post-graduate orientated (UCT, OFS, PCH, PTA, STL) and others predominantly undergraduate orientated (UPE, DWV, ZLD)[1]. Within the former universities, the total student population consists of an average of 70.9 per cent undergraduate students, 11.8 per cent lower post-graduate students and 17.3 per cent higher post-graduate students. The latter universities consist of an average of 87.4 per cent undergraduate students, 7.6 per cent lower post-graduate students and only 5.0 per cent higher post-graduate students. RHU and RAU assume a medial position, averaging around 80 per cent undergraduate and 20 per cent post-graduate students, the latter split evenly between lower and higher post-graduate levels. Post-graduates in all but one of the English and Afrikaans universities (UPE) comprise 20.0 per cent or more of the student population. This compares with an average of 12.6 per cent in the Black universities. The linkage with and possible effect of these orientations on relative efficiency measures will be assessed later in the analysis (see Chapter 8).

The admission of students to each university according to the percentage of those with a matriculation exemption and the distribution of the aggregate matriculation symbol attained (A…UN), is shown in Table 6.2. This provides an indication of the entrance criteria within these universities and the quality of student intake. On average, some 87.0 per cent of first-time entering students in the English university grouping had a matriculation exemption. Within the Afrikaans university grouping, this is marginally lower at about 85.0 per cent, while within the Black university grouping this is considerably lower at approximately 70.0 per cent.

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[1] An alternative approach is to regard universities as either research or teaching oriented, but this would not be unequivocal as there are insufficient bases to arrive at this classification, although the terms post-graduate and research are probably analogous.

Table 6.2. First-time entering undergraduate students with matriculation exemption, showing aggregate matriculation level by symbol[2], 1997 (per cent).

	UNIVERSITIES									
	ENGLISH			AFRIKAANS					BLACK	
%	UCT	UPE	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
MATRIC EXEMPT[1]	91.3	85.9	83.3	84.2	63.0	98.1	82.5	95.2	78.8	59.7
A[2]...	22.1	9.1	27.8	16.9	5.4	28.3	14.9	10.9	2.6	0.0
B...	30.1	26.1	27.0	19.5	16.5	32.9	25.7	23.0	0.7	0.3
C...	28.8	33.1	22.9	24.2	31.8	27.6	34.1	33.9	15.2	2.4
D...	12.8	25.3	16.0	30.9	30.4	6.4	19.3	26.1	65.2	33.0
E...	0.4	3.7	4.3	7.7	14.8	0.2	6.0	5.9	13.1	64.3
UN[3]...	5.8	2.7	2.0	0.8	1.1	4.6	0.0	0.2	3.2	0.0

Note: [1] Matriculation exemption. [2] Matriculation aggregate pass category or symbol. [3] UN – Unknown.

The distribution (by percentage) of the aggregate matriculation symbols for each of these culturally grouped universities and indeed amongst all individual universities, shows appreciable variation. Those universities that display the highest selection criteria (predominantly A-C symbols, which account for approximately 80.0 per cent of student intake) include UCT, RHU and PTA. A moderately lower selection standard is seen in the universities of UPE, OFS, PCH, RAU and STL, where symbols B-D predominate. The entrance standard for DWV is again lower, mainly with symbols C-E, while for ZLD it is appreciably lower, principally with symbols D-E. The impact of student admission criteria on the measured relative efficiencies of each university will be examined in the analysis of results.

The use of full-time equivalent personpower resources deployed within the universities, by major personnel category, is shown in Table 6.3. This reveals the extent to which personnel are utilised in the mainstream activities (instruction and research) of each university and the extent to which they are engaged in administrative, specialist support and service capacities.

Table 6.3. Utilisation of full-time equivalent personpower resources (based on numbers) by major personnel category, 1997 (per cent).

	UNIVERSITIES									
	ENGLISH			AFRIKAANS					BLACK	
%	UCT	UPE	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
INSTR/ RESCH[1]	33.0	36.6	31.5	31.2	31.7	36.0	34.0	35.8	25.1	29.5
EXEC/ ADMIN[2]	27.3	23.9	22.8	25.3	24.4	19.0	43.9	28.8	22.4	22.9
SPECL SUPPT[3]	4.4	6.8	3.0	8.1	5.5	5.0	2.5	3.2	13.9	2.3
TECH/ SERV[4]	35.3	32.7	42.7	35.4	38.4	40.0	19.6	32.2	38.6	45.3

Note: [1] Instruction/research academic professional. [2] Executive/administrative/managerial professional and administrative non-professional. [3] Specialist support professional. [4] Technical/service/trade employee.

Across the universities, an average of 32.4 per cent of personnel are used for instruction and research, 26.1 per cent in administration, 5.5 per cent in specialist support and 36.0 per cent in technical services/trades. The percentage of personnel used for instruction and research in most universities is remarkably consistent, showing a low dispersion about the average (standard deviation = 3.3), although in both Black universities this percentage falls notably below the average. With the exception of PTA (19.0 per cent – low) and RAU (43.9 per cent – very high), the use of personnel in administration reflects a reasonably even pattern. This is not the case with the use of personnel either in specialist support (particularly high at DWV) or in technical/trade services (very low at RAU). The spread between the main personnel categories will be analysed as to their possible effect on relative efficiencies.

In Table 6.4 the personnel category of instruction/research professionals' personpower resource is presented in various ways to show how this resource is allocated by SAPSE programme and by course level. The proportion of professional teaching personnel and the effect of this on university efficiency will be examined.

Table 6.4. Instruction/research professionals' personpower resources (full-time equivalent) by programme and by student status, 1997 (per cent).

	UNIVERSITIES									
	ENGLISH			AFRIKAANS					BLACK	
%	UCT	UPE	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
INSTR[1]	48.9	70.1	71.0	60.7	59.0	52.5	68.3	53.6	66.2	72.5
RESCH[2]	37.7	20.3	21.5	25.2	26.0	24.1	21.0	38.7	17.6	18.7
ADMIN /SUPT[3]	13.4	9.6	7.5	14.1	15.0	23.4	10.7	7.7	16.2	8.8
UGRAD[4]	75.7	80.0	76.0	75.4	62.4	68.6	42.2	80.9	75.1	78.8
PGRAD[5]	17.9	11.7	17.9	17.0	22.7	23.8	33.5	13.7	19.4	17.4
PGRES[6]	6.4	8.3	6.1	7.6	14.9	7.6	24.3	5.4	5.5	3.8

Note: [1] Instruction – professional teaching and allied activities. [2] Professional activities to produce research. [3] Ancillary support and academic administration. [4] Undergraduate. [5] Post-graduate [6] Post-graduate research.

An average of 62.3 per cent of instructional/research resource is used in formal teaching, although this varies considerably amongst the universities, with a range from 48.9 per cent (UCT) to 72.5 per cent (ZLD). Similarly, there is a significant variation in the use of this resource for research, where the average use is 25.1 per cent, with a range between 17.6 per cent (DWV) and 38.7 per cent (STL). These variations can largely be attributed to the undergraduate or post-graduate orientations of the universities alluded to earlier. The use of personnel for ancillary support and academic administration averages 12.6 per cent, but again this varies across institutions and is notably higher at PTA (23.4 per cent) and lower at RHU, STL and ZLD (between 7.5 and 8.8 per cent).

The utilisation of instruction/research resource in terms of student status shows that on average, 71.5 per cent is used at undergraduate level (notably lower at RAU = 42.2 per cent), 19.5 per cent at lower post-graduate level (lowest at UPE and highest at RAU) and 9.0 per cent at higher post-graduate level (highest at PCH and RAU).

Table 6.5. Division of instruction/research professionals' personpower resource by professional position attained, including the percentage holding a doctoral degree, 1997.

	UNIVERSITIES									
	ENGLISH			AFRIKAANS					BLACK	
%	UCT	UPE	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
PROF[1]	43.6	29.7	28.4	38.0	38.6	35.2	47.8	34.4	24.6	18.2
LECT[2]	54.5	63.6	71.6	56.6	60.6	54.4	50.5	64.8	74.7	81.5
OTHER[3]	1.9	6.7	0.0	5.4	0.8	10.4	1.7	0.8	0.7	0.3
PROF DDEG[4]	76.9	78.6	86.2	80.4	92.9	84.8	90.3	86.1	90.2	92.5
LECT DDEG[5]	42.8	37.3	32.4	30.3	32.9	19.5	32.2	40.0	27.4	10.1
TOTAL DDEG[6]	57.0	47.5	47.7	48.8	55.7	40.5	60.8	55.8	43.1	25.0

Note: [1] Professor (including associate). [2] Lecturer (junior to senior). [3] Other (below junior lecturer).
[4] Professor with doctoral degree. [5] Lecturer with doctoral degree. [6] All staff with doctoral degrees.

The division of instructional and research personpower resource by professional position attained, including the analysis of those personnel holding a doctoral degree, is shown in table 6.5. Viewed from the perspective of the professional positions achieved by this resource group, an average of 33.9 per cent (standard deviation = 8.4) are employed at the level of professor (including associate), while 63.3 per cent (standard deviation = 9.5) occupy the various positions at lecturer level (junior to senior); those in positions below junior lecturer (notably few incumbents) average 2.8 percent. The Afrikaans university group shows an above average presence of personnel at professorial level (38.8 per cent) while the Black university group has a well below average figure (21.4 per cent).

An analysis of the highest most relevant qualification obtained amongst all instructional and research staff across the universities shows that on average 48.2 per cent hold a doctoral degree (standard deviation = 9.9) in a range from 25.0 per cent at ZLD to 60.8 per cent at RAU. In terms of the culturally grouped universities, the average is 34.1 per cent within the Black universities, 50.7 per cent in the English universities and 52.3 per cent in the

Afrikaans group. In four of the post-graduate-oriented institutions (UCT, OFS, PCH and STL), the averages are moderately above the general average of 48.2 per cent.

At the level of professor, those holding a doctoral degree amongst all of the institutions average 85.9 per cent (standard deviation = 5.4), with a low at UCT (76.9 per cent) and a high at PCH (92.9 per cent). The figure in the English universities is below average at 80.6 per cent, is marginally above average at 86.9 per cent in the Afrikaans universities and well above average at 91.4 per cent in the Black group. The significance of the qualification base is that it does provide an indicator of the quality of a group of professional teaching and research staff. This indicator will be related to the levels of research output and the graduation rates within institutions.

Table 6.6. Annual expenditure on personnel compensation as a percentage of total annual recurrent expenditures and by major personnel category, 1997.

	UNIVERSITIES									
	ENGLISH			AFRIKAANS					BLACK	
%	UCT	UPE	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
PEREXP[1]	58.6	63.7	63.5	71.9	56.8	65.6	60.4	64.1	70.2	71.5
OTHEXP[2]	41.4	36.3	36.5	28.1	43.2	34.4	39.6	35.9	29.8	28.5
INSTR/ RESCH[3]	48.9	51.8	53.6	48.1	54.4	55.3	48.6	45.0	33.8	45.3
EXEC/ ADMIN[4]	22.2	21.6	20.7	24.0	20.2	20.9	36.6	21.7	27.0	22.1
SPEC SUPP[5]	5.6	9.2	4.5	7.9	8.9	6.3	3.5	3.2	9.3	3.6
TECH/ SERV[6]	23.3	17.4	21.2	20.0	16.5	17.5	11.3	30.1	29.9	29.0

Note: [1] Personnel compensation (all staff categories). [2] Other categories of expenditure.
[3] Instruction/research professional. [4] Executive/managerial/administrative professional.
[5] Specialist support professional (academic, student and institutional).
[6] Technical/service – non-professional (technical, administrative, trades and services).

The extent to which annual total recurrent expenditure in universities consists of personnel compensation and the manner in which this expenditure is allocated to the principal categories of personnel expense are shown in Table 6.6 (cross-refer to Table 6.3 for a comparison). The overall importance of personnel compensation as a component of recurrent expenditure (an average of 65.0 per cent) is clear. This cost centre expense can be regarded as being a fixed expense in the short to medium term and consequently has important implications for university cost structures[1]. A high fixed cost structure implies a degree of inflexibility and a reliance on high volume throughput to maintain an acceptable level of unit cost, which in this instance may be referred to as the cost per student. A cost structure of this nature suggests limited ability, at least in the short term, to adequately respond to a decline in student numbers in any one year, thereby placing an institution under unwelcome financial pressure. The level of personnel compensation varies moderately within the universities (standard deviation = 5.0), being marginally below average in the English university group and well above average in the Black university group.

Within the category of personnel compensation expenditure, the instruction/research cost component is the most significant, accounting for an average of 48.5 per cent of this expenditure, which, with the exception of DWV, is reasonably consistent amongst most universities (standard deviation = 6.0). The balance of expenditure is attributable to executive management and administration (average of 23.7 per cent and a standard deviation = 4.7), technical support and services (average of 21.6 per cent and a standard deviation = 6.1) and professional specialist support (average of 6.2 per cent). The effect of the varying levels of personnel compensation and the sub-division of this expenditure by cost centre will be viewed against relative efficiency measures.

[1] Defined as the relationship of fixed cost to total cost of an operating unit (see The Chartered Institute of Management Accountants, 1991). A university is generally characterised by a high fixed overhead cost and a low variable cost.

Table 6.7. Graduate/staff and student/staff ratios, 1997.

NUMBERS	UNIVERSITIES									
	ENGLISH			AFRIKAANS					BLACK	
	UCT	UPE	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
GRAD/ STAFF[1]	4.9	5.1	3.9	4.0	5.3	4.2	16.8	5.3	5.2	2.5
STUD/ STAFF[2]	21.3	32.1	16.2	19.5	23.4	18.8	73.1	22.1	23.7	25.9
STUD/ FTES[3]	25.1	39.3	17.7	28.3	33.9	35.2	72.4	31.6	32.7	37.1
UGRAD/ FTES[4]	23.0	42.9	18.4	27.4	38.4	37.5	136.3	26.8	36.5	42.9
PGRAD/ FTES[5]	31.9	24.9	15.2	31.1	26.5	30.1	25.7	52.0	21.3	15.5

Note: [1] Graduates per staff member. [2] Students per staff member. [3] Students per full-time equivalent staff. [4] Undergraduate students per full-time equivalent staff. [5] Post-graduate students per full-time equivalent staff.

The ability to measure how much personpower resource is available for assignment to various institutional programmes is important in the management of resources. An approximation can be obtained by a headcount of individuals in the various personpower categories. However, it is rather the amount of labour input available over a given period that determines the amount of resource that is in fact available. This may be ascertained by using the full-time equivalence of part-time and fractionally appointed personnel. Ratios have therefore been calculated for students per FTE staff member. Excluding RAU, which has an exceptionally high set of ratios, the average student – staff ratio is 22.6 (standard deviation = 4.3) within a range from 16.2 (RHU) to 32.1 (UPE), while the average student – FTE staff ratio is 31.2 (standard deviation = 6.3) within a range from 17.7 (RHU) to 39.3 (UPE). This latter ratio is a better indicator of the efficient use of personnel. Comparing these two sets of ratios using a ranking approach, it is noted that UCT, STL and DWV show an improved position while PTA reveals a marked decline (no change in respect of the other universities).

The average graduate – staff ratio is 4.5 (standard deviation = 0.9) within a range from 2.5 (ZLD) to 5.3 (PCH, STL) – excluding RAU. By linking the student – staff and graduate – staff ratios, the rate at which students are transformed to graduates can be measured, the outcome of which provides a measure of efficiency[1]. This rate of student transformation ranges from 4.2 to 4.9 students to a graduate in all universities, with the exception of UPE(6.3) and ZLD(10.4). These ratios will be used to provide an indication of the efficient use of personpower resources, bearing in mind that there is an underlying quality dimension to them. The well-documented ratios of students/graduates per staff member are shown in Table 6.7 (see page 122).

Table 6.8. Annual classroom contact hours spent in formal instruction by course level, 1997.

	UNIVERSITIES									
HOURS	ENGLISH			AFRIKAANS					BLACK	
	UCT 101	UPE 108	RHU 112	OFS 107	PCH[1] 109	PTA 110	RAU 111	STL[1] 114	DWV[1] 102	ZLD 117
HRS/ UGRAD[2]	384	492	413	381	-	358	231	-	-	402
HRS/ PGRAD[3]	127	130	101	86	-	84	167	-	-	70
HRS/ STUD[4]	304	447	348	301	-	285	218	-	-	373

Note: [1] Data appear to be unreliable, as the computed values do not logically fit in with this set of measures.
[2] Hours per undergraduate. [3] Hours per post-graduate. [4] Hours per student (across all levels).

The use of instructional staff resource may be assessed by measuring formal student contact with teaching staff, expressed in terms of annual expended staff hours per student. Students in seven universities (excluding PCH, STL, DWV) experienced an average of 325 hours of contact with instructional staff over the year (median = 304 hours). Although there is a wide variation (standard deviation = 67 hours) in the figures reported in Table 6.8, which in part

[1] A student/staff ratio of say 20, equates a graduate/staff ratio of say 4.5 after accounting for such factors as: first/second year students who cannot graduate, higher post-graduate students taking longer to complete their degree, non-completion of courses and failure at final-year level.

may be attributed to the difficulties in accurately recording and processing this data[1], there is some pattern indicating the distribution of instructional time between undergraduate and post-graduate levels. Undergraduate contact time averaged 380 hours while post-graduate contact time averaged 109 hours per annum. The ratio of undergraduate to post-graduate contact time amongst most universities (excluding ZLD) varies by a factor of 3 to 4.4 times. Values for UPE and RAU indicate that these are outliers, although over the previous three years, a similar set of values have consistently been reported for these two institutions.

The levels of annual recurrent expenditure and capital employed per student are shown in Table 6.9. These two process measures, which are primary financial measures, can be used as indicators of the efficiency of financial resource use. A broad breakdown of total expenditure per student by SAPSE programme (cost centre) is shown in the table. The varying level of recurrent expenditure per student suggests that cost structures differ amongst universities (fixed overhead costs[2] are estimated to vary between 59.0 per cent at PCH and 74.0 per cent at OFS). The average level of fixed costs in both the English and Afrikaans university groups is 66.0 per cent, but averages 72.0 per cent in the Black universities. Issues of historic background, institutional objectives and policy, quality in education, the humanities/science emphasis and location and age of an institution are possibly some of the factors that may account for some of these overall differences in the cost structures.

Research expenditure, which is a component of recurrent expenditure, is shown per full-time equivalent staff member. This measure, which averages R230 000, displays a high degree of consistency across the university groupings (standard deviation = 22.0).

[1] The variation will to a greater extent be affected by university subject mix and class size. Undergraduate student numbers will be larger at first year level, diminishing as students progress to final year stage and will be larger in those subjects categorised as non-science. At post-graduate level, class size will inevitably be small due to selection criteria and student demand for study at this level.

[2] Fixed overhead cost (estimated from SAPSE cost data) includes: compensation and allied expenditure for all categories of personnel and rental expenditure on buildings, land improvement and equipment.

Table 6.9. Annual recurrent expenditure per student, capital employed per student[1] and research expenditure per full-time equivalent staff member, 1997 (Rand 000's).

	UNIVERSITIES									
RAND	ENGLISH			AFRIKAANS					BLACK	
(000's)	UCT	UPE	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
INSTRU/ STUD[2]	6.7	4.7	7.2	6.4	7.1	5.5	2.4	6.2	5.0	4.7
RESEAR/ STUD[3]	7.7	1.7	3.4	3.5	3.1	3.3	1.1	4.6	1.8	1.4
ACDSUP/ STUD[4]	8.2	3.1	4.0	8.5	3.5	5.6	2.2	5.8	7.1	2.3
STUSER/ STUD[5]	0.7	1.0	0.8	0.7	0.7	0.5	0.4	0.7	0.6	0.5
BURSA/ STUD[6]	3.0	1.1	1.3	1.4	1.1	1.5	0.6	1.2	3.9	0.1
IN SUP/ STUD[7]	5.4	3.3	4.9	5.5	4.4	3.2	1.8	5.7	7.0	5.0
OPSMN/ STUD[8]	3.9	2.0	2.8	1.9	2.4	2.2	1.4	2.7	2.7	3.0
OTHSER/ STUD[9]	4.5	1.7	5.1	3.1	6.4	3.5	0.6	3.8	1.6	2.1
TOTEXP/ STUD[10]	40.1	18.6	29.5	31.0	28.7	25.3	10.5	30.7	29.7	19.1
CAPEMP/ STUD[11]	83.0	42.7	56.6	53.7	29.3	58.1	33.9	59.8	35.3	21.4
RESEXP/ FTESTF[12]	250.8	224.5	199.2	244.9	241.9	256.7	258.4	201.1	219.6	207.2

Note: [1] Capital employed is defined as the funds used by an entity for its operations, including tangible fixed assets, long-term investments and net working capital.
[2] Instruction expenditure/student. [3] Research expenditure/student. [4] Academic support expend/student.
[5] Student services expenditure/student. [6] Bursary expenditure/student.
[7] Institutional support expenditure/student. [8] Operations and maintenance expenditure/student.
[9] Other service expenditure/student. [10] Total expenditure/student. [11] Capital employed /student.
[12] Research expenditure/FTE staff.

Investment in fixed assets by major investment programme, including the main sub-divisions of educational and general fixed asset investment (a primary and prominent area of investment) is shown in Table 6.10. The term fixed asset is defined to include all long-lived property, both immovable and movable, that is owned by the institution or is in its custody by loan, hire or other specific agreement. The major classification categories of fixed assets are:

- Immovable assets: land, buildings and land improvements other than buildings.
- Movable assets: equipment, library collections, museums and art collections.
- Construction in progress (which may include immovable and movable assets).

Table 6.10. Investment in fixed assets by major investment programme, 1997 (per cent).

	UNIVERSITIES									
	ENGLISH			AFRIKAANS					BLACK	
%	UCT	UPE	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
EDUC/ GEN[1]	61.8	80.5	67.0	77.4	72.0	78.2	86.5	66.7	78.8	69.9
AUX ENT[2]	7.2	4.7	17.1	4.6	16.8	7.4	13.5	12.5	10.1	24.5
OTHER INV[3]	31.0	14.8	15.9	18.0	11.2	14.4	-	19.8	11.1	5.6
EDUC L/B[4]	35.8	48.0	33.7	30.4	46.2	31.9	40.2	55.7	71.8	53.1
EDUC EQUIP[5]	40.2	19.6	37.5	41.1	24.3	43.5	30.9	27.4	16.6	20.3
LIBRY[6]	24.0	17.5	25.9	21.6	27.6	16.8	20.2	16.4	11.6	26.5
EDUC OTHER[7]	-	14.9	2.9	6.9	1.9	7.8	8.7	0.5	-	0.1

Note: [1] Educational and general. [2] Auxiliary enterprises. [3] Other investments.
[4] Educational investments in land/buildings. [5] Educational equipment. [6] Library collections.
[7] Other educational investment.

Although the amount (in financial terms) of fixed asset investment in each university is not considered here, the pattern (in percentage terms) of investment in fixed assets by programme in each university can be observed. As fixed asset investment represents the largest financial input in the university process, it is important that institutions allocate their limited resources in an efficient manner and that they maximise the use of investment capital.

On average 73.9 per cent of institutional investment capital is allocated to the programme of educational and general fixed asset investment, varying from a low of 61.8 per cent at UCT to a high of 86.5 per cent at RAU. There is no obvious explanation for the varying levels (standard deviation = 7.2) of this investment category, although in the newer universities (UPE, RAU and DWV) this figure is above the average. Auxiliary enterprises absorb an average of 11.8 per cent of investment capital, but a wide variation is seen amongst the universities (standard deviation = 6.0). The higher levels of auxiliary investment in RHU, PCH, STL and ZLD can be attributed to the student residential complexes incorporated on these campuses. The balance of investment capital is allocated to the categories of hospitals, independent operations and unallocated expenditure (under other) and averages 14.3 per cent (standard deviation = 8.0). UCT's high figure of 31.0 per cent can be attributed to its investment in independent operations.

The main sub-divisions of educational and general fixed asset investment include: educational immovable property (average of 44.7 per cent; standard deviation of 12.4), educational equipment (average of 30.1 per cent and standard deviation of 9.4) and library collections (average of 20.8 per cent and standard deviation of 5.0). The fact that the standard deviations are high for each of these divisions confirms the irregular patterns of investment seen across all universities. RAU's educational investments conform exceptionally closely to the average investment pattern. The proportionately higher levels of investment in educational equipment observed at UCT, OFS and PTA can be associated with their high percentage of science degree credit output (> 38.0 per cent - refer to appendix Table B.7). Significantly low levels of investment in educational equipment are noted at UPE, DWV and ZLD (the last two, along with RAU, having a low proportion of science students). At DWV there is an exceptionally high (71.8 per cent) allocation of capital to immovable property investment, with a conversely low allocation to educational equipment and library collections investment. In this regard, DWV is an outlier.

6.2 Output measures.

Table 6.11. Graduates by academic status and by the percentage of formal degree credits in natural science/humanities, 1997 (per cent).

	UNIVERSITIES									
	ENGLISH			AFRIKAANS					BLACK	
%	UCT	UPE	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
UGRAD[1] TOTAL	56.9	68.8	59.8	53.7	58.8	65.6	70.4	54.4	70.1	85.6
PGRAD LOWER[2]	28.7	25.1	32.7	31.4	29.7	31.2	19.9	29.8	22.7	13.2
PGRAD HIGHER[3]	14.4	6.1	7.5	14.9	11.5	13.2	9.7	15.8	7.2	1.2
PGRAD TOTAL[4]	43.1	31.2	40.2	46.3	41.2	34.4	29.6	45.6	29.9	14.4
NATURAL SCIENCE	38.8	29.7	25.6	44.8	31.9	45.1	16.9	40.4	20.0	7.9
HUMAN SCIENCE	61.2	70.3	74.4	55.2	68.1	54.9	83.1	59.6	80.0	92.1

Note: [1] Undergraduate. [2] Post-graduate degree (bachelor, honours), diploma or certificate.
[3] Post-graduate master's and doctoral degree. [4] Post-graduate total.

In Table 6.11, the percentage of graduates per academic category (undergraduate and post-graduate) is shown for each university. This demonstrates the pattern of graduate emergence and progression within a university. In all of the undergraduate orientated universities (UPE, DWV, and ZLD), the proportion of undergraduate degrees is above the average of 64.4 per cent and in most of the post-graduate orientated universities (UCT, OFS, PCH, and STL) the proportion of post-graduate degrees is well above the average of 35.6 per cent. A further perspective can be gained from the graduate divide between the natural sciences and the human sciences. Those universities that can be categorised with a strong leaning towards natural science include UCT, OFS, PTA and STL (where the proportions of natural science graduates is significantly above the average of 30.1 per cent). Possible linkage of these orientations with the efficient use of resources will be reviewed in the analysis. Cognisance will be given to the reality that in pure expenditure terms, a graduate from a university with a natural science leaning is far more expensive to produce than a graduate from a human science-orientated university. Operating costs will inevitably be higher in those institutions with science, engineering and medical faculties, although a high operating cost structure does not necessarily mean inefficiency.

Table 6.12. Graduation rate per thousand registered students by level of degree, 1997.

UNIVERSITIES										
GRAD/ 1000	ENGLISH			AFRIKAANS					BLACK	
	UCT	UPE	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
UGRAD[2]	190	162[1]	182	153	188	202	204	190	183	91
PGRAD LOWER[3]	505	579	764	516	590	510	454	562	559	181
PGRAD HIGHER[4]	188	172	174	213	143	171	213	203	216	65
TOTAL DEGREE	231	198	241	207	225	226	230	240	219	96

Note: [1] This figure has been adjusted for the 48.8 per cent increase in undergraduate student numbers of which 1462 are distance-learning students representing the first intake of this category at UPE.
[2] Undergraduate. [3] Post-graduate degree (bachelor, honours), diploma or certificate.
[4] Post-graduate master's and doctoral degree.

The rate at which students are transformed into graduates at various academic levels is shown in Table 6.12. For total degree outcome the average is 211 graduates per thousand students (standard deviation = 40). This measure appears relatively consistent in most universities with the exception of ZLD, which is an outlier with a far lower conversion rate. This can be linked to the relatively low percentage of first-time entering undergraduate students with a matriculation exemption, exacerbated by the low matriculation cohort symbol (see Table 6.2). When ZLD is excluded from the statistical computations, the average graduation rate moves up to 224 (standard deviation = 13). Given the all university average of 522 graduates per thousand at lower post-graduate level, RHU reveals an exceptionally high conversion rate of 764 at this level. This may be due to a stringent higher degree selection process, given the evidence of a high undergraduate selection criterion at this university (see Table 6.2). The average graduation rate at higher post-graduate level is 176 per thousand students. Ignoring issues of quality, this measure is a basic indicator of efficiency. However, the issue of graduate equivalence amongst universities cannot be ignored. One way that graduate equivalence can be assessed is to measure the extent to which graduates are successful in external public examinations, for example those who sit for the public accountants' qualifying examinations.

Table 6.13. Percentage of students exiting a university without completing a degree, diploma or certificate, 1997.

	UNIVERSITIES									
	ENGLISH			AFRIKAANS					BLACK	
%	UCT	UPE[1]	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
UGRAD EXITS[2]	13.2	1.9	17.3	14.5	15.1	12.9	23.7	11.6	7.9	35.4
PGRAD EXITS[3]	42.5	0.6	4.6	19.8	22.3	17.1	26.4	18.0	23.6	56.6
TOTAL EXITS	22.3	1.7	14.7	16.0	17.2	14.0	24.3	13.6	10.5	37.3

Note: [1] The basis of this contrastingly different figure has been verified by the university. The same outcome is noted in prior years 1994-96.
[2] Undergraduate student exits. [3] Post-graduate student exits.

University non-completion rates calculated by the leaving cohort method (see section 3.4.5) are reflected in Table 6.13. An exceptionally high figure is reported for ZLD, moderately high figures for UCT and RAU, and a conspicuously low figure for UPE, while the remainder of the university group exhibits relatively similar figures of between 10.5 and 17.2 per cent. If one considers undergraduate and post-graduate levels separately, much the same result is evident, although the undergraduate exit rate at UCT is at an average level. Possible reasons for the differences in these non-completion rates will be analysed in terms of student and university related factors, for example, student-staff ratios and admission criteria. Non-completion rates will be analysed for its implications for each university's relative efficiency rating.

Table 6.14. Capital employed per graduate, total annual recurrent expenditure per graduate and expenditure per graduate by SAPSE programmes, 1997.

RAND 000'S	UNIVERSITIES									
	ENGLISH			AFRIKAANS					BLACK	
	UCT	UPE	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
CAPEMP /GRAD[1]	359.9	266.9	234.5	259.5	130.0	257.3	147.2	248.9	161.1	222.2
EXPEND /GRAD[2]	173.7	116.5	122.3	149.6	127.2	112.3	45.4	127.8	135.6	197.5
ACADEM[3] %	65.8	62.0	56.2	66.1	53.9	64.8	64.1	60.2	62.0	47.2
INSTSUP[4] %	13.5	17.9	16.7	17.8	15.5	12.4	16.7	18.5	23.7	26.1
OPSMAIN[5] %	20.7	20.1	27.1	16.1	30.6	22.8	19.2	21.3	14.3	26.7

Note: [1] Capital employed/graduate. [2] Recurrent expenditure/graduate. [3] Academic expenditure (per cent). [4] Institutional support expenditure (per cent). [5] Operations and maintenance expenditure (per cent).

The levels of annual recurrent expenditure and capital employed per graduate are shown in Table 6.14, and should be cross-referred to figures shown in Table 6.9 (on a by student basis) for comparative purposes. Annual recurrent expenditure per graduate for all universities averaged R130 800 but varied broadly (standard deviation = R38 200) in a range from R45 400 at RAU to R197 500 at ZLD. If one excludes the figure for RAU (an outlier here), then the average increases to R140 300 (standard deviation = R26 900). If these expenditures are related to a grouping of universities, either by similar admission profiles or by natural science/humanities profiles, there is no obvious relationship. In the case of the four universities (UCT, RHU, OFS and PTA) with the higher matriculation cohort, UCT and OFS have a higher than average expense per graduate, whereas RHU and PTA are well below average. Similarly, in a grouping of universities, which have a strong leaning towards natural science (UCT, OFS, PTA and STL), a division is again evident where UCT and OFS expense per graduate is above the average while PTA and STL expenditure is below average.

The aggregate expenditure per graduate is lowest in the Afrikaans university grouping (R129 200 excluding RAU), is slightly higher in the English universities (R137 500) and is highest in the Black university grouping (R166 500 – attributable to ZLD). These differing levels of expenditure are negatively related to the aggregate graduation rate.

The broad allocation of recurrent expenditure per graduate into three main collective SAPSE programmes is indicated in the table. An average of 60.2 per cent of total annual recurrent expenditure can be attributed to the collective programme categories of academic expenditure (standard deviation = 5.8), which suggests a relatively consistent level of this expenditure within the universities.

While expenditure per student is a useful measure, expenditure per graduate reflects the transformation of students to graduates and is thus a more direct measure of efficiency. In comparing these two measures, the expenditure per graduate measure shows a higher ranking for RHU, PTA and STL. Conversely, the efficiency ranking for ZLD is much lower, revealing the low student to graduate transformation rate in this university (refer to Table 6.12).

As may be expected, capital employed per graduate varies considerably amongst the universities in a range from R130 000 at PCH to R359 900 at UCT, with an average of R228 800 (standard deviation = R64 700). The universities with an above average level of capital employed are those that are post-graduate orientated (without exception) as well as those that are inclined towards the natural sciences. This measure tends to be higher in the English university group (average = R287 100).

Table 6.15. Research expenditure incurred per unit of research output (Rand 000's) and units of research produced per academic FTE research staff, 1997.

	UNIVERSITIES									
	ENGLISH			AFRIKAANS					BLACK	
	UCT	UPE	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
RES EXP /UNIT (RAND 000s)[1]	190.7	119.0	92.2	139.6	217.9	112.9	72.9	155.9	138.9	184.8
RESUNIT/ FTE STAF (UNITS)[2]	1.3	1.9	2.2	1.8	1.1	2.3	3.6	1.3	1.6	1.1

Note: [1] Research expenditure per unit of research output. [2] Research units per FTE research staff member.

The efficiency by which financial and human resources are utilised to produce research output, is set out in Table 6.15. An average of R142 500 is incurred producing one unit of research output, although this amount varies considerably between universities (standard deviation = R43 400). It is well below average in four universities (UPE, RHU, PTA and RAU) and well above average in another three universities (UCT, PCH and ZLD). The average cost of producing a unit of research in the post-graduate oriented universities (UCT, OFS, PCH, PTA and STL), is R163 400 – an amount well above the general average. This group includes the four universities with a natural science leaning. Levels of expenditure vary within, as well as between groupings of universities. If one examines research output per full-time equivalent staff member, the average across the universities is 1.8 units per staff member, (standard deviation = 0.7). Whether one considers research output performance in terms of expenditure or human resource, much the same picture emerges.

6.3 Efficiency measures.

In the two preceding sections of this chapter, various efficiency measures feature in those tables where it was felt appropriate to include them. This was done to facilitate an integrated approach to evaluating the inputs and outputs embodied in this research. These efficiency measures, which stem from the two research methodologies, are summarised in Table 6.16 overleaf.

The results of analytical review are analysed in Chapter Eight. In Chapter Seven, the efficiency measures arising from the three DEA models are analysed; the 'preferred model' is further analysed in terms of various DEA technicalities; university efficiencies are examined over time and the effect of an institution's financial structure on relative efficiency is assessed.

Table 6.16. Summary of efficiency measures, 1997.

UNIV	GRAD/STAFF[1]		GRADS/1000 STUD[2]		EXPEND/GRAD[3]		CAP EMP/GRAD[4]		RESEXP/RES UNIT[5]		RESUNIT/FTE STAFF[6]		EFFICIENCY DEA6[7]	
1997	NO'S	RANK	NO'S	RANK	RAND 000's	RANK	RAND 000's	RANK	RAND 000's	RANK	UNITS	RANK	PER CENT	RANK
UCT	4.9	6	231	3	173.7	9	359.9	10	190.7	9	1.3	7	79	7
DWV	5.2	4	219	7	135.6	7	161.1	3	138.9	5	1.6	6	100	4
OFS	4.0	8	207	8	149.6	8	259.5	8	139.6	6	1.8	5	79	8
UPE	5.1	5	198	9	116.5	3	266.9	9	119.0	4	1.9	4	75	9
PCH	5.3	2	225	6	127.2	5	130.0	1	217.9	10	1.1	10	100	3
PTA	4.2	7	226	5	112.3	2	257.3	7	112.9	3	2.3	2	93	5
RAU	16.8	1	230	4	45.4	1	147.2	2	72.9	1	3.6	1	100	1
RHU	3.9	9	241	1	122.3	4	234.5	5	92.2	2	2.2	3	100	2
STL	5.3	3	240	2	127.8	6	248.9	6	155.9	7	1.3	8	88	6
ZLD	2.5	10	96	10	197.5	10	222.2	4	184.8	8	1.1	9	74	10
AVE:	5.7		208		130.8		228.8		142.5		1.8		89	
MED:	5.0		226		127.5		241.7		139.2		1.7			

Note: [1] Graduates per staff member.
[2] Graduation (total graduates) rate per 1000 registered students.
[3] Total annual recurrent expenditure per graduate.
[4] Capital employed per graduate.
[5] Research expenditure per unit of research output (Rand 000's per unit).
[6] Research units per full-time equivalent staff member.
[7] Relative efficiency measures for model DEA6.

CHAPTER SEVEN

THE ANALYSIS OF DEA RESEARCH RESULTS

7.0 Introduction.

The results of this research reflect the performances of ten universities from a HE sector consisting of twenty-one universities. These universities are characterised by a set of dimensions that provide certain institutional uniqueness, despite the fact that fundamentally all universities have common missions and objectives. A selection of various dimensions is shown in Table 7.1 for each university and although other dimensions could have been included, these collectively provide an environmental setting in which the results may be considered and relative efficiencies assessed.

According to the various proponents of contingency theory (amongst others, Emmanuel *et al*, 1990; Otley, 1988), organisations are influenced by their environment and their history and by such factors as size, the stability of the environment, the personalities involved at all levels of operation, ownership and leadership of the entity and competitiveness of the market. It is inappropriate to assume that all institutions in the same environment respond in the same way: institutions develop disparate structures and control systems and people make different judgements and decisions. Thus there can be small but critical differences between institutions, which make some broadly more successful and relatively more efficient than others.

The universities included[1] in this research account for 52.7 per cent of the nation's total student population. At undergraduate level this is marginally less at 50.2 per cent, while at

[1] Students registered at the University of South Africa are excluded on the basis that they are distance learners, giving rise to a different nature of student body and modus operandi in that institution.

Table 7.1. Various dimensions of the universities included in the research – 1997.

University	Age (years)[1]	Location	Cultural background	Faculties (numbers)[2]	Fixed asset investment	Professional lecturing staff[3]	Total students (numbers)	Share of total S.A. student numbers[4]	Students in institutional residence[5]
UCT	125	Cape Town	English	6 – all courses	R671 m	711	15422	6.22 %	26.9 %
DWV	37	Durban	Black	9 – all courses	R297 m	412	9828	3.97 %	17.3 %
OFS	94	Bloemfontein	Afrikaans	5 – ex eng	R349 m	508	10459	4.19 %	22.0 %
UPE	33	Port Elizabeth	English	6 – ex eng	R174 m	220	7568	3.05 %	16.1 %
PCH	79	Potchefstroom	Afrikaans	8 – ex med	R257 m	468	11062	4.46 %	30.3 %
PTA	92	Pretoria	Afrikaans	10 – all courses	R799 m	1238	26004	10.49 %	20.2 %
RAU	30	Witwatersrand	Afrikaans	6 – ex med	R244 m	296	22008	8.88 %	10.4 %
RHU	94	Grahamstown	English	6 – ex eng/med	R179 m	306	4948	2.00 %	43.2 %
STL	117	Stellenbosch	Afrikaans	12 – all courses	R580 m	704	15705	6.34 %	36.0 %
ZLD	31	Ulundi	Black	6 – ex eng/med	R139 m	291	7555	3.05 %	33.2 %

Notes: [1] This is an approximation of age based on the year that the institution was recognised as a university college. The developmental history of the older universities goes back further in time though – (UCT: founded in 1829 as the South African College; PCH: founded in 1869 as a Theological Seminary; PTA: founded in 1893 as the State gymnasium; STL: founded in 1866 as the Stellenbosch gymnasium). Source: Standard Encyclopaedia of Southern Africa. 1973. Vol. 3, 8-10.

[2] A greater number of faculties does not imply an availability of more courses, but rather indicates the chosen academic structure within a university (ex eng and ex med denote respectively the absence of an engineering or health science faculty). NB – these are approximations.

[3] Includes the academic positions of junior lecturer, lecturer, senior lecturer, associate professor and professor.

[4] Provides an indication of a university's share of total university sector registered students, excluding those students registered at the University of South Africa. This exclusion is based on the nature of that institution's student body, who are distance learners.

[5] Students residing in institutional (on-campus) residences.

post-graduate level it is notably higher at 62.1 per cent. Institutions are geographically widely spread throughout the country and in terms of their cultural heritage, five are Afrikaans, two are Black and three are English-oriented. They may be categorised as either 'new' universities (DWV, UPE, RAU and ZLD), with ages ranging from 30-37 years or 'old' universities (UCT, OFS, PCH, PTA, RHU and STL), with ages in the range from 79-125 years. Only four universities (UCT, DWV, PTA and STL) offer a comprehensive range of courses. Absent from the other universities are courses in engineering (OFS, UPE), in health sciences (PCH, RAU) or in both course groups (RHU, ZLD).

The weighted average share of total South African student numbers per university is 6.53 per cent, with a low of 2.0 per cent at RHU and a high of 10.49 per cent at PTA. Investment in fixed assets range from R139 million (ZLD) to R799 million (PTA). All universities offer students institutional residential accommodation, but the proportion of students residing on campus varies considerably from 10.4 per cent (RAU) to 43.2 per cent (RHU). Universities located in small towns tend to have a larger proportion of students (> 30.0 per cent) residing in institutional accommodation and these include PCH, RHU, STL and ZLD.

The analysis that follows draws on data that is currently the most recently available from the SAPSE database and covers a four-year period from 1994-97. As all data at university level is captured within the framework of the SAPSE information system, it is reasonable to assume that the universities compile data on a basis that is broadly comparable. However, the application of DEA methodology in this research has been limited by the fact that returns of data from some universities were either outstanding or incomplete (see section 4.4). More specifically, as only ten universities could be included in the research sample, a limitation has necessarily been placed on the number of combined input and output variables used in the DEA models. The heuristic of Charnes *et al* (1989) again applies (see section 4.2.3), which recommends that the sum of inputs and outputs be equal to about one-third of the total number of universities.

It must also be stressed that DEA does not evaluate the quality of outputs and therefore it is possible that an institution's effectiveness may be negatively correlated with its relative efficiency score. It is important to give recognition to this, although DEA does offer prospects for narrowing down the need to make qualitative assessments. In the case of ZLD, for example, which has been assessed to be only 74 percent efficient (in the consolidated model) compared to the universities of PCH, RHU and RAU (its peer group – see Table 5.4), it would appear appropriate to follow this through by linking that outcome with a qualitative assessment of ZLD's outputs and seeing whether it warranted using proportionately more resources than those used in these other three efficient universities. DEA therefore seems to offer scope for integrating quantitative and qualitative assessments of performance rather than perpetuating the divide between those who advocate nothing but a numbers approach and those who believe that numbers reveal very little about reality.

With these comments and *caveats* in mind, it is now appropriate to set out an analysis of the results recorded from this research. DEA results will be discussed in the same sequence that they appear in Chapter Five and by reference to the three models developed to measure university efficiency. The individual academic and research models will not be evaluated or discussed to the same extent as the consolidated model. This is because the consolidated model integrates the elements of both the academic and the research models and it is this model that encapsulates the combined inputs and outputs, which best enables efficiency measurement. The consolidated model will therefore be analysed in terms of its development (selection of input and output variables) and in terms of its technical parameters (peer units, target values, virtual inputs and outputs, output weight restrictions). Relative efficiencies over a four-year time period will then be examined for each university.

A discussion of the possible effect of a university's financial structure on its relative efficiency will conclude the examination of the DEA results.

The wide-ranging results from the analytical review will then be analysed with particular reference to the analysis of the DEA results. These results will be used to confirm the DEA analysis or otherwise and to expand on the efficiency scores emanating from the DEA computations. Qualitative issues will be considered where appropriate throughout the analysis and specifically will incorporate data on the First Employment Experiences of Graduates (Moleke and Albertyn, 1999) and the results of the PAAB's qualifying examination results for 1997.

7.1 DEA: relative efficiency measurement of universities.

It will be recalled (see section 4.2.5) that in order to identify those factors that are most significant in their influence on university performance, the stepwise approach was used for selecting variables. Where a causal relationship was perceived to exist between a variable and performance, that variable became a candidate for inclusion in the DEA model. Some seventeen variables covering students, teaching and research personnel, recurrent annual expenditure, capital employed (including fixed asset investment) and research output were analysed to establish whether any causal inter-relationships existed amongst the variables. On this basis, their suitability for inclusion in the DEA models was determined (see section 5.1, 5.2 and 5.3 for the correlation coefficients of the variables selected). Establishing the presence of at least a modest relationship between an input and output variable is a fundamental requirement of the DEA methodology and this was achieved by measuring correlation coefficients (positive or negative). At the same time, redundancies in the input and output variables were minimised, where possible, by eliminating high inter-correlations (positive or negative) between the inputs and between the outputs. Table F.1 in the appendices shows the correlation coefficients calculated for the variables analysed.

In developing these models, an attempt was made to differentiate technical efficiency according to two types of technical measures – one based on inputs defined in cost terms (referred to as cost efficiency) and the other based on inputs that are defined in non-financial terms (referred to as technical efficiency). Tomkins and Green (1988) make this distinction in their paper on DEA efficiency evaluation.

7.1.1 The DEA academic model.

In this model, the degree credit variable was selected to represent academic output. This was used because it showed a high correlation with the selected input variables ($r > 0.9$ in all cases), as well as the perception that it reflected overall academic performance. The alternative to this was a headcount of students who had fulfilled the requirements of a degree, diploma or certificate.

DEA1A:

The first in a series of seven phase models (see section 5.1), this model examines simple cost efficiency by linking degree credits produced with total instructional recurrent expenditure and compares this outcome with the basic efficiency ratio of recurrent expenditure per graduate using rank order. The rank orders for the efficiency ratio and the DEA efficiency measure produce a very similar result. Six of the universities retain the same rankings, while those of the other four change by only one rank position.

In terms of the DEA measure, RAU is the only university to be positioned on the efficient frontier with others well behind in the 50-70 per cent range. RAU's position is clearly due to its low cost structure, both in terms of expenditure per student or expenditure per graduate. At an efficiency of 39 per cent, ZLD achieved the lowest score. The average across all universities was 63 per cent.

DEA2A:

By substituting FTE staff numbers for instructional expenditure (both with the same *r* value), this model measures simple technical efficiency. For most universities there is little change in the levels of efficiency and the average for all units was 62 per cent. However, DWV's efficiency moves up by 15 percentage points to 73 per cent (as a result of its high student/staff ratio), while RHU's efficiency drops significantly by some 37 percentage points to a level of 35 per cent, due to its low student/staff ratio. This may suggest a deliberate policy by RHU to pursue quality or it may be due to an over-staffed position although, in the face of growing student numbers, the latter is unlikely. RAU remains the only university showing unitary efficiency.

DEA3A:

In this model, cost efficiency is again considered by introducing the variable of capital employed in place of FTE staff numbers. Although the average level of efficiency remains the same at 62 per cent across all universities, there are appreciable changes in the efficiency scores of individual units. The efficiency scores for only two universities – OFS and UPE – show little change. Measured efficiencies move down for UCT, PTA, RAU and STL. Apart from RAU, these (the notably 'old' universities) exhibit high ratios of capital employed per student and per graduate (see appendix Table D.1). Although RAU has a low ratio in this regard, its efficiency of 60 per cent still ranks as fourth highest. For DWV, PCH, RHU and ZLD (an equal mixture of 'old' and 'new' universities), the efficiency scores move up, as evidenced by their low ratios (apart from RHU) of capital employed per student and per graduate. PCH, with its superior ratios, moves on to the efficient frontier as the sole unit with unitary efficiency.

DEA4A:

Technical efficiency is again considered in this model, where the input variable of student numbers is introduced. The average level of efficiency moves up sharply by 17 percentage points to 79 per cent. DWV moves on to the efficient frontier as the only unit with a score of 100 per cent (its graduation rate per 1000 students is above average and it has a particularly low non-completion rate – see Tables 6.12 and 6.13). There are now four universities (UCT, PTA, RHU and STL) with efficiency scores of ≥ 90 per cent and this may be attributed to their much higher than average graduation rate per 1000 students. There are no marked changes in the efficiency levels for either OFS or UPE while the efficiency score for ZLD drops back sharply by 24 percentage points to a level of 46 per cent.

DEA5A:

This model uses the two inputs – capital employed and student numbers – previously used separately in models DEA3A and DEA4A. Again, the average efficiency for all universities improves markedly to 94 per cent with DWV and PCH featuring on the efficient frontier. Significantly, OFS moves up to an 80 per cent efficiency level (due to the effect of combining the two variables student numbers and capital employed) having been stable around the 50 per cent mark in previous model runs and ZLD moves up again to the 70 per cent efficiency level, although they are both well below the efficiencies of the other seven universities which remain virtually unchanged.

DEA6A:

The instructional expenditure variable is reintroduced into this model, which builds on the parameters of model DEA5A. It should be noted that as this model incorporates four input/ output variables, the practical limit of variable inclusion had been reached. Beyond this level, the model would reveal a propensity for universities to assume a position on the efficiency frontier.

The combination of these three input variables sees no less than five universities – DWV, PCH, PTA, RAU and STL – being positioned on the efficient frontier. New arrivals on the efficient frontier are PTA (enhanced by its low expenditure per graduate ratio) and STL (reflecting not only a balance between its inputs, but notably being boosted by its high graduation rate per 1000 students, the effects of which were apparent in model DEA4A – see section 5.1). The average efficiency score across all universities moves down marginally to a level of 92 per cent.

DEA7A:

This model sees the exclusion of the instructional adjusted expenditure variable and the inclusion of FTE staff numbers on the basis of its fractionally higher correlation coefficient. Efficiencies measured in model DEA7A reflect a combined measure of cost and technical efficiency. The number of unitary efficient universities reduces from five in DEA6A to three – DWV, PCH and RAU. Four other universities – UCT, PTA, RHU and STL – display efficiency scores of ≥ 90 per cent. The average efficiency score for all universities in the set moves down marginally to 91 per cent, but this tends to overstate performance because it includes the best-practice units. An average inefficiency score of 87 per cent applies to those units that are less than unitary efficient.

Overall, the efficiency scores as the models are developed from DEA4A through to DEA7A (four phases), indicate remarkable consistency in the efficiency levels in most universities. This is particularly so for UCT, DWV, PCH, PTA, RHU and STL over the four phases and, OFS and ZLD in the last three phases. Only UPE fails to provide some consistency in its efficiency scores in these four phases, although this can be observed in the models DEA1A to DEA5A.

Of the three universities that are included on the efficient frontier, none are science oriented, one is predominantly an under-graduate university (DWV), a second has a postgraduate orientation (PCH) and the third (RAU) has a balance between the two categories. Two are classified as 'new' universities (DWV, RAU), two are Afrikaans oriented (PCH, RAU), only one (DWV) offers a full range of courses and notably, all have a widely different number of students. Apart from the significance of the non-science connection, these factors do not appear to influence the efficiency levels measured in the academic model.

7.1.2 The DEA research model.

A variable representing aggregate research output for universities was used in this model. This aggregation of research covers articles in approved journals, books, conference proceedings and patents. Five separate phase models are explored in the development of the research model (see section 5.2).

DEA1R:

This model examines simple technical efficiency by linking research units produced with research FTE staff numbers and compares this outcome with the basic efficiency ratio of research units produced per research FTE staff member, using rank order. The rank orders for the efficiency ratio and the DEA efficiency measure produce an identical result. This was an expected outcome and does lend support for the use of DEA methodology. Efficiencies are wide ranging in this model. RAU is the only university to be positioned on the efficient frontier with other units well behind in the 30-60 per cent range. The average efficiency measured for the set was 51 per cent.

DEA2R:

By substituting research-adjusted expenditure for research FTE staff numbers, a measure of simple cost efficiency was obtained. RAU remains the only university on the efficient frontier and while efficiencies are again wide ranging, they generally increase to higher levels. The average efficiency improves to a level of 64 per cent, which is very similar to the average cost efficiency score (63 per cent) seen for producing academic output (see model DEA1A in section 5.1). Substantial improvements are noted for UCT, PTA, RHU and STL. PTA and RHU reflect well below average expenditures per unit of research produced; for STL this is marginally above average. Seven universities are predominantly more cost efficient than technically efficient, the exceptions being DWV and ZLD.

DEA3R:

In this model, cost efficiency is again considered by replacing the variable research-adjusted expenditure with the variable capital employed. The effects of the relative values of this variable (for most universities) are observed in the efficiency scores measured. Higher efficiencies are seen for DWV, OFS, PCH, RHU and ZLD, and this is significantly so for DWV and PCH, both of which have a relatively low capital employed base. Conversely, lower efficiencies are noted for PTA and RAU.

RHU is the sole university to be positioned on the efficient frontier. This results from its all-round efficiency in producing research, assisted by its relatively low capital employed base.

The average efficiency across all universities increases to a level of 71 per cent, which is slightly higher than the comparable average (62 per cent) noted for academic input efficiency (see model DEA3A in section 5.1).

DEA4R:

This model sees the combination of the two input variables, research FTE staff numbers and capital employed, which were used in models DEA1R and DEA3R respectively. RAU and RHU, both with unitary efficiency, are positioned on the efficient frontier. Increased efficiency scores are observed for UPE, PTA and RAU, where there is evidence of the efficient use of both financial and staff resources in research output (see Table 6.16).

The average efficiency for all universities moves up to 78 per cent and this reflects the improvement of the efficiency scores of five universities – DWV, OFS, UPE, PTA and RAU.

DEA5R:

The variable research-adjusted expenditure is reintroduced into this model, which builds on the parameters of the previous model. Efficiencies measured in model DEA5R reflect a combined measure of cost and technical efficiency. As this model incorporates four input/output variables, the practical limit of variable inclusion in the DEA process was reached (see section 4.2.3).

The combination of these three input variables with the variable for research output sees only a marginal change in the various efficiency scores. RAU and RHU remain the only universities on the efficient frontier. Efficiency scores for six universities (DWV, OFS, PCH, RAU, RHU and ZLD) reveal no change from those scores observed in the model

DEA4R. Marginal efficiency improvements of between 5-7 percentage points are seen for UCT, PTA and STL. UPE shows a decline in its efficiency by 10 percentage points, despite its above average efficient use of financial and staff resources (see Table 6.16). No logical explanation is obvious for this outcome and it may be due to a DEA process technicality. The average efficiency score across all universities in the set increases fractionally to 79 per cent while the average inefficiency score is only slightly less at 74 per cent.

As this model progressed through its various phases of development and as previously observed in the academic model, there was evidence of a high degree of consistency in the efficiency levels achieved by most universities. This was particularly so for UCT, DWV, OFS, PCH, RHU, STL and ZLD in the last three phases of the model. Again, only UPE fails to provide evidence of some consistency in its efficiency scores.

Of the two universities – RAU and RHU – featured on the efficient frontier, neither is strongly science nor post-graduate oriented, but both rather have a good balance between undergraduate (teaching) and post-graduate (research) student numbers. Interestingly, they contrast strikingly in terms of their age, cultural background, student numbers and share of the total student population. Neither institution has a health science faculty and nor do they therefore offer a full range of courses. PTA, which is a strongly science and post-graduate oriented institution, is positioned very close to the efficient frontier with a score of 98 per cent.

7.1.3 The DEA consolidated model.

Consolidating the academic and research models (referred to as the single models) into a unitary model provides an overall measurement of relative efficiency for each university. The fixed output variables used in these two models – degree credits and research results – are again used in the consolidated model as the prime measures of university output. In developing this model, two types of technical efficiency measures are referred to – one based on inputs defined in cost terms (cost efficiency) and the other based on inputs that are defined in non-financial terms (technical efficiency) – (see section 7.1).

DEA1:

The consolidated model includes the development of seven phase models (see section 5.3), the first of which examines cost efficiency by coupling the two fixed output variables with total recurrent expenditure (high *r* values) and comparing this measure with the basic efficiency ratio of recurrent expenditure per graduate using rank order. A comparison of the two rank orders shows reasonably similar results. Four of the universities – DWV, OFS, RAU and ZLD – retain the same rankings, a further three – PTA, RHU and STL – change by one or two rank positions, while the last three – UCT, UPE and PCH – show some divergence in their rank order by changing between three to five positions.

With respect to the DEA measures, RAU is the sole university to be positioned on the efficient frontier with others measured in the 40-90 per cent range. RAU's position, as noted in both the academic and the research models (see sections 5.1 and 5.2), is due to its low cost structure. ZLD has the lowest efficiency score of 41 per cent. The average efficiency for all universities was 67 per cent (inefficiency = 64 per cent), which is marginally above the average for model DEA1A and well above the average for model DEA1R (see Tables 5.1 and 5.2 respectively).

DEA2:

In this model, the variable capital employed (with its very high *r* value) replaces total recurrent expenditure to provide a further measure of cost efficiency. For most universities there is a notable improvement in the levels of efficiency, with the average efficiency increasing to 82 per cent (inefficiency = 77 per cent) for all units. Efficiencies remain much the same for UCT, UPE and PTA, but there is a 22-percentage point decline in efficiency for RAU as it is displaced from the efficient frontier – despite its various low cost efficiency ratios. No logical explanation is obvious for this outcome. The substantial improvements in efficiencies for DWV, PCH and ZLD are due to their low capital employed per graduate ratios. Two universities – PCH and RHU – are positioned on the efficient frontier. PCH's unitary efficiency can be attributed to its superior capital employed per graduate ratio, while RHU's position is largely due to its research efficiency coupled with its average capital employed per graduate ratio (see Table 6.16).

DEA3:

This phase model builds on the parameters of DEA2 by adding the variable – student numbers (highly correlated with degree credits and well correlated with research output). As this model comprises a total of four variables, the practical limit of variable inclusion had been reached. Efficiencies measured in model DEA3 provide a combined measure of both cost and technical efficiency. The combination of the variables in the model sees five predominately 'old' universities – UCT, DWV, PCH, RHU and STL – positioned on the efficient frontier. Newly positioned on the efficient frontier are UCT (a high graduation rate per thousand students), DWV (showing a balance between its efficiency ratios, supported by a low capital employed per graduate ratio) and STL (boosted by a superior graduation rate per 1000 students). Improvements in efficiency of between 8-14 percentage points are recorded for OFS, UPE and PTA while the efficiencies for both RAU (78 per cent) and ZLD (72 per cent) remain unchanged. The average efficiency across all universities shows further improvement to a level of 90 per cent (inefficiency = 80 per cent). The gap of 10 per cent between the unitary efficient and the inefficient universities is now wider than for the former two models (see section 5.3).

DEA4:

The student numbers' variable was replaced by the FTE staff numbers' variable in this phase model, which again includes a maximum of four variables. This variable displays a high correlation with both output variables, particularly with research output. There are still five universities positioned on the efficient frontier, although some changes are reflected in the make-up of this group. While DWV, PCH and RHU retain their unitary efficient measures, the efficiencies for UCT and STL fall back marginally, both to the 97 per cent level (due to their low research output per FTE staff member). Newly positioned on the efficient frontier is PTA (as a result of its high research efficiency), while RAU's unitary efficient measure is due to its particularly high research efficiency (see Table 6.16). Very marginal improvements – 2 to 3 percentage points – in the efficiency levels of OFS and UPE are noted, while the efficiency of ZLD remains unchanged at the lowest level of measured efficiency. The average efficiency level for all universities improves fractionally to 92 per cent (inefficiency = 85 per cent), while a narrowing of the difference between the two groupings is apparent (see section 5.3).

DEA5:

This model excludes the variable FTE staff numbers and includes adjusted expenditure to test the effect of including an expenditure variable that can be directly attributed to instructional and research activities. Correlation coefficients of this variable are high and almost identical to those measured for total expenditure (see section 5.3). Efficiencies measured in model DEA5 therefore reflect a measure of cost efficiency. The number of unitary efficient universities reduces from five in DEA4 to three – PCH, RAU and RHU. The universities of DWV and PTA are displaced from the efficient frontier, although their measured efficiencies only fall back marginally to the mid-ninety per cent levels. A decline in efficiencies is noted for UCT, OFS and STL (attributed to their higher than average cost structures), UPE shows a small improvement in its efficiency (attributed to a lower than average cost structure), while ZLD remains at the same level of efficiency measured in models DEA2 – DEA4. The average efficiency score for all universities declines by 4 percentage points to 88 per cent (inefficiency = 83 per cent) – this gap again reducing (see Table 5.3).

DEA6:

By substituting the variable total expenditure for the variable adjusted expenditure, a minor change to the parameters of this model was made. Measures again focus on cost efficiency. Although there are only marginal changes to the efficiency scores measured for most universities, there is one addition – DWV – to the group of three unitary efficient universities – PCH, RAU and RHU – that made up the efficient frontier in model DEA5. Five universities – UCT, DWV, OFS, STL and ZLD – show improved efficiency scores, although only of between one and four percentage points. Two universities – UPE and PTA – show a decline in their efficiency levels of similar magnitude. Given the moderate difference between these two expenditure variables for the university set (13-25 per cent with an average of 18.5 per cent), the overall measures reflected in this model were partially expected. The positive/negative adjustments and the degree of this adjustment to the measured efficiencies of each university were certainly expected, but the fact that the rank position of each university remained unaltered was an unexpected outcome and could provide further evidence of the stability of DEA measurement. The average efficiency across all universities increases by one percentage point to 89 per cent (average inefficiency = 81 per cent), but the difference between these two measures increases (see Table 5.3).

Of the four universities that are positioned on the efficient frontier; none is science oriented, one is mainly an undergraduate university (DWV), a second has a post-graduate orientation

(PCH), while RAU and RHU have a balance between these last two categories. They are equally divided between 'new' universities (DWV and RAU) and 'old' universities (PCH and RHU). At least one university is represented in each of the divisions of the cultural heritage classification, only one university (DWV) offers a full range of courses and all have markedly different total student numbers. Apart from the significance of the non-science factor, these other factors do not appear to influence the efficiencies measured in the consolidated model.

DEA7:

Technical efficiency is considered in this phase model – the final in the series. Model input parameters are changed to include the variables of student numbers and FTE staff numbers, with the result that financial inputs are poorly represented (FTE staff expenditure accounts for approximately 31 per cent of total recurrent expenditure). As might be expected, this model presents a set of efficiency measures different from those seen in model DEA6, although the underlying shift in measured efficiencies does not indicate a substantial change in the total outcome of university relative efficiency measurement.

Five universities – UCT, DWV, PTA, RAU and STL – are positioned on the efficient frontier (attributed to an all-round balance shown between their respective efficiency ratios: graduates per staff member, graduates per 1000 students and research output per FTE staff member – see Table 6.16). This group includes DWV and RAU, both of which feature amongst the set of four unitary efficient universities measured in model DEA6. The other two universities – PCH and RHU – see their efficiency measures marginally decline to the mid/lower-ninety per cent level. For PCH this could be due to its low research output per FTE staff member, while for RHU, its low graduates per staff measure will have influenced its efficiency level. Efficiencies for OFS and UPE show positive improvement, although this is not appreciable, but the measure for ZLD declines to the 50 per cent level (very low efficiency ratios: graduates per staff member, graduates per 1000 students and research output per FTE staff member – see Table 6.16). The average efficiency score for all universities is 90 per cent (inefficiency = 79 per cent) – this being the widest difference noted between efficiency and inefficiency measures across all models.

A comparison of the rank orders of university efficiencies measured in models DEA6 and DEA7, show that four universities – OFS, UPE, RAU and ZLD – retain the same rank, three universities – DWV, PTA and STL – change rank by one or two positions and three universities – UCT, PCH and RHU – change their rankings by four or five positions (see Table 5.3). Further comparison of the two models suggests that PCH and RHU are cost efficient, that UCT, PTA and STL show evidence of technical efficiency and that DWV and RAU are both cost and technical efficient.

As this model progressed through its phases of development, there is repeated evidence of a high degree of consistency and stability in the efficiency measures recorded for most universities, as previously observed in both the academic and research models. This was particularly the case for DWV, UPE, PCH, PTA, RAU, RHU and ZLD over 4-6 phases of model development (DEA2 – DEA7). To a lesser extent, this consistency was seen in the measures for OFS, but was less apparent for UCT and STL.

Having assessed the relative efficiency measures computed in the various phases of the consolidated model, the ongoing DEA analysis required the selection of a preferred model. Models DEA3 – DEA7 provided the options for this selection, as they all (at least) comprised the maximum number of input/output variables permitted. As this study intended to focus on a wide spectrum of input resources, it was considered that capital employed and recurrent expenditure embodied this requirement, particularly with the imposed limitation of being able to use only two input variables. The expense for FTE staff members is covered in the recurrent expenditure variable in any event, and although the student numbers' variable is an important input, it was considered that its influence on efficiency measures could be assessed through the subsequent analytical review analysis. The process of selecting a model was therefore reduced to opting for either model DEA5 or DEA6. In the end, the choice of model DEA6 was made because the total recurrent expenditure variable reflects the overall discretion that university management has in determining levels of expenditure, whereas the use of adjusted expenditure excludes some expenditure that is not directly attributable to instruction and research activities (both variables display almost identical *r* values – see section 5.3). The input variables in model DEA6 are both highly correlated with the output variables.

To conclude this section, the relative efficiencies recorded for all universities in the three preferred principle models – DEA7A, DEA5R and DEA6 – are summarised in the following Table 7.2.

Table 7.2. A summary of efficiency measures for the academic (DEA7A), research (DEA5R) and consolidated (DEA6) models – 1997 (per cent).

MODEL	I/PUT[1]	O/PUT[2]	EFFICIENCY									
			UCT	DWV	OFS	UPE	PCH	PTA	RAU	RHU	STL	ZLD
DEA7A	C/EMP STUD FTE/ST	DEG/C	94	100	80	75	100	99	100	90	99	70
DEA5R	C/EMP FTE/RS R/EXP	RES/U	80	64	77	65	75	98	100	100	78	56
DEA6	C/EMP T/EXP	DEG/C RES/U	79	100	79	75	100	93	100	100	88	74

Note: [1] INPUT: C/EMP - capital employed.
STUD - student numbers.
FTE/ST - full-time equivalent staff.
FTE/RS - full-time equivalent research staff.
R/EXP - research adjusted recurrent expenditure.
T/EXP - total recurrent expenditure.

[2] OUTPUT: DEG/C - degree credits.
RES/U - research output.

7.2 Further analysis of model DEA6.

The examination of relative efficiency of each university uses a DEA programme that assumes input minimisation. The DEA 'proposed structure of inputs and outputs' formulated for each target university, i.e. a university under evaluation, constructs a 'composite unit', which has at least the output levels of the target university while using as low a proportion of its inputs as possible. The resulting 'composite' university is calculated from a weighted average of efficient reference (peer group) universities that have input efficiency scores equal to unity. Results from the DEA programme output show that four universities – DWV, PCH, RAU and RHU – are cited in the reference groups of the inefficient universities of model DEA6. RAU is cited a maximum of 6 times and features in the peer group of each inefficient university; PCH and RHU are both cited 5 times, while DWV is cited only once. The most common and frequent grouping of peer universities includes PCH, RAU and RHU and they are associated with the target universities of OFS, PTA, STL and ZLD (see Table 5.4). Because of their relatively large number of citings, RAU, RHU and PCH are individually not necessarily uniquely efficient and therefore could be regarded as preferred universities by which to analyse best practice.

Examination of the targets set by the DEA programme for the inefficient universities reveals a consistent pattern of balanced reduction in capital employed and total recurrent expenditure. Reductions of between 7-26 per cent for both variables across all inefficient institutions is called for, although for those that are least efficient – ZLD, UPE, OFS and UCT – an average reduction of 23 per cent is required to achieve a unitary efficient unit. As an exception, UCT has an additional target to improve output of degree credits by some 14 per cent to become efficient (see Table 5.5). While the moderate inefficiencies of PTA and STL could probably be addressed in practical terms and efficiencies improved to a unitary efficient level, the reality of the fixed investment/cost structures in the remaining four notably inefficient institutions is that, whereas recurrent expenditure could be reduced given an appropriate plan of managerial action, it would be difficult (at least in the short-term) to address the over-capitalisation which is apparent.

DEA establishes a set of weights for the input/output variables that position a university on the efficient frontier, ensuring that the value of each weight is the most balanced for each unit and as close to equality as possible (see section 5.3). Model DEA6 assumed uniform priorities for both input/output variables but, as pointed out earlier (see section 5.3), it may be argued that the relative importance of university output could be skewed towards academic results rather than research results. By including a range of weights with higher values specifically for the research output variable, the influence of an imposed constraint on research output and its effect on the relative efficiency scores of all universities was observed in model DEA6 (see Table 5.7).

This constraint had no effect on the unitary efficient scores of three efficient universities – DWV, PCH and RAU – noted in model DEA6; almost no effect (< 1 per cent decrease) on the efficiencies of ZLD and UPE; a moderate effect (13-15 per cent decrease) on those of OFS, PTA and STL and a substantial effect on the efficiencies of UCT (26 per cent decrease) and RHU (29 per cent decrease). The efficiency changes for the various universities occurred concurrently with the following weight changes: RHU (multiplied by 2); STL (multiplied by 5); UCT and OFS (multiplied by 10) and PTA (multiplied by 25). The amount of change in the weight factors, and the level at which this change impacts on a university's efficiency score, is inversely related to its sensitivity to these weight adjustments. For example, RHU's efficiency score is particularly sensitive to a small weight adjustment; STL's efficiency score is less sensitive; and PTA's efficiency score is relatively insensitive to weight adjustments. There is no obvious relationship between the changes to the efficiency scores under the adjusted weights and the ratios measured for research efficiency (research expenditure per research unit produced and research output per FTE staff member – see Table 6.16). For example, in those universities where a moderate effect on DEA efficiencies was observed, OFS's research efficiencies are at an average level, PTA's are well above average while STL's are well below average.

If research output is viewed as being marginally less important than academic output, then RHU's sensitivity to increasing the weights for the research output variable brings into question the efficacy of its unitary efficient score observed in model DEA6.

7.3 Relative efficiency measures over time.

An examination of the relative efficiencies of the university set between 1994-97 using the same definitions of model DEA6 (see section 5.3) demonstrates an underlying stability in the DEA model over time and reveals some interesting trends in the efficiencies of certain universities. In general, the average efficiency increased from 86 per cent in 1994 to over 91 per cent in 1995, but declined the following year to 89 per cent and then fell back marginally to 88 percent in 1997. This decline over the latter two years could partially be due to the slow growth in student numbers, particularly in 1996 (< 1 per cent – see Table B.2). Much the same trend is seen for average inefficiencies, with the difference between these two measures widening over the last three years. The discussion that follows draws on information tabled in the appendices (see Tables B.2, B.8, C.7, C.9, D.1, D.6, D.7).

Of the unitary efficient universities (in 1997), PCH and RAU remained efficient over the four years; RHU, after recording an 89 per cent measure of efficiency in 1994 (low graduates per staff member, below average research output per FTE staff member), recorded unitary efficiency throughout the last three years; and DWV improved its efficiency from 79 per cent in 1994 (low graduation rate per 1000 students) to being unitary efficient in 1996 and 1997. The efficiencies of UCT and OFS were both unitary in 1994, but steadily declined to 79 per cent over the next three years. UCT's decline was largely due to the negative trends seen in its research activities (increasing expenditures and decreasing output per units of measure) and a below average ratio for graduates per staff member, as well as being influenced by its high cost structure. OFS's change in efficiency can be attributed to its decline in the rate of graduates per 1000 students and graduates per staff member, both to levels below average, exacerbated by the influence of its above average cost structure. Both universities featured a decline in their student population growth rates during this period.

The relative efficiency scores for PTA and STL remained in a narrow band, but the trends that developed in their respective measures did so in opposite directions during the four-year period. For PTA, efficiencies generally improved from an 82 per cent level in 1994 to 92 per cent in 1997. This can be attributed to the positive trend seen in the expenditure per graduate ratio and a slight improvement in both the graduation rate and in research output per FTE staff member, despite the decline noted in the student growth rate. The efficiencies for STL slipped from a level of 92 per cent in 1994 to 85 per cent in 1996 and then improved to 88 per cent in the next year. The stability of these measures is supported by the relatively minor changes noted in the main efficiency ratios of this university. Research output per FTE staff member fell below average in 1996 and 1997, expenditure on research increased to an above average level in 1997 and the rank positions for recurrent expenditure (just below average) and capital employed (slightly above average) per graduate improved in 1997.

UPE's efficiency fell from 67 per cent in 1994 to 59 per cent the following year, then over the next two years increased to a level of 75 per cent in 1997[1]. This was mainly due to an improvement in research efficiencies (research expenditure per unit of output declined to

[1] Research output is lagged e.g. by two years behind the relevant expenditure.

below average and research output per FTE staff member improved to above average in 1996 and 1997) and an improvement in the ranking of recurrent expenditure per graduate (below average) in 1997. An exceptional growth rate in undergraduate student numbers (the first intake of distance learners) in 1997 had a favourable impact on the expenditure per student ratio. In prior years however, the overall growth rate was notably well below average.

ZLD's efficiency of 48 per cent in 1994 was the lowest recorded for any university over the four-year period. However, a substantial improvement was seen in the following year when efficiency increased to 83 per cent, but decline was evident in the ensuing years and in 1997 efficiency reached a level of 74 per cent. The initial increase in efficiency in 1995 can be attributed to a number of factors, which include: an exceptional growth rate in student numbers, an increase in the graduation rate and the number of graduates per staff member and a decrease in recurrent expenditure and capital employed per graduate (these four ratios showed decline over the next two years).

The universities – DWV, UPE, PTA and RHU – that showed an improvement in efficiency over the four years are mainly undergraduate oriented (excluding PTA), with an equal mixture of 'new/old' institutions. Those universities – UCT, OFS, STL and ZLD – where efficiencies declined are characterised as being essentially post-graduate, scientifically oriented and 'old' institutions (excluding ZLD). Neither group can be differentiated by cultural background or share of total university sector student numbers.

7.4 Financial structure and relative efficiency measures.

An analysis of the financial structure of each university shows that the components of its total capital employed broadly consist of permanent capital (equivalent to the equity in a company) and long-term debt. The relationship between these two types of finance gives rise to the concept of financial gearing and the gearing ratio analyses the extent to which long-term finance is used as a source of funding.

Gearing ratios calculated (see Table 5.9) for the university set, range between 0.8 per cent at DWV and 21.9 per cent at ZLD, with an average of 9.6 per cent across all universities. These universities can therefore be described as being 'low geared' i.e. having a low component of debt finance. The assumed interest rates calculated (see Table 5.9) for each university provide an interesting set of figures: interest rates are very low at DWV and ZLD (both 1.4 per cent per annum and presumably include interest-free government loans), while at the other universities they are in a range from 9.4 – 15.5 per cent per annum and appear to be market related. If the rates for DWV and ZLD are excluded, then the average interest rate (un-weighted) is about 12.5 per cent per annum. These low levels of gearing infer that the interest expense associated with long-term debt should not impact to any great extent on each university's cost structure, particularly in those universities where the interest rates are also low.

The variation in the gearing ratios in a range from 0-50 per cent suggested a theoretical restructuring of university financial structures. This provided the basis for observing the effects of these changes on the established measures of relative efficiency computed for model DEA6 (see Tables 5.10-5.12). The DEA computations of relative efficiency for the different levels of gearing in each university show that the four unitary efficient universities – DWV, PCH, RAU and RHU – remained unitary efficient over the gearing ranges. The low interest rates evident in DWV and ZLD had very little impact on their respective cost structures and consequently on their relative efficiency measures. ZLD's relative efficiencies showed a less than one per cent change. For DWV, however, if an interest rate of about 13 per cent per annum is assumed, then a re-run of model DEA6 over the gearing range finds that the relative efficiency for this university falls below unitary level.

For the less efficient universities – UCT, OFS, UPE, PTA and STL – whose interest rates are assumed to be market related, relative efficiencies change within a range from 3 per cent (STL) to 10 per cent (UCT) across the gearing range. UCT, OFS and UPE all have interest rates of marginally over 13 per cent per annum and very similar model DEA6 efficiency scores, but their relative efficiencies change by 10.0, 3.5 and 5.4 per cent respectively. PTA with the highest interest rate only shows a change in efficiency that is slightly less than average for this group of inefficient universities. There is therefore no discernible relationship either between the level of interest rate or the level of model DEA6 efficiency measure and the percentage change in relative efficiency. It is likely that the inherent nature of these institutions – embodied in their individual input and output variables – gives rise to this outcome. The effect of a theoretical increase in the level of gearing appears not to markedly impact on the measurement of their relative efficiency.

In the next chapter, three apparent levels of efficiency and the grouping of institutions within these levels are suggested; an attempt is made to explain efficiency across various dimensions and efficiency in relation to the quality issue is considered.

CHAPTER EIGHT

THE ANALYSIS OF ANALYTICAL REVIEW RESEARCH RESULTS

8.0 Introduction.

It will be recalled from Chapter 6 that the results of the analytical review were broadly reported under the main headings of inputs, outputs and efficiency measures of the university process. These individual efficiency measures present various combinations of institutional input (student population, personpower and financial resources) and output (graduates and research produced) in ratio form.

In this chapter, the efficiency measures summarised in Table 6.16 will be further evaluated and analysed to establish the possible factors that give rise to these individual levels of efficiency. The trends and the changes of efficiency scores over the period 1994-97 will be examined. The dimension of quality in the university process will be explored to determine its possible impact on the reported efficiency measures. In support of this, the findings of the HSRC's First Employment Experiences of Graduates' (Moleke and Albertyn, 1999) research will be related to the efficiency measures. The outcome of the PAAB's examination results for 1997 will be mentioned as an indicator of the quality of institutional graduate output, although no definitive conclusion can be inferred from this data.

The summary of efficiency scores (see Table 6.16) includes the relative efficiencies computed for each university using DEA methodology (model DEA6). A general comparison can therefore be made between the different individual efficiency measures arising from the analytical review and the overall relative efficiency score produced by DEA. Because a group of widely differing variables is used in the derivation of a set of contrastingly dissimilar ratios, a rank order approach is used to provide a basis for this comparison. As might be expected, the rank positions of each university vary from one individual efficiency ratio to another, although the more efficient universities generally tend to occupy the higher order rank positions (and *vice versa*). Certain difficulties arise in attempting to make this comparison. Firstly, there is the difficulty of combining these individual efficiency ratios into one composite measure that reflects overall efficiency. Secondly, there is the problem that the efficiency ratios are not of equal standing and therefore a weight needs to be assigned to each ratio so that its relative importance is acknowledged. Not only is this difficult to achieve in practice, but assigning weights becomes a matter of subjective judgement. Thirdly, the rank positions for any given efficiency ratio does not give credit to a measure(s) that is particularly high or low relative to other measures for any university (for example, RAU in graduates per staff member and ZLD in graduates per 1000 students – see Table 6.16). And finally, there is the question of what to include or exclude from the list of efficiency ratios that constitute a composite measure.

In spite of these difficulties, a crude overall rank measure of efficiency can be obtained by summing the rank positions of all the individual efficiency ratios for each university shown in Table 6.16 and then ranking these to provide a 'composite rank measure'. The results of this approach are shown in Table 8.1.

Table 8.1. Rank positions of university efficiency by method of computation.

UNIV	UCT	DWV[1]	OFS	UPE[2]	PCH[2]	PTA	RAU	RHU	STL[1]	ZLD
DEA	7	4	8	9	3	5	1	2	6	10
RATIO	9	4	8	7	6	3	1	2	5	10

Notes: [1] DWV and STL ranked = 4 on ratio efficiency; STL placed 5th on generally lower efficiency scores.
[2] UPE and PCH ranked = 6 on ratio efficiency; UPE placed 7th on generally lower efficiency scores.

Although the measurement of efficiency using ratios cannot provide a definitive measure of efficiency for a university, the composite rank measure does permit comparison with the DEA efficiency measure. A comparison of the rankings of efficiency by the two methods shows a similar outcome (Spearman's coefficient of rank correlation $r' = 0.87$). No less than five universities – DWV, OFS, RAU, RHU and ZLD – have unchanged rank positions; UPE and PTA increase their rankings by two positions, STL moves up by one rank position while UCT and PCH decline by two and three rank positions respectively (an increase denotes an improvement on a DEA rank – and vice versa). RAU and RHU retain their positions as the two most efficient universities; PTA, which was measured as marginally inefficient (93 per cent) in the DEA6 model, now assumes the third ranked position in terms of composite ratio efficiency; while DWV retains its fourth ranked position under both methods of efficiency measurement. The low levels of efficiencies noted for the research activities at PCH largely contribute to the decline in its efficiency rating, from third position under the DEA evaluation to sixth position under ratio measurement. Despite the modest change of rankings seen for UCT ($7 \rightarrow 9$) and UPE ($9 \rightarrow 7$), these two universities alongside OFS (unchanged rank 8), remain amongst the group of inefficient institutions. ZLD retains its position as the least efficient university in the set (under either method) – confirmed by the low efficiency ratios reported for this institution.

Taking into consideration the results arising from both methods of efficiency measurement, it may be appropriate to group the universities according to their overall efficiency performance rather than being markedly categorical about each university's efficiency scores. Consequently, the following levels of efficiency and the grouping of universities within these levels are suggested, as shown in Table 8.2.

Table 8.2. Grouping of universities by apparent level of efficiency.

EFFICIENCY LEVEL[1]	................................UNIVERSITY GROUPING................................				
RELATIVELY EFFICIENT:	RAU	RHU	PTA	DWV	
RELATIVELY INEFFICIENT:	STL	PCH	UPE	OFS	UCT
LEAST EFFICIENT:	ZLD				

Note: [1] A decision-making unit can only be measured as being either relatively efficient or inefficient. The term 'least efficient' emphasises the degree of inefficiency.

8.1 Explaining university efficiency.

In this section, the various factors that contribute to the efficiency score of each university will be closely examined and analysed. The analysis will attempt to draw together all the underlying indicators that collectively offer an explanation of why the inputs in certain institutions are efficiently utilised while in others they are under-utilised in terms of the outputs produced. This research is oriented towards input minimisation rather than output maximisation and therefore the focus of the analysis leans towards explanations that consider the array of input variables, although the analysis would be incomplete without reference to the dimensions – quantitative and qualitative – of university output.

8.1.1 The effects arising from student population dimensions.

It has been shown that some universities – UCT, OFS, PCH, PTA and STL – may be regarded as strongly post-graduate oriented and others – UPE, DWV and ZLD – mainly undergraduate oriented (see section 6.1). In 1997, the post-graduate universities' student populations consisted of an average of 70.9 per cent undergraduate students, 11.8 per cent lower post-graduate students and 17.3 per cent higher post-graduate students. On the other hand, in the undergraduate universities' there was an average of 87.4 per cent undergraduate students, 7.6 per cent lower post-graduate students and only 5.0 per cent higher post-graduate students. RAU and RHU however, reflected a more balanced position – averaging around 80 per cent undergraduates and 20 per cent post-graduates (divided equally between lower and higher levels). As a whole, the composition of student populations over the four-year period has remained stable, although there is evidence of marginal shifts in the distribution of students across the two main categories in certain universities and in some post-graduate groupings (see appendix Table B.1). The post-graduate group of universities remained essentially unchanged across all categories; the undergraduate universities were characterised by a small increase in their undergraduate student group (3.3 percentage points) and a corresponding decrease in their post-graduate student group; while the most obvious change occurred within the balanced group – RAU and RHU. For these two institutions, the undergraduate group increased from 74 to 80 per cent while the post-graduate group showed a decline from 26 to 20 per cent and, within this latter group there was a shift in the proportions from lower to higher post-graduates. The manner in which the distribution of student populations by academic status relates to efficiency is not clear, as the four efficient universities are represented in each of the academic groups. As an indicator however, both RAU and RHU – the two institutions most consistently measured as being efficient – have a middle position in the split between undergraduate and post-graduate student populations and this balance may contribute to their measured efficiency.

Consideration also needs to be given to the changes in student numbers that occurred between 1994-97. An overall assessment of student growth rates (see appendix Table B.2) reveals a rather varied pattern of positive and negative student growth, both at undergraduate and post-graduate levels. Across the university set, student numbers grew by an average of 4.7 per cent (compound rate) per annum. In 1995[1], student numbers increased

[1] The first full academic year in the post-apartheid era.

by an average of 10.4 per cent, but this was accentuated by the extraordinary increases seen at RAU (average 31.8 per cent) and ZLD (average 30.4 per cent) – affecting all academic categories – and at RHU (average 13.7 per cent; 17.6 per cent at undergraduate level). There was a less than 1 per cent average growth in 1996, although meaningful growth was again seen at RAU (> 5 per cent), RHU (>5 per cent) and STL (4 per cent) – affecting both undergraduate and post-graduate levels. In the following year, student numbers increased by an average of 4.8 per cent, although this rate includes the abnormal growth seen in undergraduate numbers at UPE (> 45 per cent – their first intake of distance learning students). Above average growth of 6.3 per cent was seen at PCH (> 21 per cent at higher post-graduate level), while meaningful growth increased student numbers at OFS (3.7 per cent – affecting all student levels) and at RAU (average 3.1 per cent; 8.3 per cent at undergraduate level).

A comparison of the changes in student numbers and the changes in relative efficiencies measured in model DEA6 (see Table 5.8) over this four-year period, indicates the possible influence that student numbers have on university efficiency measures. The high student growth at RAU was paralleled by its consistent unitary efficiency; the high undergraduate student growth at RHU in 1995 saw its efficiency moving to the unitary level, while further undergraduate growth in the following year maintained this position; the exceptionally high undergraduate student growth at ZLD in 1995 marked a substantial improvement in its efficiency measure and the abnormally high undergraduate student growth at UPE in 1997 saw an improvement in its efficiency score. Conversely, the low student growth at UCT and the below average growth for OFS and STL, accompanied declines in their respective efficiency measures. Explanations other than student numbers must account for the position at DWV, where despite successive declines in student numbers (negative growth of 7.3 per cent), its relative efficiency measure steadily improved to the unitary level. Similarly, less than average growth did not influence the maintenance of PCH's unitary efficiency nor did it impede the improvement of PTA's efficiency measures.

The extent to which an institution is efficient in producing graduates may also be linked to its quality of student intake. The admission of students to each university according to the proportion of those with a matriculation exemption and the levels of matriculation symbols achieved, provides some indication of the quality of student intake and its likely impact on efficiency. It has been noted that there is a wide variation in both the percentage of first-time entering undergraduate students with a matriculation exemption – ranging from 59 per cent at ZLD to 98 per cent at PTA – and in the level of matriculation symbol achieved by students accepted into the universities (see section 6.1). By linking entrance criteria with the efficiency ratio of graduates per 1000 students, its impact on efficiency measurement may, to a certain extent, be examined. The relationship between the percentage of students admitted to a university with a matriculation exemption and the ratio of graduates produced per 1000 students is not noticeably strong ($r = 0.64$), although for this ratio, the five top-ranked universities – UCT, PTA, RAU, RHU and STL – all show an above average percentage of students with a matriculation exemption and upper level symbols (predominantly A – C). In spite of the high percentages of matriculated students at OFS and UPE, both have a low rate of graduate output, although this could partially be due to their lower matriculation symbols (B – D). PCH presents an interesting case in that its percentage of matriculated students is considerably below average with matriculation symbols falling mainly in the C – D group, but graduate output is above average (ranked sixth) – evidence of a sound academic support programme. Much the same outcome is seen at DWV, where although the percentage of matriculated students is only marginally below average and their matriculation symbols are predominantly in the D group, graduate output is above average (ranked seventh). This brings into contention the issue of graduate quality, which will be discussed more fully later (see section 8.2). ZLD with its low admission criteria (both in terms of matriculation percentage and symbol) demonstrates a low graduate output rate.

The percentage of students exiting a university without completing a degree, diploma or certificate contrasts with the graduation rate per 1000 students. In 1997, five institutions – OFS, PCH, PTA, RHU and STL – revealed non-completion rates around the average rate for both undergraduate (15 per cent) and post-graduate (23 per cent) levels. Apart from PCH, these universities have an above average percentage of first-time entering undergraduate students with matriculation exemption together with higher-order matriculation symbols. This group is also characterised by the relatively high number of students that reside in university residences (on-campus) and apart from RHU, by their Afrikaans oriented grouping. While PTA and STL offer a full range of courses, certain faculties are excluded from the other three – OFS (engineering), PCH (health sciences) and RHU (both engineering and health sciences). UCT with its high undergraduate entrance standards shows an undergraduate non-completion rate (13 per cent) that is slightly below the average rate, but the post-graduate exit rate (42 per cent) is nearly double the average rate, although it is noted that in previous years this rate was stable at the 25 per cent level. The low overall non-completion rate at DWV is largely attributable to its substantially below average undergraduate exit rate (8 per cent). Viewed in relation to its liberal entrance levels (student matriculation percentage and symbols), the question of graduate quality is again raised.

UPE reveals an outcome that is difficult to interpret; over the four-year period, UPE has shown a consistent and strikingly low average non-completion rate (between 2-3 per cent) affecting both academic levels, even though the student matriculation percentage is only about average and symbols are mainly in the B – D levels. A university official has verified these data. The favourable student/staff ratio for UPE may have contributed to some of this outcome, but the underlying reason is probably related to academic standards. RAU's quality of student intake is comparable to UPE's, but the average non-completion rate (24 per cent) is particularly high and affects both academic levels. The extraordinarily high student/staff ratio at RAU may to some extent account for this, but the proportionately high number of appointed professors together with the high number of staff holding a doctoral degree, counters this. Again, the reason for this may rest on institutional academic standards (see section 8.2). The situation at ZLD appears to be more obvious because its very high non-completion rate can be attributed to a very low quality of student intake (student matriculation < 60 per cent, with D – E symbols) and an exceptionally low number of appointed professors, together with a low number of professional staff holding a doctoral degree. The student/staff ratio, however, is about average.

Over the four-year period, the overall non-completion rate has increased from 13 per cent in 1994 to 17 per cent in 1997 (see appendix Table B.5). This has occurred at undergraduate and post-graduate levels, although the emphasis has been more marked at undergraduate student level. The trend is generally apparent in most universities, although there are some exceptions. UPE's non-completion rates remained at much the same low level over the period (as discussed above) and may be regarded as an exceptional case; DWV's rates declined from 20 per cent in 1994 to 10 per cent in the following year and remained there in successive years – post apartheid era; while ZLD's rates decreased from 24 per cent in 1994 to remain at 19 per cent over the next two years, but then increased to 37 per cent in 1997.

8.1.2 The deployment and quality of personnel resources.

The use of total personpower resources deployed across all universities in 1997 shows that an average of 32.4 per cent of personnel are used for instruction and research, 26.1 per cent in administration, 5.5 per cent for specialist support and 36.0 per cent in technical services and trades (see section 6.1). For the relatively efficient universities – DWV, PTA, RAU and RHU – their use of personnel within these major categories, displayed some differences though. DWV's use of instruction and research personnel (25.1 per cent) was well below average while PTA and RAU's use (around 35 per cent) was moderately above average. Apart from RAU, which shows an exceptionally high percentage of administrative staff use (43.9 per cent), the other universities' proportions in this category are below average – especially at PTA (19 per cent). The use of specialist support professional staff at DWV is extraordinarily high (13.9 per cent), but this probably complements their low percentage of instruction and research staff. The higher than average percentage of technical services and trades staff at PTA and RHU and the lower than average percentage of these staff at RAU, could be a function of their ages.

Within the five less efficient universities – STL, PCH, UPE, OFS and UCT – the distribution of personnel across these main categories more or less follows average institutional levels. ZLD presents something of a difference: instructional and research staff use together with specialist support professionals is well below institutional average, while the use of technical services and trade staff is well above the average. While various apparent differences in the distribution of personnel across the universities have been noted, there is little indication to suggest that notable imbalances exist – apart from those at ZLD – which may be cited as indicators of efficiency or inefficiency.

Over the four-year period, the position remained particularly stable for overall institutional personpower use, there being only minimal change in the averages for each category (see appendix Table C.1). This was to be expected in view of the fixed nature of the cost attributable to personnel (in the short term). However, certain intra-university changes are noted, even though the magnitudes of these changes are not marked (about 10 per cent). An increase in the percentage of instruction and research staff is seen for UPE, PCH and STL while decreases in this category occurred at DWV and RAU (both DEA unitary efficient). The effect of this decrease at RAU can be seen in the increases noted in its student/staff ratio during the period (see appendix Table C.7). Specialist support increased at DWV but decreased at UPE and PCH and there were increases in the administrative category at PCH, RAU and STL. The technical services and trades category declined at STL.

Having established that some 32 per cent of personpower input is allocated to formal instruction and research, this category of personnel will now be analysed to examine how the various universities use their staff for the different programmes of instruction, research and academic administration/ancillary support (see Table 6.4). In the undergraduate oriented universities – DWV, UPE and ZLD, between 66-72 per cent of this staff category is involved in formal teaching (above the average of 62 per cent), while only 17-20 per cent of staff is associated with research activities (well below the average of 25 per cent). In the post-graduate universities – UCT, OFS, PCH, PTA and STL – the use of staff in formal teaching is below average and in a range from 49 per cent at UCT to 60 per cent at OFS, while in the area of research this is generally above average and in the range of 24 per cent at PTA to 38 per cent at STL (research output per FTE staff member for these universities is however mainly on the low side – see Table 6.16). For RAU and RHU – balanced in terms of their undergraduate/post-graduate divide – their use of staff approximates 70 per cent for teaching (above average) and 21 per cent for research (below average), although their research output ranks first and third respectively. The use of staff for academic administration/ancillary support varies considerably across the institutions, from 7 per cent at RHU to 23 per cent at PTA – with an average of 13 per cent for all universities.

From these figures, it is difficult to discern indicators that further explain reasons for efficiency or inefficiency, but the following observations are made. The relatively efficient universities of RAU and RHU have a below average percentage of staff in academic administration/ancillary support, while PTA has a lower proportion of teaching staff accompanied by a particularly high proportion of academic administration/ancillary support staff. Of the inefficient universities, UCT and STL may have an imbalance between teaching and research staffing levels – leaning towards research – and ZLD is possibly a little over-staffed in the teaching category, given its low graduate/staff ratio (see Table 6.16).

The averages for all institutions in the three categories have shown no significant changes over the four-year period, but minor changes in these categories have occurred at certain universities (see appendix Table C.2). At DWV, the staff level in teaching decreased from 74 per cent in 1994 to 66 per cent in 1997 and this was balanced by an increase in academic administration/ancillary support staff, from 10 to 16 per cent over the same period. An increase in the percentage of teaching staff at UPE, from 64 per cent to 70 per cent, was matched by a decrease in their research staff percentage, attributable to negative growth in post-graduate student numbers. At RAU and RHU, the same trend was seen, although the change was less apparent. For RAU however, this occurred before its negative growth in post-graduate numbers in 1997, but at RHU, post-graduate numbers showed marginal positive growth over the period (see appendix Table B.2).

From analysing the use of instruction/research professional personnel, we move on to examine how the formal instruction component of this category (average of 62 per cent for all institutions in 1997) is allocated across student academic levels (see appendix Table C.3). In the undergraduate oriented universities – DWV, UPE and ZLD – the percentage of teaching staff at undergraduate level is above the institutional average of 71 per cent, although for DWV, its percentage is the lowest in the group (75 per cent). This may be an indicator of the efficient allocation of teaching staff at this university. Conversely, the percentage of teaching staff at post-graduate and post-graduate research levels are below average in all three universities. In the post-graduate oriented universities – UCT, OFS, PCH, PTA and STL – the percentage of teaching staff at undergraduate level is above the institutional average at UCT, OFS and STL, while it is below average for PCH and PTA – the latter university classified as relatively efficient. The percentage of teaching staff at post-graduate and post-graduate research levels are consequently below average at UCT, OFS and STL – this is suggestive of an imbalance in the deployment of teaching staff in these three institutions – and above average for PCH and PTA. An interestingly different distribution of staff is noted at RAU, where a very low percentage (42 per cent) of staff is allocated to undergraduate teaching and a correspondingly high percentage is deployed in both areas of post-graduate studies. The way in which teaching staff is allocated in this university may be a factor contributing to its relative efficiency measure. The use of teaching staff at RHU reveals no difference from overall institutional use and in fact, assumes median values at all academic levels. In the science-oriented universities – UCT, OFS, PTA and STL – with the exception of PTA (marginally below average), the use of teaching staff is above average.

During the period 1994-97, the staffing position for overall institutional instruction remained stable, although some minor changes are evident. There were small decreases (3-7 percentage points) at undergraduate teaching level at DWV, RAU and ZLD and increases (4-6 percentage points) at OFS and UPE; in 1997 at PCH, there was a shift in emphasis away from post-graduate teaching to post-graduate research teaching (attributable to a 21 per cent increase in higher post-graduate student numbers), while at RAU in the same year, the trend was in the opposite direction, despite the negative growth in lower post-graduate numbers (see appendix Table B.2).

Analysing levels of appointment in conjunction with the highest most relevant qualification obtained at each level can provide an indicator of the quality of professional instruction and research staff employed in an institution. For this group of staff in 1997, an average of 34 per cent was appointed at the level of professor, 63 per cent were employed in various lecturing positions and 3 per cent at levels below junior lecturer level – across all institutions (see Table 6.5). The percentage of staff appointed at professorial level shows some dispersion around the average. At the two Black universities – DWV and ZLD – the appointment of professors is particularly low (24 and 18 per cent respectively) and this can be compared with the high appointments of professors at RAU (47 per cent) and UCT (43 per cent). It is noted that in the post-graduate institutions – which includes the four science oriented universities – the appointments at professor level is above average, while in the undergraduate institutions the converse applies. With the exception of RAU, the 'new' universities generally have a lower percentage of positions at professor level.

Over the four-year period, a high degree of stability is seen in the pattern of appointments in all institutions; the average staff appointments at professor level increased by 1 percentage point during this time. However at RHU, the percentage of professors appointed decreased from 33 to 28 per cent and at DWV they increased from 21 to 24 per cent (see appendix Table C.4). Conversely, staff appointments at lecturer level decreased on average by 1 percentage point in all institutions.

Within these levels of appointments, an analysis of the highest most relevant qualification obtained by all teaching/research professional staff for 1997 shows the following. Overall, an average of 48 per cent of all staff hold a doctoral degree, 30 per cent have a master's degree and 22 per cent are equipped with qualifications below these two degree levels (see appendix Table C.5). The proportion of teaching and research staff with a doctoral degree is above the average at UCT, OFS, PCH, RAU and STL; is notably high at RAU (60 per cent) and low at ZLD (25 per cent). Again, the post-graduate universities (excluding PTA) are characterised by staff that generally hold higher qualifications across all appointment levels.

By relating highest relevant qualification to the specific level of staff appointment, a somewhat different picture emerges. At the level of professor, the post-graduate university group as a whole tends on the one hand, to have a slightly less than average percentage of staff with a doctoral degree, while on the other hand at the level of lecturer, there is a higher percentage of staff holding this degree. This spread of doctoral staff may be a function of the number of faculties, departmental size, staffing policy and availability of appropriately qualified personnel. Those institutions that show an above average percentage of staff with a doctoral degree at both professor and lecturer level include PCH, RAU, RHU and STL. If highest relevant qualification is defined to include doctoral and master's degrees, then the institutions with an above average percentage of this category of staff at all levels of appointment, include UCT, DWV, PCH, RAU, RHU and STL.

Having analysed the qualification base of professional instruction and research staff across all institutions, six universities stand out as having appointed a greater percentage of higher qualified staff. Although not conclusive, this at least provides an indicator of the quality of their respective staff complements. Relating qualification level (total percentage of staff with a doctoral degree) to the graduation rate per 1000 students shows that these two dimensions are moderately well correlated ($r = 0.81$). If qualification level is expanded to include master's degree, the relationship is still evident though less well established ($r = 0.71$). Thus, the above average graduation rate measured in certain universities can partially be attributed to the generally higher qualification base of the staff appointed in these universities.

Linking the qualification level (total percentage of staff with a doctoral degree) to the levels of research output produced, provides no indication of a strong relationship between these two dimensions – in fact they are poorly correlated ($r = 0.32$). If the level of appointment (percentage of staff at professorial level) is related to research output produced, there is evidence of an improved relationship, although the degree of correlation is again on the low side ($r = 0.54$). This may suggest that in certain universities, research is either a secondary activity or that some of the research carried out is of a private nature (consultancy) and therefore work not credited to the institution – or both. In any event, there are many other explanatory variables at individual level that influence research productivity – as well as those at departmental and institutional level.

The efficient use of instructional staff may also be evaluated by analysing formal student contact with teaching staff in the classroom environment. Annual contact hours spent in formal instruction at undergraduate and post-graduate levels in 1997 is shown and briefly discussed in Chapter 6 (see section 6.1). An analysis of the full set of figures for annual student contact time (see appendix Table C.6) indicates that there are wide inter-university variations in these figures (evidenced by the measured standard deviations) and that no useful or substantial conclusion as far as efficiency is concerned, can be drawn from these ratios.

8.1.3 The general allocation of financial resource – recurrent expenditure.

A comparison of the absolute levels of institutional expenditure provides no indication of the extent to which financial resources have been efficiently used. By analysing expenditure in terms of a common unit or by percentage, it is possible to measure the relative degree of efficiency associated with a programme or category of expenditure. University expenditure has therefore been extensively analysed in terms of registered students, graduate numbers and as a percentage per SAPSE programme and per category of expenditure (cost centres).

Although expenditure per student provides a basis on which to make useful inter-university comparisons, this is an intermediary or process measure that does not fully explain how expenditure is used in the transformation of students into graduates. This point is wellillustrated in the following two examples. Over the years 1995 to 1997, RHU's expenditure per student was above the institutional average but below average for expenditure per graduate (high graduation rate per 1000 students), while ZLD's pattern of expenditure was markedly in the opposing direction (low graduation rate per 1000 students) – (see appendix Tables B.8 and D.1).

Before proceeding to a general analysis of institutional expenditure by programme and cost centre, it is important to revisit the subject of cost structure, i.e. the relationship of fixed cost to total cost. In the context of university cost structures, reference has been made to the fact that not only do cost structures differ rather widely between universities (varying from 59 per cent at PCH to 74 per cent at OFS), but also more importantly, they are characterised by a high fixed cost component that averages around 67 per cent, comprising mainly aggregate personnel compensation costs (see section 6.1). The implications of this are far reaching, for the justification of each university's fixed cost level is reliant upon a critical student mass throughput. Relative efficiency in an institution is partially dependent on an adequate student complement accompanied by growth in student numbers that emerge from the planning process – at both institutional and national levels, although the number of students desired can never be guaranteed. The effects of fluctuating student numbers at both undergraduate and post-graduate levels have been noted in the discussions regarding DEA efficiency measures (see Chapter 7). Amongst the group of relatively efficient universities, PTA, RAU and RHU each have fixed costs that are below institutional average. Within the group of generally inefficient universities, fixed cost percentage is however below average at UCT, PCH and STL but above average at OFS and UPE. A high fixed cost structure is noted at ZLD – a particularly inefficient institution. Although no definite conclusion can be drawn from these observations, there is sufficient evidence to suggest that lower levels of fixed costs accompany institutional efficiency.

Relating cost structure to expenditure per graduate in 1997 shows the following: in those universities – PCH, PTA, RAU, RHU and STL – where expenditure per graduate is below the institutional average, fixed cost levels are all below the 67 per cent average. By contrast, expenditure per graduate is generally above average in those universities with higher than average fixed cost levels – notably at OFS and ZLD, but also at DWV. The exceptions to this relationship are seen at UCT (notably so) and at UPE. This provides further evidence of the relationship between fixed cost levels and the efficiency measure of expenditure per graduate.

An analysis of recurrent expenditure per graduate in 1997 shows that this efficiency measure varies broadly between universities (see section 6.1) – from R45 400 at RAU to R197 500 at UCT, with an average of R130 800 across all institutions. If the rank outliers – UCT, ZLD (both high) and RAU (low) – are set aside, then expenditures for the remaining seven universities fall within a more defined range from R112 300 at PTA to R149 600 at OFS, demonstrating some measure of a common level of university expenditure per graduate, despite the inherent differences that exist between institutions. In terms of this efficiency measure, there are six universities – UPE, PCH, PTA, RAU, RHU and STL – with below average expenditures. Those universities that have been measured as efficient – PTA, RAU and RHU – rank in the top four universities on this measure.

An intra-university comparison of expenditure per graduate over the four-year period provides some interesting trends. In order to make this comparison all expenditures were converted into constant money terms (1997 = 100) using a composite index to adjust for the effects of inflation (see appendix Table D.10). Changes in the levels of expenditure per graduate in real terms were determined for each university; these changes provide the basis of an inter-university comparison. The influence of the growth in graduate numbers (both positive and negative) on expenditure levels is examined and provides a further indication of an underlying cause of efficiency. The changes in the levels of expenditures and in graduate numbers are shown in Table 8.3.

Table 8.3. The changes in expenditure per graduate (in real terms) and in graduate numbers, 1994-97 (per cent).

CHANGES:	UCT	UPE	RHU	OFS	PCH	PTA	RAU	STL	DWV	ZLD
EXPENDITURE /GRADUATE	+15.6	+22.0	+0.0	+15.6	+19.4	−12.8	−12.9	−15.8	+35.9	+18.8
GRADUATE GROWTH	−5.3	−5.8	+2.1	−4.6	+8.3	+9.8	+40.6	+0.1	+4.5	−14.5

In real terms, expenditure per graduate increased by an average of 8.6 per cent across all institutions; increased in six universities – UCT, DWV, OFS, UPE, PCH and ZLD, remained unchanged at RHU and declined at PTA, RAU and STL. The increases in expenditure averaged 21.2 per cent over the four years, although the majority of universities managed to contain their increases at a level between 15-19 per cent. Decreases in expenditure ranged between 12-16 per cent over the period. Within the various university groupings: increase/decrease applies equally in the post-graduate and science oriented universities; increases alone are seen in the undergraduate universities; while in the balanced group there was no change/decrease. Across the cultural divide, increases alone are noted in the English and Black universities and although there was a mix of both increase/decrease in the Afrikaans universities, these were mainly decreases.

The effect of growth (both positive and negative) in graduate numbers on expenditure levels per graduate is demonstrable. The relatively high growth in graduate numbers (see appendix Table B.4) at PTA and RAU provided for a substantial decrease in expenditures per graduate; the modest increase in graduate numbers at RHU assisted in maintaining expenditure at a constant level; while the increase of graduates at STL in 1996 and 1997 contributed to the substantial decrease in expenditure per graduate.

The decline in graduate numbers at UCT, OFS, UPE and ZLD was accompanied by increases in expenditure per graduate, although it is noted that despite the substantial negative growth in graduate numbers at ZLD, the increase in the level of expenditure per graduate at this university was in line with the general level of institutional increase; other factors contributed to the containment of costs. The exception to the general association between these two variables is noted at DWV and PCH, where growth in graduate numbers did not appear to restrain the increases seen in expenditure levels and other factors will have accounted for this. In broad terms though, an analysis of the figures underlying this relationship indicates the following: that a 1 per cent decrease in graduate numbers approximates a 3 per cent increase in expenditure per graduate; whereas a 1 per cent increase in graduate numbers approximates a < 1 per cent decrease in expenditure per graduate (in real terms). There is thus an apparent multiplier effect on expenditure levels – markedly negative when graduate numbers decline. Maintaining graduate numbers and in the face of the transformation process, student numbers alike, is an economic imperative that institutions should as a minimum focus on in order to effect the maintenance and improvement of their efficiency levels.

8.1.4 Allocation of recurrent expenditure by SAPSE programme.

The overall levels of institutional expenditure and the changes in real terms that have occurred in these expenditures have been noted and discussed. The analysis now moves on to examine the allocation of institutional financial resources and how this may affect relative efficiency levels. Broadly, this allocation is made across three main collective SAPSE programmes – academic, institutional support and operations/maintenance (see Table 6.14 and appendix Table D.2). In 1997, an average of 60 per cent of total annual recurrent expenditure was allocated to the various academic programme categories, 18 per cent to institutional support and 22 per cent to operations and maintenance. The efficient universities are generally characterised by: a higher than average expenditure on academic programmes (excluding RHU); a lower than average expenditure on institutional support (excluding DWV); while the level of expenditure on operations /maintenance – above and below average – could be linked to institutional age (higher than average at PTA and RHU). Higher levels of expenditure on this latter category appear also to be associated with those institutions – PCH, RHU, STL and ZLD – that accommodate a relatively high percentage of students in campus residences. Apart from PCH and ZLD, where academic expenditure is well below the average, there is a consistent level of this expenditure within most universities (60-66 per cent). ZLD presents a pattern of allocation that appears unbalanced, as shown by its relatively high proportion of expenditure on institutional support activities and operations/maintenance. Much the same can be said of PCH, where a particularly high percentage of expenditure is allocated to operations/maintenance (an 'old' institution with a high percentage of students in campus residences). Academic expenditure is generally higher in the post-graduate, science oriented and 'old' institutions, which are for the most part inefficient – the exception being PTA.

Over the four-year period, this pattern of expenditure has remained largely unchanged, although there are some shifts in expenditures that are worth mentioning. Academic expenditure increased in the following universities: at OFS by 7 percentage points in 1995; at UPE by 5 percentage points over the period 1995-97; at PTA by 10 percentage points in 1995; at RHU by 3 percentage points in 1995; at STL by 10 percentage points in 1995; while at ZLD there was a decrease of 9 percentage points over the four years. Common to these changes in expenditure levels is their timing and although there may be various explanations for this, 1995 was a year in which student numbers showed above normal growth in most institutions. The measured efficiencies of model DEA6 during this period showed improvement at UPE, PTA and RHU and decline at ZLD, suggesting some link between increased/decreased expenditure on academic activities and relative efficiency.

The allocation of about 60 per cent of total institutional recurrent expenditure to the broad category of 'academic activities' covers a number of principal cost centres that provide for widely differing institutional academic programmes. These include instruction, research, academic support, student services and bursaries. Further analysis of expenditure in these cost centres shows that of the total recurrent expenditure across all institutions in 1997, an average of about 22 per cent is allocated to formal instruction; 11 per cent to research; 19 per cent to academic support; 3 per cent to student services; and 5 per cent to bursaries (the total is 60 per cent – see appendix Table D.3). Variations in these levels of expenditure are seen across all institutions and in all cost centres, but particularly in those of research, academic support, student services and bursaries. Given the different classifications (cultural, post-graduate, science oriented, etc.) of the university set, this is to be expected, and expenditure should in any event be commensurate with university objectives and policies. The difficulty however, lies in determining whether such expenditure has been used efficiently.

As formal instruction and academic support are so closely linked, they will be considered unitarily in the ongoing analysis. Together they account for an average of 41 per cent (range 37-48 per cent) of total recurrent expenditure in all institutions. This expenditure is on/ above average at DWV, OFS, UPE, PTA, and RAU – which includes three universities from the group of four relatively efficient institutions. The somewhat below average expenditure at UCT and STL should be viewed against their high research expenditures, as both these universities are post-graduate and science oriented, but nevertheless are in the group of inefficient institutions. The expenditure levels at PTA and OFS can be compared with these two universities as they are similarly classified. Whereas PTA's expenditure on research is above the institutional average, it is nevertheless at a level below that of UCT and STL's, while combined instruction/academic support expenditure at PTA is above the institutional average. This presents a more balanced pattern of expenditures, bearing in mind that PTA is an efficient university with high research efficiency ratios (see Table 6.16). Expenditures at OFS are again different – average for research, but well above the average for instruction/academic support expenditure. This perceived imbalance in expenditure is reflected in this university's middle order research efficiency rankings and in its measure of inefficiency. The lower than average combined expenditures at PCH, RHU and ZLD are directly attributable to their low levels of academic support expenditure. In most institutions, expenditure on student services is a little above 2 per cent, but at UPE and RAU the level of this expenditure is particularly high. Bursary expenditure is generally in the range between 4-6 per cent in the majority of universities, but is notably high at UCT and DWV and surprisingly low at ZLD. These last two cost centre expenditures are perceived as being important in marketing the services that a university may offer and in attracting and maintaining student registration. Higher levels of expenditure in these combined cost centres are associated with three efficient universities – DWV, PTA and RAU.

An assessment of the average percentage of expenditure for each academic programme over the four-year period shows an apparent general level of consistency and stability amongst institutional expenditures. Earlier on it was noted that the level of overall academic expenditure showed change in some institutions and this occurred mainly in 1995. Similar changes are evident in the combined expenditures of formal instruction and academic support, but there are some differences that arise in this combined expenditure because of the subdivision of overall academic expenditure into its more detailed cost centres. The level of this combined expenditure, including any changes to this, will be analysed in terms of the relative efficiencies measured for each university in model DEA6 (see Table 5.8). A summary of this analysis is shown in Table 8.4.

Table 8.4. Level of instruction/academic support expenditure in relation to model DEA6 efficiency scores, 1994-97 (per cent).

UNIV	Instruction and academic support expenditure	Model DEA6 efficiency measurement
UCT	In the narrow range 36 – 39 per cent; higher in earlier years, marginal decline in 1996 and 1997.	Unitary efficient in 1994, but efficiency scores declined in each successive year.
DWV	In the range 41 – 48 per cent; increased in 1995 to highest level of 48 per cent, then decreased to 41 per cent in both 1996-97.	Although inefficient in 1994-95, efficiencies improved to reach unitary level in 1996-97.
OFS	In the range 42 – 49 per cent; increased in 1995 to 49 per cent, then remained around this level in successive years.	Unitary efficient in 1994, but efficiency scores declined in successive years.
UPE	In the range 38 – 43 per cent; decreased in 1995 to 38 per cent, then increased in each successive year.	Inefficient, although efficiency scores generally improved over the four years.
PCH	In the range 33 – 37 per cent; lowest in 1995, then increased in each successive year to 37 per cent.	Unitary efficient over all four years.
PTA	In the broad range 38 – 48 per cent; large increase in 1995, up again in following year, but decreased to 44 per cent in 1997.	Measured as inefficient, but efficiency scores improved over the four years to highest level in 1997.
RAU	In the range 43 – 47 per cent; marginal increase over the first three years, then decrease to 43 per cent in 1997.	Unitary efficient over all four years.
RHU	In the narrow range 35 – 37 per cent; increased to 37 per cent level in 1995 and remained there.	Inefficient in 1994, but measured unitary efficient in 1995 and in all following years.
STL	In the range 36 – 43 per cent; increased to 43 per cent in 1995, then decreased to 39 per cent to remain at this level in 1996-97.	Measured as inefficient; efficiency scores show marginal decline over the period, although a small improvement seen in 1997.
ZLD	In the range 30 – 37 per cent; high increase in 1995, remained at this level in following year, then increased marginally in 1997.	Inefficient in all years; efficiency improved substantially in 1995, but then tailed-off in each successive year.

It appears that the level of this expenditure is not an underlying determinant of unitary efficiency – RAU and DWV's allocation is around 43-45 per cent, while PCH and RHU's expenditure is at the 35-37 per cent level. These differences are not insignificant. Of more interest are the incremental changes that occur and the effects that change – both positive and negative – have on efficiency scores. There appears to be a plausible relationship between change in the level of expenditure and changes in efficiency scores. UCT demonstrates a steady decline in DEA efficiency following marginal decreases in expenditure, notwithstanding the other factors that may have contributed to this. UPE, PTA and RHU all show improved DEA efficiency scores following increases in their expenditure. PCH and RAU illustrate a different scenario in that increased expenditure in these two universities could be a factor in maintaining their unitary efficient scores, while the increased expenditure at DWV and ZLD in 1995 contributed to a significant improvement in their efficiency scores. The exceptions to this relationship are noted for OFS and STL, where in the light of increased expenditure, DEA efficiency scores declined, although other factors will have accounted for this. This is not to suggest that by continually increasing expenditure, efficiencies will improve; indeed, excessive incremental expenditure may lead to inefficiency. An institution is required to achieve a balance between expenditure in the different cost centres so that limited financial resource is optimised and an overall measure of unitary efficiency is achieved.

8.1.5 Allocation of recurrent expenditure by functional categories.

Thus far the analysis has focused on recurrent expenditure within the SAPSE programme structure. A different orientation to the analysis can be achieved by examining this expenditure in terms of broad functional categories of expenditure (see Table 6.6), the principal one being personnel expenditure. It has already been shown that personnel compensation is the most important component of recurrent expenditure – accounting for an average of 65 per cent of total annual expenditure across all institutions in 1997. The high fixed cost nature of personnel expenditure and its implications for institutional cost structures have been referred to earlier (see also section 6.2).

Personnel expenditure ranges between 57 per cent at PCH to 72 per cent at OFS, is well above average in the Black university group and apart from DWV, is at or below average in the relatively efficient universities. Over the four-year period, there has been little change in the average level of institutional personnel expenditure – attributable to its fixed cost classification. However, intra-university changes mainly in the range of 3-7 percentage points have occurred in some institutions: decreases are noted at UCT, OFS, UPE and PTA and increases at DWV, STL and ZLD (an exceptional 12 percentage points). Stability in the levels of expenditure is evident at PCH, RAU and RHU – three of the four unitary efficient universities measured in model DEA6 (see Table 5.8).

An analysis of personnel compensation by main cost centre for all institutions in 1997 shows that the category of instruction and research attracts an average of 48 per cent of total personnel expenditure. In this cost centre there is reasonable consistency amongst the university set – excluding DWV, which has a low of 34 per cent. Apart from DWV, the relatively efficient universities allocate financial resource at above average levels. The remaining expenditure is allocated to executive management and general administration – average of 24 per cent, but particularly high at RAU (36 per cent); technical support and services – average of 22 per cent, although generally high at DWV, STL and ZLD and low at RAU (11 per cent); and specialist support – average of 6 per cent, but differing between universities and rather high at DWV, UPE and PCH.

Over the four-year period there has been an interesting shift in the levels of overall institutional expenditure: a 4 percentage point decrease in the average for instruction and research expenditure has been accompanied by a corresponding increase in executive management and general administration expenditure of 3 percentage points. Little change occurred in the levels of technical support/services and specialist support expenditure. With the exception of UCT and PCH, all other institutions reflected some degree of change in either one or in both of these cost centres. Decreases in instruction and research expenditure are seen at DWV (1997), UPE, PTA (significantly in 1995), RAU, RHU (1995) and STL (1996) while an increase against the trend is seen at OFS. Increases in executive management and general administration expenditure are observed at DWV, OFS, UPE, PTA (high in 1995 and 1997) and RAU (high in all years) while decreases occurred at ZLD. The relatively efficient universities all showed a decline in their percentages of instruction and research expenditure and with the exception of RHU, these were offset by an increase in executive management and general administration expenditure.

Analysing the allocation of personnel resource in a cost centre according to attributable expenditure and by the full-time equivalence of personnel (numbers) – both in percentage terms – can provide the basis of an interesting comparison. By computing a ratio of these two different values, it is possible to determine whether institutions are spending proportionately more or less than others on their employee compensation within the different categories. These ratios are shown in Table 8.5 for the cost centres of instruction/research and executive management and general administration.

Table 8.5. The ratio of the percentage of expenditure/percentage of FTE personnel by cost centre, 1997.

COST CENTRE	UCT	DWV	OFS	UPE	PCH	PTA	RAU	RHU	STL	ZLD	AVE:
INST/ RES	1.48	1.35	1.54	1.42	1.72	1.54	1.43	1.70	1.26	1.54	1.50
EXEC/ ADMIN	0.81	1.21	0.95	0.90	0.83	1.10	0.83	0.91	0.75	0.96	0.93

For instruction and research, institutions are on average allocating 1.5 per cent of total personnel expenditure for each 1 per cent of instruction and research FTE personnel. Based on an arbitrary variance greater than 10 per cent around the average, a lesser proportion of expenditure is allocated at DWV (low percentage of appointed professors and doctoral degrees) and STL (due to other employment factors), while a greater proportion is allocated at PCH (high percentage of appointed professors and doctoral degrees) and RHU (due to other employment factors).

Institutions are on average allocating 0.93 per cent of total personnel expenditure for every 1 per cent of executive management and general administration personnel. Assuming the same variance, a lesser proportion of expenditure is allocated at UCT, PCH, RAU and STL, while a greater proportion is allocated at DWV and PTA. These ratios reflect each institution's specific terms and levels of appointment and quality of personnel.

8.1.6 Financial investment in fixed assets.

The term fixed assets has previously been defined (see section 6.1), and generally includes all long-lived property – immovable and moveable – owned by an institution or secured by formal agreement. Although the analysis of investment in fixed assets dwells mainly on the pattern (in percentage terms) of allocation of financial resource by SAPSE programme in each institution, it is interesting to note the levels (in financial terms) of investment that universities have undertaken to establish their educational infrastructure. As an introduction to the subsequent discussion, the total amount invested in fixed assets in 1997 at each institution is shown in Table 8.6, along with some other dimensions useful for gaining a perspective on this investment.

It is difficult to draw a comparison between these varying levels of investment expenditure as the amounts are shown in historical cost terms – annual fixed asset investment summed over varying time periods – and no provision is made for their depreciation (an institutional accounting policy). Nevertheless, there are some interesting observations that can be made about the levels of institutional investment and for purposes of comparison, a value showing fixed asset investment per 1000 students has been calculated for each university. These values are conveniently grouped in one of four suggested categories of investment:

1. High – R40 million and above: UCT is the only university included at this level.
2. Above average – R30 to 39 million: included are DWV, OFS, PTA, RHU and STL.
3. Below average – R20 to 29 million: UPE and PCH are invested within these levels.
4. Low – below R20 million: includes RAU and ZLD.

Table 8.6. Total investment in fixed assets (Rand million); total student numbers (000's) and students residing in institutional residences (per cent), 1997.

UNIV	UCT	DWV	OFS	UPE	PCH	PTA	RAU	RHU	STL	ZLD
FIXED ASSETS[1]	671	297	349	174	257	799	244	179	580	139
FIXED ASSETS GROWTH[2]	30.4	22.3	36.7	29.7	27.3	35.6	26.5	26.6	24.9	12.6
FA INV/1000 STUDENTS[3]	43	30	33	23	23	31	11	36	37	18
STUDENT NUMBERS	15.4	9.8	10.5	7.6	11.1	26.0	22.0	4.9	15.7	7.6
STUDENT GROWTH[4]	7.9	−7.3	13.9	34.7	11.0	7.7	43.1	20.9	9.9	22.5
STUDENTS ON-CAMPUS	26.9	17.3	22.0	16.1	30.3	20.2	10.4	43.2	36.0	33.2

Note: [1] Historical cost terms, per 1997 balance sheet.
[2] Growth between 1993-96 as a percentage.
[3] Fixed asset investment per 1000 students (Rand million).
[4] Growth between 1994-97 as a percentage.

An analysis of the level of fixed asset investment in each university shows that overall: it is higher in institutions structured to provide a full range of faculties and in those that are post-graduate and science oriented; it is generally lower in the undergraduate group of universities; it is lower in the new group of universities (and *vice versa*); and it is generally higher in those institutions that have a relatively high proportion of students that reside in institutional accommodation (PCH and ZLD are exceptions). This is a logical outcome, although it is difficult to reconcile the differences that exist in the level of investment at UCT and RHU on the one hand and at RAU and ZLD on the other, given their respective student numbers.

A plot of the two variables – investment per 1000 students and total student numbers – shows some interesting groupings of universities *vis-à-vis* their fixed asset investment levels (see appendix Figure F.4). The group of five universities in the 'above average' category of investment per 1000 students (average = R28.5m) is of interest because their student levels differ widely and their distinguishing characteristics are not all the same. Within this group, given their similarities, OFS, STL and PTA may be compared, as a sub-group in which STL's level of investment appears to be relatively high whilst PTA's investment is at a relatively lower level. UCT and STL are likewise similar in many respects and with almost the same student numbers, but STL's infrastructure has, by comparison, been established on a relatively lower investment outlay.

Comparing the investment in infrastructure at OFS and PCH, these are at quite different levels despite the fundamental similarities of these two institutions – including student numbers – and whereas OFS is science oriented and warrants higher investment, PCH has a relatively larger student population residing in campus accommodation, which requires additional investment. The justification for this difference may partially be attributed to investment efficiency at PCH. A useful comparison can also be made between investment levels at UPE and ZLD – both have similar dimensions including almost identical student numbers though ZLD has double the percentage of students living on-campus – but a differential does exist and though not as marked as in the case of OFS and PCH, its underlying cause may be due to policy fundamental to the apartheid era.

Two institutions that stand out are RHU and RAU. A high investment level is noted at RHU and, although the particularly high proportion of students that reside on-campus may account for part of this, it is nevertheless devoid of a health science and engineering faculty. In view of its modest student numbers, perhaps an optimal investment level has not been realised at this university, despite being measured as efficient in model DEA6 (see Table 5.8). The relatively low level of investment at RAU should not be taken to suggest that RAU offers a limited physical infrastructure; the absolute amount of investment is very similar to that of PCH's, but its student numbers are double those at PCH. The effect of a high student population on resource utilisation is again evident at this university, which has been measured as unitary efficient in model DEA6.

An interesting comparison can be made between the growth in absolute fixed asset investment (measured between 1993-96) and the growth in student populations (measured between 1994-97) at each university over a three-year staggered period[1]. The high fixed asset investment growth at UCT, OFS, UPE and PTA is matched by high student growth at UPE, average student growth at OFS and well below average student growth at UCT and PTA. Average fixed asset investment growth at PCH, RAU and RHU is accompanied by lower than average student growth at PCH and above average student growth at RAU and RHU (all unitary efficient in model DEA6 – see Table 5.8). The lower than average fixed asset investment growth seen at DWV, STL and ZLD (in particular), is viewed against negative growth at DWV, below average growth at STL, but high student growth at ZLD. That there are variable outcomes to increases in investment are due to its nature: investment may be for renewal or replacement purposes, or, it may be for planned new development. The former category does not necessarily anticipate student growth, but the latter almost

[1] The effect on student numbers is assumed to lag the investment in infrastructure by one year on average.

certainly does. Overall, student growth (exogenously determined) follows increases in fixed asset investment for new development (endogenously planned and controlled).

Investment in fixed assets comprises a substantial portion – an average of 56 per cent for all universities – of the total assets, which further includes long-term investments and working capital, employed in these institutions. The analysis of investment in fixed assets centres on the eleven major programmes defined in the programme classification structure of post-secondary educational institutions. These programmes will be grouped into three categories: the first is an aggregation of eight of these programmes and is referred to as the functional category of 'educational and general'; the second covers the programme of 'auxiliary enterprises'; and the third, referred to as 'other', includes the programmes of hospitals and independent operations (see appendix Table D.8 for explicit definitions).

The category of 'educational and general' absorbs about 74 per cent of financial resource allocated for the purpose of overall fixed asset investment. This allocation varies amongst institutions, with high investment levels seen at UPE and RAU and a notably lower level at UCT. The below average level of investment recorded at PCH, RHU, STL and ZLD must be viewed against their respective above average investments in auxiliary enterprises, as these institutions are characterised by a significantly high percentage of students who reside in institutional accommodation (fixed asset investment in the programme auxiliary enterprises provides for student accommodation). Educational and general fixed asset investment is above average in the 'new' university group, including ZLD – taking into account its high investment in auxiliary enterprises. It would appear that investment in this category is above average in all the post-graduate/science oriented institutions. This is clearly the case at OFS and PTA and if the high investment seen at UCT and STL in the category of 'other' – which covers medical infrastructure investment – is taken into consideration, then these two universities comfortably fit into this observation. The efficient group of universities all display educational and general fixed asset investment levels that are above institutional average – by approximately 5 percentage points – and this includes RHU if its high investment in auxiliary enterprises is taken into account.

Over the four-year period there has been insignificant change in the average percentage of investment in the three categories across all institutions, largely because of the nature of these assets. However, small shifts in the proportions of investment are seen in seven universities – excluding UCT, RAU and ZLD. Educational and general investment decreased at DWV, OFS, UPE and STL by between 2-6 percentage points; the shift generally to the category 'other' investment. The proportion of investment in auxiliary enterprises decreased by 3 percentage points at PCH and RHU; shifting to educational and general investment at both universities as well as to 'other' investment at RHU. At PTA, the shift was from 'other' investment to auxiliary enterprises by 3 percentage points. There are no clear links between these trends and the relative efficiencies measured in model DEA6 between 1994-97 (see Table 5.8).

The analysis proceeds to examine in more detail the allocation of financial resource to the three main investment centres – educational land and buildings, equipment and library collections – that fall under the major category of educational and general fixed asset investment. Investment in educational immovable property accounts for an average of 45 per cent of this resource, educational equipment 30 per cent and library collections 21 per cent (the remaining 4 per cent relates to construction in progress, etc. – see appendix Table D.9). The apparent irregular patterns of investment seen across the institutions have been noted (see section 6.1), but in most instances the inherent characteristics of each university account for this.

The post-graduate/science oriented institutions are generally distinguished by a below average level of investment in immovable property and an above average level of investment in educational equipment and library collections. An exception to this pattern is seen at STL, where there is a marked emphasis on immovable infrastructure and proportionately less investment in the other two investment centres. The 'new' universities – largely undergraduate with a low percentage of science students – are generally typified by a proportionately high investment in land and buildings and a consequential low investment in equipment and library collections, although RAU's investment pattern reflects more balance in the distribution of resources, which conforms very closely to average institutional investment levels. The exceptionally high investment (71 per cent) in immovable property at DWV suggests that educational equipment and library collections may be under capitalised at this university. Of the group of efficient universities, all show different patterns of allocation across the three main investment centres, reflecting their different characteristics and needs for the achievement of educational objectives.

During the period 1994-97, there has been a shift in the distribution of investment across the category of educational and general fixed assets: the average institutional level of investment in immovable property has decreased by 4 percentage points, leading to a 1 percentage point increase in educational equipment investment and a 2 percentage point increase in library collection investment. More specifically, the level of investment in immovable property has decreased by some 3-12 percentage points in seven universities, countered by an increase of 2-5 percentage points in the investment level of educational equipment and by further investment in library collections of 2-3 percentage points. Only at PTA has there been an increase in the level of investment in immovable property (by 5 percentage points), while at UPE and STL, decreases of 4-5 percentage points occurred in the investment level of educational equipment. The efficient group of universities – apart from PTA – are characterised by a shift in the level of resources, away from immovable property into moveable assets, which mainly featured library collection investment.

8.2 Efficiency and the quality dimension.

It will be recalled from Chapter 3 that the quality of teaching needs to be assessed mainly by reference to the achievement of students once they have graduated (see section 3.4.1). But defining standards for undergraduate degrees is difficult to accomplish, not only between the faculties of a university but to a greater extent, across the university sector as a whole.

There is a general perception that graduates command a competitive advantage in the labour market. They have better prospects of securing employment, of achieving job satisfaction and of making more satisfactory progress in their careers. However, this raises the issue of graduate equivalence amongst institutions, an aspect of performance that has been alluded to previously. It is unlikely that all institutions are able to produce graduates of equal standing and whereas the graduates of certain universities will be regarded as comparable, others will not be viewed quite in the same way. Institutions are required to produce output as efficiently as possible, but a fine line divides this requirement and that of maintaining quality standards in teaching and research. In recognition of this, we move on to examine the relationship between institutional efficiency and the First Employment Experiences of Graduates (HSRC, 1999)[1], as well as the extent to which audit and accounting graduates are successful in external public examinations (PAAB)[2] – used merely as one possible example.

8.2.1 First employment experiences of graduates.

For all institutions, an average of 62 per cent of graduates secured employment immediately after graduating; this ranged from a low of 46 per cent at DWV to a high of 70 per cent at PTA (see appendix Table E.1). Of this successful group of graduates, 56 per cent were from

[1] The survey for this report commenced in April 1997 in respect of graduates who graduated between 1991-95. Data specific to this study was made available by the HSRC on request.

[2] The results of the PAAB's examinations for 1997 were provided by special arrangement.

Other influences that may give rise to different graduate success include for example: the location of an institution, its history and age, and the composition of its graduates – e.g. philosophy *versus* the business disciplines.

8.2.2 Periods of unemployment.

Of the graduates that eventually secured employment (delayed employment); 33 per cent achieved this within the first three months of searching; 67 per cent within the first six months and 88 per cent within the first year (cumulative percentages). The remaining 12 per cent of graduates required more than one year to find a position (see appendix Table E.2).

Graduates from OFS, UPE, RAU and STL fared better than those from other universities in finding employment during the first three months, while over the first six months, graduates from this group, in addition to those from PTA and RHU, achieved a higher rate of success. Conversely, graduates from UCT, DWV and PCH required a longer period to secure a position. The analysis does not refute the proposition that the attainment of relative efficiency does not necessarily preclude the achievement of quality and therefore equivalence in university graduate out-turns.

Findings of the HSRC's survey (1999) suggest that a lack of experience and the limited availability of positions in specific fields of study were the main difficulties encountered in finding employment. White graduates sited population group prejudice as another important factor that hindered their search. Difficulties encountered in securing employment by graduates from the historically black universities (and not by others), included a reluctance to relocate to other areas and employers' bias towards the institution they had studied at.

8.2.3 The value of a degree on entering the labour market.

An average of 58 per cent of graduates across all universities indicated that their qualifications had assisted them to a great extent in securing employment; a further 24 per cent felt that to some extent they had been assisted; while 18 per cent of graduates felt that their qualifications either assisted them to a small extent or had made no impact at all (see appendix Table E.3).

Amongst the relatively efficient group of universities, a higher than average percentage (62 per cent) of graduates felt that their degrees had assisted them to a greater extent in securing a position (excluding RAU – 52 per cent). An above average (63 per cent) of graduates in the relatively inefficient universities of UCT, UPE and PCH, indicated that they had also been assisted to a greater extent. As might be expected, graduates with vocational education and training in specific professions, including medicine (79 per cent), engineering (70 per cent) and law (61 per cent), indicated that they had been assisted to a great extent in the search for a position.

8.2.4 Graduate performance in public examinations.

The quality of institutional graduate output and therefore the extent of graduate equivalence may also be assessed by measuring the success rate of graduates in external public examinations. The results of the Public Accountants' and Auditors' Board's qualifying examination results for 1997 have been used for this analysis (see appendix Table E.4). A mixed performance by the graduates of both the relatively efficient and inefficient universities, who wrote these examinations, is seen in these results. Graduates from PTA and RAU achieved an overall high pass rate of around 70 per cent for both parts – accountancy and auditing – of the examination, while for DWV and RHU this was much lower at around 40 per cent and well below the total institutional average of 55 per cent (for all fourteen universities offering candidates). In the relatively inefficient university group, above average pass rates were recorded at UCT (84 per cent), PCH and STL, while below average performances were seen at OFS and UPE. An analysis of the results of the individual examinations for accounting and auditing shows a similar trend amongst both institutional groups (by efficiency level), even though the pass rates for the auditing examination are generally lower (excluding UCT and PCH).

Although these results and this analysis are not representative of overall university graduate quality and are too specific to be of use in drawing general conclusions, they do provide some indication of the extent to which graduates from different universities are able to perform in the public domain. They again demonstrate that some relatively efficient institutions are equally able to achieve standards of quality in their teaching and as a consequence, produce graduates of a high calibre, but they also show the variance that exists amongst institutions – be they efficient or not – in terms of graduate equivalence. However, the quality of teaching in this area is regarded by many as being more important than the overall efficiency of an institution as a whole.

Various aspects of the overall analysis of university efficiency, arising from this chapter, are summarised in Table 8.7 overleaf.

The final chapter provides a summary of the main research findings; suggests benchmarks of 'best practice' for the university sector; discusses some further considerations and sets out conclusions.

Table 8.7. Summary of the analysis of analytical review research results – chapter 8.

CATEGORY	UCT	DWV	OFS	UPE	PCH
EFFICIENCY:	Inefficient	Efficient	Inefficient	Inefficient	Inefficient
STUDENTS:					
Undergraduate no's	below average	above average	below average	well above average	below average
Post-graduate no's	well above average-pgh[1]	well below average	above average	well below average	well above average
Growth-4 year	well below average	negative	average	well above average-dist[2]	below average
Graduate growth-4 year	negative	positive, around average	negative	negative	positive, above average
Entrance criterion	high standards	below average	around average	marginally above average	around average
On campus residence	average	relatively low	below average	relatively low	above average
PERSONNEL:					
Instruction/research no's	average	well below average	around average	above average	average
Administration no's	marginally above average	below average	around average	below average	marginally below average
Tech service/trades no's	average	above average	around average	below average	above average
Professors appointed	high per cent	low per cent	above average	below average	above average
Doctoral qualification	high per cent	below average	average	average	well above average
Research output per FTE	below average	below average	around average	around average	well below average
EXPENDITURE:					
Fixed cost structure	below average	above average	high	around average	well below average
Expenditure per graduate	high	marginally above average	above average	below average	marginally below average
Real expend per grad-4yr	+15.6 per cent	+35.9 per cent	+15.6 per cent	+22.0 per cent	+19.4 per cent
Academic expenditure	above average	marginally above average	above average	marginally above average	below average
Inst/acad support expend[3]	below average	average	above average	marginally above average	below average
Research expenditure	high	low	average	below average	about average
Personnel expend-4year[4]	no change in allocations	dec inst/res; inc exec/adm	inc inst/res; inc exec/adm	dec inst/res; inc exec/adm	no change in allocations
FA INVESTMENT:					
Investment/1000 students	high	above average	above average	below average	below average
Investment growth-4year	above average	below average	high	marginally above average	average
Educ/general investment	well below average[5]	above average	above average	well above average	below average[6]
QUALITY:					
Employment experience	below average	low	marginally above average	marginally below average	below average
Unemployment 6-month[7]	below average success	below average success	high rate of success	average rate of success	below average success

Notes: [1] Pgh – post-graduate higher. [2] Dist – distance-learning from 1997. [3] Instruction/academic support expenditure. [4] Considers changes in the cost centres: Instruction/ research; executive/administration (dec – decrease; inc – increase). [5] Should be viewed against high investment in medical/independent operations. [6] Should be viewed against investment in auxiliary enterprises. [7] Unemployment over 6-month period: success in securing a position.

Table 8.7. Summary of the analysis of analytical review research results – chapter 8 (continued).

CATEGORY	PTA	RAU	RHU	STL	ZLD
EFFICIENCY:	Efficient	Efficient	Efficient	Inefficient	Inefficient
STUDENTS:					
Undergraduate no's	below average	around average	around average	well below average	very high
Post-graduate no's	above average-pgh[1]	around average	around average	well above average-pgh[1]	very low
Growth-4 year	well below average	high-dist[2]	well above average	below average	well above average
Graduate growth-4year	positive, well above ave	positive, very high	positive, below average	positive, below average	high negative
Entrance criterion	high standards	above average	well above average	well above average	well below average
On campus residence	below average	very low	very high	well above average	above average
PERSONNEL:					
Instruction/research no's	above average	above average	around average	above average	below average
Administration no's	well below average	high	below average	above average	below average
Tech service/trades no's	above average	low	well above average	below average	high
Professors appointed	above average	high per cent	below average	average	very low
Doctoral qualification	below average	high per cent	average	well above average	very low
Research output per FTE	above average	very high	above average	below average	well below average
EXPENDITURE:					
Fixed cost structure	average	below average	below average	marginally below average	well above average
Expenditure per graduate	below average	low	below average	marginally below average	very high
Real expend per grad-4yr	−12.8 per cent	−12.9 per cent	0.0 per cent	−15.8 per cent	+18.8 per cent
Academic expenditure	above average	above average	below average	average	well below average
Inst/acad support expend[3]	above average	above average	below average	marginally below average	below average
Research expenditure	above average	marginally below average	average	well above average	low
Personnel expend-4year[4]	dec inst/res; inc exec/adm	dec inst/res; inc exec/adm	decrease inst/res	decrease inst/res	decrease exec/admin
FA INVESTMENT:					
Investment/1000 students	above average	low	above average	above average	low
Investment growth-4year	high	around average	around average	below average	low
Educ/gen investment	above average	high	below average[5]	below average[6]	below average[5]
QUALITY:					
Employment experience	well above average	above average	about average	about average	no data
Unemployment 6-month[7]	average rate of success	above average success	above average success	above average success	no data

Notes: [1]Pgh – post-graduate higher. [2]Dist – distance-learning from 1997. [3]Instruction/academic support expenditure. [4]Considers changes in the cost centres: Instruction/ research; executive/administration (dec – decrease; inc – increase). [5]Should be viewed against investment in auxiliary enterprises. [6]Should be viewed against high investment in medical/independent operations. [7]Unemployment over 6-month period: success in securing a position.

CHAPTER NINE

SUMMARY OF FINDINGS AND CONCLUSIONS

9.0 Introduction.

The main objectives of this thesis were to measure the relative efficiency of a selection of South Africa's public universities between 1994-97, to examine the changes in these efficiency levels and to offer explanations for the levels of relative efficiency observed in these institutions. This study was specifically concerned with the measurement of technical efficiency. Prior to dealing with these objectives, the broad parameters of the university sector and the importance of the topic were examined – both in general terms and particularly in the context of the new Higher Education Act (Government Gazette, 1997) and the report of the Council on Higher Education (2000), which recommends the reclassification of public universities. The difficulties facing the HE sector include the declining overall national participation rate in HE, competition between institutions for a decreasing number of matriculated students, a decline in student numbers in the historically black universities as a result of migration to the historically white universities, an overall research output decline since 1994 and the effect of reduced government funding on institution financial viability. Whilst a degree of rationalisation has occurred in many institutions, the sector as a whole is poised for overall restructuring.

9.1 Summary of findings.

There can be little doubt that the scope of this thesis would have been rather limited had the analysis depended on the use of only one of the two methodologies used. As it turned out, the use of both DEA and analytical review broadened the scope of the research and added depth and balance to the analysis. This is not to suggest that there are no limitations to either method but, in view of their complementary qualities, some of these limitations have been obviated and others reduced. While DEA was particularly suitable for providing an overall measure of institution relative efficiency, for providing a comparative assessment of efficiencies and for facilitating other observations concerning efficiency measurement, analytical review was notably useful for identifying specific measures of relative efficiency and, importantly, for confirming and consolidating the efficiency measures derived from the DEA computations. Analytical review was especially appropriate for providing interesting pointers to the likely factors contributing to efficiency levels and their changes.

9.1.1 DEA efficiency measurement.

Three different DEA models were developed to measure relative efficiency of each institution. The first two of these models – referred to as preliminary models – separately considered the measurable output of academic teaching (degree credits) and research results (total research output). Various input variables were tested in each model, which produced a series of phase or interim models: the academic model consisting of seven phases (see section 5.1) and the research model comprising five phases (see section 5.2). By integrating the elements of the academic and research models, the consolidated model – structured over seven phases – provided for the overall measurement of relative efficiency (see section 5.3). Input minimisation was assumed in all model development, which was limited by the DEA technical requirement that a maximum of only four variables (inputs and outputs in combination) could properly be used in the computations (see section 4.2.3).

The choice of DEA6 as the preferred model for the ongoing DEA analysis was made on the basis that its two input variables – capital employed and total recurrent expenditure – embodied the thesis intention of capturing a wide spectrum of input resources, while satisfying the technical requirements of DEA computation. Although these two variables represent the overall financial dimensions of institutional resources, it was considered that further quantitative and some qualitative dimensions of the professional staff and certain dimensions of the student population, could appropriately be assessed through analytical review analysis. In developing these models, technical efficiency was differentiated according to two types of measures – one based on inputs defined in cost or financial terms (cost efficiency) and the other based on inputs defined in non-financial terms (technical efficiency).

As the three models progressed through their phases of development, there was repeated evidence of a high degree of consistency and stability in the relative efficiency scores recorded for most institutions. This was particularly the case for DWV, UPE, PCH, PTA, RAU, RHU and ZLD over some four to six phase developments – i.e. models DEA2 to DEA7. To a lesser extent this characteristic was seen in the scores for OFS and was less apparent for UCT and STL.

Measures of unitary efficiency were recorded for DWV, PCH and RAU in the academic model (DEA7A); for RAU and RHU in the research model (DEA5R) and for DWV, PCH, RAU and RHU in the consolidated model (DEA6). Other institutions not positioned on the efficient frontier recorded measures of relative inefficiency at varying levels: in the academic model from 70 per cent for ZLD to 99 per cent for PTA and STL; in the research model from 56 per cent for ZLD to 98 per cent for PTA; and in the consolidated model from 74 per cent for ZLD to 93 per cent for PTA (see Tables 5.1, 5.2, 5.3).

Of the four universities that were measured unitary efficient, one is mainly an undergraduate university (DWV), a second (PCH) has a post-graduate orientation, while RAU and RHU have a balance between these last two categories. Only one university (DWV) offers a comparatively wide range of courses, all have markedly different total student numbers, they are represented in each of the divisions of the cultural classification and they are equally divided between the 'new' and 'old' institutions. These characteristics were found not to influence the efficiencies measured in the consolidated model.

Using DEA programme output, further technical analysis of model DEA6 showed that DWV, PCH, RAU and RHU were cited in the reference or peer groups of the less efficient universities. RAU was cited six times and featured in the reference group of all less efficient universities, PCH and RHU were both cited five times and DWV only once. The most common and frequent grouping of peer universities included PCH, RAU and RHU and they were associated with the less efficient universities – OFS, PTA, STL and ZLD (see Table 5.4).

Analysis of the targets set by DEA for input improvement showed a consistent pattern of balanced reduction of capital employed and total recurrent expenditure in the less efficient institutions. Reductions between 7 and 26 per cent for both variables across all institutions were indicated, although for the less efficient institutions – ZLD, UPE, OFS and UCT – an average reduction of 23 per cent is needed to achieve a unitary efficient unit. Further, UCT has an additional need to improve output of degree credits by about 14 per cent to achieve unitary efficiency (see Table 5.5).

The influence of an imposed constraint on research output and its resultant effect on efficiency scores was observed in model DEA6. There was no effect on the unitary efficient scores of DWV, PCH and RAU; almost no effect on the efficiencies of ZLD and UPE (less than 1 per cent decrease); a moderate effect on those of OFS, PTA and STL (13-15 per cent decrease) and a marked effect on the efficiencies of UCT (26 per cent decrease) and RHU (29 per cent decrease). If research output is seen to some extent less important than academic output, then RHU's sensitivity to weighting the research output variable brings into contention the efficacy of its unitary efficient score (see Table 5.7).

The analysis of relative efficiency between 1994-97 demonstrated a further underlying stability in the DEA model over time and revealed some interesting trends in the efficiencies of certain institutions (see Table 5.8). Overall, the average efficiency for the university group increased from 86 per cent in 1994 to over 91 per cent in 1995, but then declined in each successive year to reach a level of 88 per cent in 1997. Much the same trend was seen for average inefficiencies, with the difference between these two measures widening over the latter three years. Only two universities – PCH and RAU – were unitary efficient over the four-year period. Increased relative efficiency was noted for RHU (89 per cent in 1994 to unitary level in 1995 onwards), for DWV (79 per cent in 1994 to unitary level in 1996-97), for PTA (82 per cent in 1994 to 92 per cent in 1997) and for UPE (67 per cent in 1994 to 75 per cent in 1997). Decreases were seen at OFS and UCT alike (both unitary in 1994, but declining to 79 per cent in 1997), at STL (92 per cent in 1994 to 88 per cent in 1997) and at ZLD (although improving substantially to 83 per cent in 1995, declined to 74 per cent in 1997). Various wide ranging causal factors that possibly explain these changes include changes in student population numbers, the graduation rate, the number of graduates per FTE staff, the changes in levels of recurrent expenditure, expenditure per graduate and research activities (expenditure and output). The underlying cause(s) of each institution's change in relative efficiency was found to be uniquely different, involving a combination of these factors.

Those universities that showed an improvement in efficiency over the four years (excluding PTA) are mainly undergraduate-oriented with an equal mix of 'new' and 'old' institutions. Of those universities where efficiencies declined (excluding ZLD), most are post-graduate, scientifically oriented and 'old' institutions. Neither the efficient or less efficient group could be differentiated along cultural lines or by share of total sector student numbers.

Examining financial structure and its influence on relative efficiency, showed that institutions are 'low geared' i.e. financially structured with a small component (an average of 10 per cent) of debt finance (see Table 5.9). Varying the gearing ratios in a range from 0-50 per cent provided the basis for observing the effects of these changes on the established measures of university relative efficiency computed for model DEA6 (see Tables 5.10- 5.12). It was found that the effect of a change in the level of gearing appeared not to significantly impact on overall relative efficiency measures; it variously affected the inefficient universities, but had no effect on the unitary efficient universities.

9.1.2 Analytical review analysis.

Widely different input and output variables were used to derive a set of efficiency ratios of the university system. These individual efficiency measures were then ranked to provide a basis for comparative purposes. A crude overall measure of efficiency was constructed by summing the rank order positions of all the individual efficiency ratios for each university (see Table 6.16) and this summation was used to produce a 'composite rank measure' (see Table 8.1). Although the measurement of efficiency using ratios is unable to produce a definitive overall measure of efficiency for a university, this composite rank measure did permit comparison with the DEA efficiency measures. A comparison of the rankings of efficiency by the two methods showed a similar outcome ($r' = 0.87$) – five universities (DWV, OFS, RAU, RHU and ZLD) had unchanged rank positions, UPE and PTA increased their rankings by two positions, STL moved up by one position while UCT and PCH declined by two and three rank positions respectively (here an increase refers to an improvement on a DEA rank and vice versa). By taking into consideration the results arising from both methods of efficiency measurement, it was appropriate to group the universities according to their overall joint efficiency performance rather than being categorical about each university's efficiency score. On this basis, the following apparent levels of efficiency and the grouping of institutions within these levels were suggested:

- Relatively efficient: RAU, RHU, PTA and DWV.
- Relatively inefficient: STL, PCH, UPE, OFS, and UCT.
- Least efficient: ZLD.

Various factors that might contribute to institutional efficiency have been examined and analysed in an attempt to draw together all the underlying indicators that collectively explain why the inputs in some institutions are efficiently utilised while in others they are not, in terms of output produced. It could be argued that the answers to certain questions posed in the objectives of this thesis were obvious (see section 1.1). Will not high quality students and staff inevitably result in more efficient outcomes than in universities with lesser quality inputs? This research shows that such reasoning is flawed. Some universities with excellent staff and student inputs are not as efficient as those less well endowed. The determinants of efficiency are not only wide-ranging but are also often subtle in their configuration. A summary of the main findings arising from this study, some of which go at least partially towards explaining university efficiency, are listed as follows:

- The distribution of student populations by academic status and its relationship to efficiency is not clear. However, RAU and RHU have a middle position in the division between undergraduate (80 per cent) and post-graduate (20 per cent – which is divided equally between lower and higher levels) student numbers and this division may contribute to their unitary efficiency.
- The effect of student growth rate on efficiency was demonstrable – high student growth is clearly one factor that contributes to efficiency, while in some instances – but not all – low growth accompanied a decline in efficiency.

- The relationship between the percentage of students admitted to a university with a matriculation exemption and the ratio of graduates produced per 1000 students is not noticeably strong ($r = 0.64$), although for this ratio, the five top-ranked universities – UCT, PTA, RAU, RHU and STL – have an above average percentage of students with matriculation exemption and upper level matriculation symbols. This group includes three unitary efficient institutions.
- While various apparent differences in the distribution of total personnel across the main institutional employment categories were noted, there was little evidence to suggest that imbalances exist that might be cited as indicators of efficiency or inefficiency.
- Those institutions that employ an above average percentage of teaching/research staff with a doctoral or master's degree at all levels of appointment, are generally efficient universities.
- Cost structures were found to differ rather widely between institutions, varying from an estimated 59 per cent at PCH to 74 per cent at OFS (i.e. percentage of fixed cost to total operating costs). More importantly, cost structures are characterised by a high fixed cost component that averages around 67 per cent of total operating cost, comprising mainly aggregate personnel compensation costs. Although the connection between cost structure and efficiency was indeterminable, there was some evidence to suggest that lower levels of fixed costs contribute towards institutional efficiency.
- In most universities (excluding UCT and UPE), where expenditure per graduate is less than institutional average, fixed cost levels are below the 67 per cent average level (and vice versa).
- In real terms, expenditure per graduate increased by an average of 8.6 per cent across all institutions between 1994-97. However, expenditure increases averaged 21 per cent in six universities – UCT, DWV, OFS, UPE, PCH and ZLD, although the majority of these managed to contain their increases to a range between 15-19 per cent. Expenditure

decreases ranged between 12-16 per cent at PTA, RAU and STL. Increases alone were noted in all undergraduate-oriented universities and in the English/Black institutions.

- Broadly, it was found that a 1 per cent decrease in graduate numbers approximates a 3 per cent increase in expenditure per graduate, whereas a 1 per cent increase in graduate numbers approximates a less than 1 per cent decrease in expenditure per graduate (in real terms). Thus, there is an apparent multiplier effect on expenditure levels, which is notably negative when graduate numbers decline and, by inference, when student numbers decrease.
- The efficient universities are generally characterised by a higher than average recurrent expenditure on academic programmes and a lower than average expenditure on institutional support programmes. The higher levels of expenditure on operations/ maintenance programmes noted in some institutions could be linked to institutional age and to those institutions that accommodate a relatively high percentage of students in campus residences.
- It was found that the level of combined formal instruction and academic support expenditure is not an underlying determinant of unitary efficiency – RAU and DWV's allocation is about 43-45 per cent of total recurrent expenditure, while PCH and RHU's is at the 35-37 per cent level (see Table 8.4).
- Incremental changes in this combined expenditure were found to generally affect DEA efficiency scores: increased expenditure leads to an improvement or at least, the maintenance of efficiency; decreased expenditure gives rise to a decline in efficiency.
- An analysis of overall personnel compensation by main cost centre showed that relatively efficient institutions – excluding DWV – generally allocate financial resources at above average levels (by around four percentage points) for instruction/research programmes. Over the period 1994-97, these particular institutions all showed a decrease in this expenditure (while maintaining the expenditure at above average levels)

and with the exception of RHU, this was offset by an increase in executive management and general administration expenditure.

- The intensity of fixed asset investment (i.e. rate of investment per 1000 students) is viewed as relatively high for UCT and RHU, with STL on the fringe, but relatively low for ZLD and RAU – given their respective dimensions and characteristics (see Figure F.4).
- The efficient group of universities all show above average levels of investment in 'educational and general' fixed assets – by approximately five percentage points (RHU included on account of its high investment in auxiliary enterprises). But all show different distributions of financial resources across the three main education investment centres, reflecting their individual characteristics and needs for the achievement of educational objectives.
- Size of an institution in terms of student numbers was found not to be a critical factor in the attainment of unitary efficiency. The student populations in the efficient universities ranged from 5000 (RHU) to 26000 (PTA). The scale of operation opted for in each university would have been taken into consideration and factored into the DEA computations – not explicitly, but through the magnitude of the input/output variables.
- A comparison of graduate first employment success rates and relative efficiency scores showed a mixed relationship between these two measures. The data suggested that certain universities (PTA, RAU and RHU) are able to maintain an acceptable standard of quality in teaching along with their unitary efficient scores; that some universities (OFS and STL) attain their quality standards to the possible detriment of efficiency; while others (DWV and PCH) achieve efficiencies at the expense of questionable graduate quality.
- The quality of institutional graduate output and by inference, the extent of graduate equivalence, was partially assessed by measuring the success rate of graduates in an

external public examination (accounting and auditing). It was shown that some relatively efficient institutions (PTA and RAU) are able to achieve high standards of graduate quality, but it was also shown that quality variance exists amongst institutions, be they efficient or not.

9.2 Benchmarking.

It might be useful to draw together a number of the most important parameters that have been considered in the analysis of efficiency and highlight these by way of benchmarks for the HE sector. A broad definition of this management tool is provided by Bowerman and Stephens (1997.76) as follows:

> Benchmarking is the search for best practice and the subsequent translation of this best practice into use in the organisation. The whole approach often uses comparative performance statistics to identity either areas for improvement or the better performers amongst a group of benchmarkers.

This definition contains very succinctly the key to successful benchmarking – it is as much about practices or how things should be done, as what level of performance should be achieved. Using comparative statistics to see where performance could be improved is informative, but of limited use if nothing is done to improve that performance. Of more importance is the institutional learning that flows from exchanging ideas about processes and their improvement. Benchmarking is best seen as an internal management tool for continual improvement.

The application of this technique in the HE sector broadly requires a two-stage process. Firstly, an institution will need to accurately document its performance across the many dimensions by which performance is evaluated. Such measures of performance can then be compared to the benchmarks of 'best practice' suggested for the university sector shown in Table 9.1 and the detailed performance data shown in appendices B-D. This will permit a university administrator to gauge, by comparison, where his/her institution is positioned. It is suggested that a less efficient university attempts to align itself with these parameters of 'best practice'.

Secondly, where an institution sets out to benchmark the practices and operating processes that others use, then such institution will need to know precisely how it performs. Otherwise it will not be able to benchmark effectively, let alone improve performance. Indeed, according to Scott (1996), 'no business has ever improved its performance just from undertaking benchmarking: at some point management must implement change in order to achieve the benefits' (p.50). Benchmarking can assist the implementation of change by not only focusing on 'hard' processes such as operational logistics, student admissions, campus accommodation and the like, but importantly, should converge on 'soft' processes such as organisational learning and innovation, developing personal contributions, cross-functional integration, quality of major organisational processes and so on, in order to understand not only what is done in procedural terms but what the framework is that enables it. As the objective of benchmarking is to obtain external comparison with 'best practice' to determine the scope for achievable improvement of efficiency, the overall performance of RAU, RHU and PTA – and the apparent determinants of their efficiency – should also be considered by university administrators.

The benchmarks of 'best practice' suggested for the university sector, shown in Table 9.1, have been developed from the information arising from the results and analysis set out in this study.

Table 9.1 Benchmarks of suggested 'best practice' for the university sector.

University orientation:	**Undergraduate**	**Post-graduate**
Students (numbers):		
Undergraduate balanced institution	80 %	20 % (50 % master's/doctoral)
Post-graduate oriented institution	71 %	29 % (62 % master's/doctoral)
Matriculation	95 % of students with full matriculation exemption - (at least eighty per cent of these with A-C symbols)	
Personnel (numbers):		
Instruction/research	34 %	36 %
Executive/management/administration	24 %	25 %
Specialist support professional	5 %	6 %
Technical/services/trades	37 %	33 %
	100 %	100 %
Instruction/research (detail):		
Formal instruction	69 %	57%
Research	21 %	29 %
Academic admin/ancillary support	10 %	14 %
	100 %	100 %
Formal instruction (detail by level):		
Undergraduate	73 %	69 %
Post-graduate	27 %	31 %
	100 %	100 %
Appointment of professors	38 % of instruction/ research professional staff	
Total staff with a doctoral degree	55 % (ninety per cent of professors)	
Recurrent expenditure (1997 money terms):		
Cost structure (fixed/total cost)	64 %	
Expenditure per student	R22 000	R25 000
Expenditure per graduate	R103 000	R115 000
SAPSE programme expenditure:		
Academic	62 %	64 %
Institutional support	17 %	15 %
Operations/maintenance	21 %	21%
	100 %	100 %

Table 9.1 Benchmarks of suggested 'best practice' for the university sector (continued).

University orientation:	**Undergraduate**	**Post-graduate**
Academic expenditure (detail):		
Formal instruction	24.0 %	22.5 %
Research	11.5 %	15.0 %
Academic support	17.5 %	18.0 %
Student services	3.0 %	2.0 %
Bursaries	6.0 %	6.5 %
	62.0 %	64.0 %
Personnel expenditure:	61 % (of total recurrent expenditure)	
Instruction/research	51 %	54 %
Executive/management/administration	21 %	22 %
Specialist support professional	6 %	7 %
Technical/ services/trades	22 %	17 %
	100 %	100 %
Investment intensity (per 1000 students)**:**	R23m	R31m
Fixed asset investment:		
Educational and general	78 %	76 %
Auxiliary enterprises	11 %	11 %
Other	11 %	13 %
	100 %	100 %
First employment success rate	70 % (overall institution level)	
Ratios:		
Students per staff	21-23	
Students per FTE staff	29-32	
Graduates per staff	4.5-5.5	
Graduates per 1000 students	230-235	
Expenditure per student	R22 000	R25 000
Expenditure per graduate	R103 000	R115 000
Expenditure per research unit	R83 000	R112 000
Research units per FTE staff	2.3	2.5
Expenditure per FTE staff	R225 000	R245 000

9.3 Final considerations and conclusions.

The overall nature and theoretical strengths of DEA have been discussed, while some of the advantages that this technique offers over other methods were highlighted in the development of the models used for measuring institutional relative efficiency. The stability and consistency seen in the DEA models using different input and output mixes suggest that given a more extensive series of institution data, DEA would prove even more useful. There is also the practical limit to the incorporation of multiple variables, but as we have seen in this study, efficiency scores stabilised using only a few variables and this offers support for the application of DEA in this situation.

The use of DEA as an analytical tool should be seen in the context of its application in human analysis rather than merely being a programmed counter of the 'virtual input' to 'virtual output' ratio that measures efficiency. To the extent that the technique has provided further insight and assisted in the focus of enquiry and evaluative discussion of university performance, its use has been found to be more than appropriate. The multi-dimensional aspect of the evaluation problem that is embodied in this study is well suited to DEA, which has also provided insights on performance not available from other methods of assessment.

Although it was only possible to measure and further assess the relative efficiencies of ten institutions from the public university sector, we have nevertheless established an overall appreciation of institutional efficiency and gained an understanding of some of the factors that underpin this efficiency. The variation in the levels of relative efficiency measured amongst institutions has been noted and, in particular, the performance of RAU and ZLD – two outliers that emerged from this research – have been extensively discussed. The unitary efficient scores recorded in four institutions were necessarily measured in relative terms rather than in absolute terms. As a consequence, we do not know just how efficient these universities really are. It would be useful to learn how South Africa's public universities rate by comparison to some foreign institutions which are regarded as efficient. This presents an opportunity for further research in the area of university performance measurement using DEA.

This study has generally analysed and evaluated each institution in terms of its reported data, albeit from a distance, because it was not possible to gain an intimate knowledge of the 'inner character and workings' of each university. Such insights could have contributed towards establishing a greater understanding of the efficiency scores measured for all institutions and of the approaches taken by universities to achieve the necessary balance required to perform effectively while operating efficiently. In view of the nature of the study, highly aggregated data have been assembled and used in the computations. It is believed that the use of such data has not diminished the value of the research findings.

Whilst we have focused solely on each institution as an entity, there is also the importance of not considering universities as a whole, because pockets of excellence – embracing efficiency and effectiveness – will usually be found in some faculties, in certain schools and in parts of the administration. Allied to this is the matter of cross-subsidisation – deliberate or otherwise – where a disproportionate amount of resource is allocated to a programme or function in order to meet some objective, thereby promoting inefficiency. On the other hand, the incidence of sloth found in an institution – be it in academic or other areas – will undermine efficiency levels. This thesis, however, reports on aggregate levels of efficiency that combine these factors where they exist.

It is perhaps appropriate to touch upon issues of what may be referred to as the 'halo effect' – institutional reputation versus reality of performance. The efficiency scores recorded for some of the older more traditional, post-graduate and science-oriented institutions are lower than might be expected, given their standing in the community at large and their established international reputations. In these institutions, it would appear that efficiency has unintentionally become a secondary consideration to effectiveness or, more precisely, the necessary balance between these two criteria has not been achieved. This raises the question of the appropriateness of organisation structures in universities – have they been designed to support the interests of academia while the administrative function has to some extent been distanced to assume a more subordinate and parochial role? If this is so, then organisational structures need to be re-examined in universities so that the administrative and financial functions are accorded greater prominence; a balance is required between academic aspirations and operational needs and realities.

The subject of 'rationalization' of the HE sector has briefly been mentioned in previous chapters. The need for rationalization arises directly from a circumstance where inefficiency abounds, requiring the reorganisation of an entity or groups thereof to reduce or eliminate waste of resources. This has obvious implications for policy in HE, which can be considered at two decision-making levels – government and institutional.

Distorted by apartheid planning, crucial shortcomings extend from the secondary school system to the HE sector. The most significant area of concern is the declining national participation rate in HE – this being a direct result of the large decline of matriculated students eligible for university entrance. Another factor that has contributed to this decline is the lack of bursary and loan funds for poor but academically capable students. Geographic location of some historically disadvantaged universities has further aggravated matters because these institutions have experienced difficulties in attracting suitably qualified staff and students alike – and this has been exacerbated by a degree of student migration to the historically white institutions. Added to this is the rapid increase seen in the number of private institutions, including those from overseas, which have impacted on the supply side – resulting in the HE sector becoming 'over-traded'. In effect there are now too many institutions and this has meant overlap and duplication in the total system. Some institutions are inappropriately located while the sector as a whole displays a wide variation in quality of all output – graduates and research alike.

A further area of concern is that research output has declined since 1994 – a situation that South Africa can ill afford, especially in view of its participation in the global economy. It is worth noting that about 74 per cent of recognised research output can be attributed to only seven institutions, which incidentally also produce some 75 per cent of the country's master's and doctoral graduates. The ten historically disadvantaged universities account for a total of only 11-12 per cent of all research publications produced in 1997.

The HE sector has witnessed and been a party to a variety of changes in many aspects of our society since its emergence as a democracy. But HE faces significant change within itself:

> We cannot underestimate the potential crisis before our universities, neither the enormous opportunities to respond in fresh and innovative ways to the new national situation and needs. Our university system seems…still too much caught up and bound in mindsets of our past. Five years into the new political dispensation…it does not seem as if there has been a significant reconfiguration of the tertiary education landscape. Rationalization, niche definitions, regional co-operation and co-operative pruning, location determination of function and mission, system-wide planning and sharing of the access burden with its particular demographic demands – none of these seem…to have been significantly advanced and progressed during these years. (Gerwel, 1999. 1)

HE faces challenging times in South Africa, but these issues will in the first place have to be addressed centrally by HE planning structures. After the tertiary education landscape has been fully reconfigured and rationalized, those institutions that remain in the sector will need to realistically redefine their missions to take full cognisance of their changed environment. Although all institutions could continue to offer a wide range of undergraduate studies, some form of specialisation will in all likelihood be necessary. While this is likely to occur at all academic levels, the impact will mainly be at post-graduate level affecting the range of studies offered and research fields possible. Science (including the health sciences) and engineering studies will probably be concentrated in fewer institutions.

The essential question to be addressed is how the country can most effectively and efficiently use its limited resources to reorganise the HE sector as a whole so that national HE objectives will be met and value for money achieved. The contribution that performance measurement can make to this ongoing process of change and its overall importance to the governance of public HE institutions is indisputable.

APPENDIX A

UK UNIVERSITY MANAGEMENT STATISTICS AND PERFORMANCE INDICATORS

Table A.1 Selected UK university management statistics and performance indicators.

Costs	
1	Total costs incurred by HE institutions
2	Cost per student year in good standing
Financial statistics	
3	Index of revenue resources
4	Index of public funding of HE
5	Ratio of all public funds to total income
6	Ratio of liquid assets to current liabilities
7	Per cent ratio of total payroll costs to total expenditure
8	Per cent ratio of interest payable to total income
Expenditure in academic departments (by cost centre)	
9	Expenditure per FTE student
10	Expenditure per FTE academic staff
Expenditure on central administration	
11	Central administrative expenditure as a percentage of total general expenditure
12	Pay expenditure as a percentage of central administrative expenditure
13	Central administrative expenditure per FTE student
Expenditure on libraries	
14	Library expenditure as a percentage of total general expenditure
15	Library expenditure per FTE student
16	Library pay expenditure as a percentage of total library expenditure
Expenditure on computer services	
17	Computer services expenditure as a percentage of total general expenditure
18	Computer services expenditure per FTE student
19	Computer services pay expenditure as a percentage of total computer expenditure
Expenditure on premises	
20	Total premises expenditure as a percentage of total general expenditure
21	Premises pay expenditure as a percentage of premises expenditure
22	Repairs and maintenance as a percentage of total general expenditure
23	Total premises expenditure per FTE student

Source: University Management Statistics and Performance Indicators in the UK, CVCP, 1995b.
Higher Education Management Statistics Group, 1995, CVCP/SCOP/COSHEP.

Table A.2 Research indicators.

1	Books published per member of academic staff
2	Books edited per member of academic staff
3	Short works per member of academic staff
4	Refereed conference papers per member of academic staff
5	Articles in academic journals per member of academic staff
6	Review of academic books per member of academic staff
7	Other public output per member of academic staff
8	Total publications per member of academic staff
9	FTE post-graduate research students per member of academic staff
10	Value of research council grants per member of academic staff
11	Value of research grants from charities per member of academic staff
12	Total external research income per member of academic staff
13	Ratio of total external research income to funding council research grants/funds allocated per member of academic staff
14	Income earned from patents and licences (by institution)

Source: Higher Education Management Statistics: A future Strategy, CVCP, 1995a.

Table A.3 Research performance indicators used in the CVCP's first annual publications survey (1991).

1	Authored books
2	Edited books
3	Short works
4	Conference contributions, refereed
5	Conference contributions, other
6	Departmental working papers
7	Edited works: contributions
8	Editorships: journal
9	Editorships: newsletter
10	Journal letters, notes, etc.
11	Academic journal papers
12	Professional journal papers
13	Popular journal papers
14	Official reports
15	Review articles
16	Review of single academic books
17	Other publications: research
18	Other publications: research equivalent
19	Other media: research
20	Other media: research equivalent

Source: CVCP, Research Performance Indicators: Annual Publications Survey, First Annual Publications Survey: Calendar year 1991, N/93/51, 1993.

APPENDIX B

STUDENT STATISTICS AND RATIOS

Source: South African Post-secondary Education (SAPSE) Information System

Department of National Education, Pretoria

Table B.1. The classification of registered students by academic status 1994-97 (per cent).

UNIV	1994				1995			
	UGRAD[1]	PGRAD Lower[2]	PGRAD Higher[3]	PGTOT[4]	UGRAD	PGRAD Lower	PGRAD Higher	PGTOT
UCT	70.02	13.85	16.13	29.98	69.64	13.53	16.83	30.36
DWV	84.70	9.72	5.58	15.30	83.35	10.83	5.82	16.65
OFS	72.00	11.66	16.34	28.00	71.48	13.14	15.37	28.52
UPE	79.60	13.00	7.41	20.40	80.23	12.31	7.45	19.77
PCH	68.17	13.69	18.15	31.83	68.89	14.39	16.72	31.11
PTA	71.35	11.43	17.23	28.65	72.45	10.63	16.92	27.55
RAU	72.46	13.84	13.70	27.54	75.66	12.89	11.45	24.34
RHU	75.65	13.63	10.72	24.35	78.20	12.09	9.71	21.80
STL	71.40	11.87	16.73	28.60	70.01	12.46	17.53	29.99
ZLD	88.10	10.25	1.65	11.90	89.31	9.04	1.65	10.69
AVE:	75.35	12.29	12.36	24.66	75.92	12.13	11.95	24.08
MED:	72.23	12.44	14.92	27.77	74.06	12.39	13.41	25.95

UNIV	1996				1997			
	UGRAD	PGRAD Lower	PGRAD Higher	PGTOT	UGRAD	PGRAD Lower	PGRAD Higher	PGTOT
UCT	69.62	13.53	16.84	30.38	69.17	13.13	17.70	30.83
DWV	83.64	9.41	6.95	16.36	83.83	8.91	7.25	16.17
OFS	73.12	12.43	14.44	26.88	72.95	12.61	14.44	27.05
UPE	82.63	9.88	7.49	17.37	87.38	6.94	5.68	12.62
PCH	71.49	12.77	15.74	28.51	70.63	11.34	18.03	29.37
PTA	73.41	9.43	17.16	26.59	73.12	9.40	17.48	26.88
RAU	75.61	13.49	10.89	24.39	79.43	10.07	10.50	20.57
RHU	79.16	11.40	9.50	20.90	79.30	10.35	10.35	20.70
STL	69.14	11.56	19.30	30.86	68.54	12.76	18.70	31.46
ZLD	90.29	8.17	1.53	9.71	91.13	7.03	1.84	8.87
AVE:	76.81	11.21	11.98	23.20	77.55	10.25	12.20	22.45
MED:	74.51	11.48	12.67	25.49	76.21	10.21	12.47	23.79

Notes: [1] UGRAD – undergraduate. [2] PGRAD Lower – post-graduate degree (bachelor, honours), diploma, or certificate. [3] PGRAD Higher – post-graduate master's and doctoral. [4] PGTOT – post-graduate total.

Table B.2. Rate of growth[1] in student populations by academic status 1995-97 (per cent).

UNIV	1995					1996				
	UGR[2] %	PGR[3] Lower %	PGR Higher %	PGR Total %	TOT STUD[4] %	UGR %	PGR Lower %	PGR Higher %	PGR Total %	TOT STUD %
UCT	3.76	1.97	8.80	5.65	4.32	2.70	2.73	2.83	2.78	2.72
DWV	-2.53	10.39	3.21	7.77	-0.95	-4.65	-17.33	13.58	-6.52	-4.89
OFS	6.92	21.38	1.33	9.68	7.70	4.30	-3.54	-4.21	-3.90	1.96
UPE	2.59	-3.56	2.40	-1.40	1.78	-1.16	-23.01	-3.52	-15.66	-4.02
PCH	6.12	10.41	-3.26	2.62	5.01	3.23	-11.75	-6.35	-8.85	-0.53
PTA[5]	9.02	-0.14	5.46	3.22	7.36[5]	1.50	-11.11	1.60	-3.31	0.17
RAU[6]	37.6	22.69	10.16	16.45	31.77[6]	5.27	10.30	0.22	5.55	5.34
RHU	17.57	0.90	2.96	1.81	13.73	6.56	-0.71	3.10	0.99	5.35
STL	1.01	8.14	7.95	8.03	3.02	2.70	-3.54	14.53	7.02	3.99
ZLD	32.17	15.03	30.39	17.17	30.38	-0.03	-10.59	-8.27	-10.23	-1.12
AVE:	11.42	8.72	6.94	7.10	10.41	2.05	-6.86	1.35	-3.21	0.90
MED:	6.52	9.27	4.34	6.71	6.19	2.70	-7.07	0.91	-3.61	1.07

UNIV	1997				
	UGR %	PGR Lower %	PGR Higher %	PGR Total %	TOT STUD %
UCT	0.04	-2.36	5.81	2.17	0.69
DWV	-1.35	-6.81	2.74	-2.75	-1.58
OFS	3.44	5.18	3.64	4.35	3.69
UPE[5]	45.85	-3.14	4.62	0.21	37.93[5]
PCH	5.00	-5.64	21.79	9.50	6.28
PTA	-0.22	-0.16	2.02	1.25	0.17
RAU	8.29	-23.08	-0.69	-13.08	3.08
RHU	1.13	-8.41	9.87	-0.10	0.88
STL	1.70	13.28	-0.61	4.59	2.59
ZLD	-4.11	-18.31	13.93	-13.21	-4.99
AVE:	5.98	-4.95	6.31	-0.71	4.87
MED:	1.42	-4.39	4.13	0.73	1.74

Notes: [1] Growth in student numbers over prior year. [2] UGR – undergraduate. [3] PGR – post-graduate. [4] TOT STUD – total students. [5] First intake of distance-learning students. [6] Substantial increase in distance-learning.

Table B.3. Percentage of graduates in each academic category 1994-97.

UNIV	1994				1995			
	UGRAD[1] %	PGRAD[2] Lower %	PGRAD Higher %	PGTOT[3] %	UGRAD %	PGRAD Lower %	PGRAD Higher %	PGTOT %
UCT	58.73	31.07	10.20	41.27	57.19	31.21	11.60	42.81
DWV	69.84	24.87	5.29	30.16	67.93	26.96	5.11	32.07
OFS	58.11	26.47	15.42	41.89	54.83	31.35	13.82	45.17
UPE	66.59	27.26	6.15	33.41	61.63	31.62	6.75	38.37
PCH	59.10	31.52	9.38	40.90	56.41	33.95	9.64	43.59
PTA	62.62	25.21	12.17	37.38	61.70	25.30	13.00	38.30
RAU	61.98	26.42	11.60	38.02	71.89	19.55	8.56	28.11
RHU	60.82	32.25	6.93	39.18	60.82	31.67	7.51	39.18
STL	59.59	27.04	13.37	40.41	56.86	29.20	13.94	43.14
ZLD	72.92	24.38	2.70	27.08	78.08	20.51	1.41	21.92
AVE:	63.03	27.65	9.32	36.97	62.73	28.14	9.13	37.27
MED:	61.40	26.76	9.79	38.60	61.23	30.21	9.10	38.78

UNIV	1996				1997			
	UGRAD %	PGRAD Lower %	PGRAD Higher %	PGTOT %	UGRAD %	PGRAD Lower %	PGRAD Higher %	PGTOT %
UCT	56.62	29.60	13.78	43.38	56.85	28.73	14.42	43.15
DWV	70.25	25.24	4.51	29.75	70.10	22.75	7.15	29.90
OFS	52.92	33.50	13.58	47.08	53.74	31.39	14.87	46.26
UPE	67.04	26.88	6.08	32.96	68.76	25.12	6.12	31.24
PCH	56.16	32.20	11.64	43.84	58.84	29.69	11.47	41.16
PTA	64.21	23.02	12.77	35.79	65.56	31.23	13.21	34.44
RAU	67.60	23.32	9.08	32.40	70.42	19.87	9.71	29.58
RHU	63.91	28.72	7.37	36.09	59.80	32.75	7.45	40.20
STL	57.42	27.68	14.90	42.58	54.35	29.85	15.80	45.65
ZLD	84.81	13.24	1.95	15.19	85.60	13.17	1.23	14.40
AVE:	64.09	26.34	9.57	35.91	64.40	25.46	10.14	35.60
MED:	64.06	27.28	10.36	35.94	62.68	26.93	10.59	37.32

Note: [1] UGRAD – undergraduate. [2] PGRAD – post-graduate. [3] PGTOT – post-graduate total.

Table B.4. Rate of growth[1] in graduate populations by academic status 1995-97 (per cent).

UNIV	1995					1996				
	UGR[2] %	PGR[3] Lower %	PGR Higher %	PGR Total %	TOTAL GRAD[4] %	UGR %	PGR Lower %	PGR Higher %	PGR Total %	TOTAL GRAD %
UCT	-3.90	-0.86	12.27	2.39	-1.30	-2.36	-6.48	17.21	-0.06	-1.38
DWV	19.17	32.75	18.35	30.23	22.50	-7.40	-16.15	-20.93	-16.91	-10.45
OFS	-7.96	15.47	-12.57	5.15	-2.47	-5.27	4.90	-3.59	2.30	-1.85
UPE	-1.75	23.14	16.46	21.91	6.15	-6.79	-27.15	-22.83	-26.39	-14.31
PCH	-6.25	5.79	0.93	4.67	-1.78	-1.72	-6.38	19.27	-0.71	-1.28
PTA	1.11	2.97	9.69	5.16	2.62	7.45	-6.06	1.40	-3.52	3.25
RAU	66.91	6.41	6.22	6.35	43.88	-3.86	22.01	8.33	17.84	2.24
RHU	15.05	13.00	24.69	15.07	15.06	2.81	-11.27	-3.96	-9.87	-2.16
STL	-8.46	3.63	0.00	2.43	-4.06	2.72	-3.60	8.73	0.38	1.71
ZLD	51.77	19.23	-26.09	14.72	41.74	-26.06	-56.05	-5.88	-52.83	-31.93
AVE:	12.57	12.15	5.00	10.81	12.23	-4.05	-10.62	-0.23	-8.98	-5.62
MED:	-0.32	9.71	10.98	5.76	4.39	-2.04	-6.22	4.87	-0.39	-1.33

UNIV	1997				
	UGR %	PGR Lower %	PGR Higher %	PGR Total %	TOTAL GRAD %
UCT	-2.32	-5.55	1.79	-3.22	-2.71
DWV	-4.97	-14.19	50.98	-4.31	-4.77
OFS	1.22	-6.59	9.15	-2.05	-0.32
UPE	6.26	-3.18	4.23	-1.82	3.60
PCH	16.99	2.92	10.00	4.80	11.64
PTA	5.83	-4.37	7.19	-0.25	3.66
RAU	-0.39	-18.53	2.29	-12.70	-4.38
RHU	-15.10	3.44	-8.25	1.05	-9.27
STL	-2.94	10.61	8.76	9.96	2.56
ZLD	-10.60	-11.93	-43.75	-16.00	-11.42
AVE:	-0.60	-4.74	4.24	-2.45	-1.14
MED:	0.42	-3.78	7.98	-1.04	1.12

Note: [1] Growth in graduate numbers over prior year.
[2] UGR – undergraduate. [3] PGR – post-graduate.
[4] TOTAL GRAD – total graduate population.

Table B.5. Percentage of students exiting[1] a university without completing a degree, diploma or certificate 1994-97.

UNIV	1994			1995		
	UG EXIT[2] %	PG EXIT[3] %	TOT EXIT[4] %	UG EXIT %	PG EXIT %	TOT EXIT %
UCT	9.30	25.23	14.08	9.63	25.51	14.45
DWV	15.60	48.21	20.59	8.57	16.70	9.92
OFS	12.25	17.81	13.80	11.67	17.80	13.41
UPE	2.97	0.44	2.46	3.38	0.97	2.90
PCH	4.52	4.32	4.46	4.65	4.30	4.54
PTA	11.12	16.77	12.74	13.41	16.76	14.33
RAU	15.32	20.85	16.84	19.05	25.60	20.65
RHU	13.08	6.82	11.55	14.80	3.45	12.33
ST	9.84	8.22	9.38	11.49	11.30	11.43
ZLD	21.99	40.19	24.16	17.27	35.12	19.17
AVE:	11.65	19.12	13.04	11.17	15.64	12.09
MED:	12.25	17.81	13.80	11.49	16.70	12.33

UNIV	1996			1997		
	UG EXIT %	PG EXIT %	TOT EXIT %	UG EXIT %	PG EXIT %	TOT EXIT %
UCT	9.95	25.17	14.57	13.22	42.51	22.25
DWV	8.30	24.05	10.88	7.91	23.60	10.45
OFS	13.77	23.79	16.47	14.53	19.79	15.96
UPE	3.33	0.63	2.86	1.86	0.63	1.70
PCH	12.15	16.21	13.31	15.08	22.28	17.19
PTA	13.61	16.14	14.28	12.91	17.07	14.02
RAU	21.71	23.70	22.20	23.74	26.43	24.30
RHU	16.34	5.46	14.07	17.33	4.59	14.69
STL	11.43	21.72	14.61	11.55	17.99	13.58
ZLD	17.21	38.86	19.32	35.37	56.57	37.25
AVE:	12.69	19.95	14.25	15.35	23.15	17.14
MED:	12.15	23.70	14.57	13.88	21.04	15.33

Notes: [1]Excluded on academic grounds, on other grounds and in good standing.
[2]UG EXIT – undergraduate student exits. [3]PG EXIT – post-graduate student exits.
[4]TOT EXIT – total student exits.

Table B.6. First-time entering undergraduate students according to type of school leaving certificate[1] 1997 (per cent).

UNIV	MATRIC EXEMPT[3]	CONDIT EXEMPT[4]	OTHER CERT[5]	ANALYSIS OF MATRIC EXEMPT BY SYMBOL[2]					
				A	B	C	D	E	UN[6]
UCT	91.30	5.60	3.10	22.1	30.1	28.8	12.8	0.4	5.8
DWV	78.80	17.70	3.50	2.6	0.7	15.2	65.2	13.1	3.2
OFS	84.20	15.70	0.10	16.9	19.5	24.2	30.9	7.7	0.8
UPE	85.90	6.60	7.50	9.1	26.1	33.1	25.3	3.7	2.7
PCH	63.00	4.30	32.70	5.4	16.5	31.8	30.4	14.8	1.1
PTA	98.10	1.20	0.70	28.3	32.9	27.6	6.4	0.2	4.6
RAU	82.50	4.90	12.60	14.9	25.7	34.1	19.3	6.0	0.0
RHU	83.30	12.30	4.40	27.8	27.0	22.9	16.0	4.3	2.0
STL	95.20	3.20	1.60	10.9	23.0	33.9	26.1	5.9	0.2
ZLD	59.70	40.00	0.30	0.0	0.3	2.4	33.0	64.3	0.0

Note: [1] Academic prerequisite for university admission. [2] Matriculation aggregate pass category.
[3] MATRIC EXEMPT – matriculation exemption. [4] CONDIT EXEMPT – conditional exemption.
[5] OTHER CERT – other certificate. [6] UN – unknown/not indicated.

Table B.7. Percentage of total formal degree credits[1] obtained in natural sciences by students fulfilling the requirements for a degree/diploma/certificate 1994-97.

UNIV	1994	1995	1996	1997
UCT	38.85 [E]	38.94	39.40	38.77
DWV	22.06	21.83	20.20 [E]	19.95 [E]
OFS	40.53 [E]	41.84	44.58	44.83
UPE	28.76	28.86	29.67	29.74
PCH	19.86 [E]	23.90 [E]	31.34 [E]	31.90 [E]
PTA	47.00	45.72	46.14	45.08
RAU	19.42 [E]	16.12 [E]	15.43 [E]	16.86 [E]
RHU	21.86	21.63 [E]	21.80 [E]	25.59 [E]
STL	42.66	43.96	43.17	40.36
ZLD	5.18	11.28	6.12	7.85

Note: [1] Degree credits obtained by students who fulfilled the requirements for a degree/diploma/certificate.
[E] Denotes a DEA measured unitary efficient university.

Table B.8. Graduation rate per thousand registered students by level of degree 1994-97.

UNIV	1994				1995			
	UGRAD[1]	LOWER PGRAD[2]	HIGHER PGRAD	TOTAL GRAD[3]	UGRAD	LOWER PGRAD	HIGHER PGRAD	TOTAL GRAD
UCT	220	590	166	263	204	573	171	249
DWV	160	498	184	195	196	599	211	241
OFS	199	561	233	247	172	534	201	224
UPE	191	479	190	229	183	612	216	238
PCH	200	532	119	231	177	510	125	216
PTA	194	488	156	221	180	503	163	212
RAU	200	447	198	234	243	388	191	256
RHU	230	676	185	286	225	757	223	289
STL	220	601	211	264	199	576	195	246
ZLD	114	329	225	138	131	341	128	150
AVE:	193	520	187	231	191	539	182	232
MED:	200	515	188	233	190	554	193	240
SDV:	32	91	32	39	29	111	33	34

UNIV	1996				1997			
	UGRAD	LOWER PGRAD	HIGHER PGRAD	TOTAL GRAD	UGRAD	LOWER PGRAD	HIGHER PGRAD	TOTAL GRAD
UCT	194	522	195	239	190	505	188	231
DWV	190	607	147	227	183	559	216	219
OFS	156	581	202	215	153	516	213	207
UPE	173	579	173	213	162	579	172	198
PCH	169	541	159	215	188	590	143	225
PTA	191	532	162	218	202	510	171	226
RAU	222	429	207	248	204	454	213	230
RHU	217	676	208	268	182	764	174	241
STL	200	576	185	240	190	562	203	240
ZLD	97	168	131	103	91	181	65	96
AVE:	181	521	177	219	171	522	176	208
MED:	191	559	179	223	186	538	181	226
SDV:	34	132	25	42	35	138	43	43

Notes: [1] UGRAD – undergraduate. [2] PGRAD – post-graduate. [3] TOTAL GRAD – total graduate students.

APPENDIX C

PERSONPOWER STATISTICS AND RATIOS

Source: South African Post-secondary Education (SAPSE) Information System

Department of National Education, Pretoria

and

South African Universities' Vice-Chancellors' Association (research output)

Table C.1. Utilisation of full-time equivalent personpower resources by personnel category 1994-97 (per cent).

UNIV 1994	INST/RES PROF[1]	EXEC/ADM MANPROF[2]	SPEC/SUPP PROF[3]	TECHNIC EMP[4]	ADMIN NONPROF[5]	SERVICE/ TRADE[6]
UCT	32.4	1.0	3.7	13.3	24.8	24.8
DWV	29.2	1.5	5.8	17.5	22.7	23.3
OFS	30.5	2.3	8.0	5.6	20.4	33.2
UPE	32.9	1.7	6.4	4.7	17.9	36.3
PCH	29.3	0.9	4.7	5.5	19.4	40.2
PTA	36.0	2.8	5.0	5.8	14.1	36.3
RAU	37.3	1.3	3.6	4.7	29.1	24.0
RHU	31.7	1.6	2.7	5.2	19.8	39.0
STL	30.9	2.8	3.3	11.8	21.5	29.6
ZLD	28.2	3.5	2.6	4.6	22.3	38.8
AVERAGE:	31.8	1.9	4.6	7.9	21.2	32.6
MEDIAN:	31.3	1.7	4.2	5.6	21.0	34.8
STD DEV:	2.8	0.8	1.7	4.4	3.8	6.3

UNIV 1995	INST/RES PROF	EXEC/ADM MANPROF	SPEC/SUPP PROF	TECHNIC EMP	ADMIN NONPROF	SERVICE/ TRADE
UCT	33.8	0.9	3.9	12.7	25.1	23.6
DWV	30.5	1.3	8.4	19.0	21.3	19.5
OFS	28.4	2.4	8.6	5.8	22.7	32.1
UPE	34.4	1.7	6.7	4.9	19.7	32.6
PCH	30.0	1.0	4.7	5.6	19.8	38.9
PTA	36.6	3.0	4.9	5.7	14.6	35.2
RAU	35.6	1.4	3.6	3.9	33.3	22.2
RHU	32.8	1.5	2.8	5.6	19.8	37.5
STL	32.4	2.9	3.2	10.5	22.3	28.7
ZLD	28.1	3.1	2.5	4.7	22.6	39.1
AVERAGE:	32.3	1.9	4.9	7.8	22.1	31.0
MEDIAN:	32.6	1.6	4.3	5.7	21.8	32.3
STD DEV:	2.8	0.8	2.1	4.6	4.6	6.8

Notes: [1] Instruction/research academic professional.
[2] Executive/administrative/managerial professional.
[3] Specialist support professional (academic, student and institution).
[4] Technical employee (qualified for technical activities).
[5] Administrative non-professional (clerical and secretarial).
[6] Service (unskilled activities) and trade (manually skilled activities).

Table C.1. (continued) Utilisation of full-time equivalent personpower resources by personnel category 1994-97 (per cent).

UNIV 1996	INST/RES PROF[1]	EXEC/ADM MANPROF[2]	SPEC/SUPP PROF[3]	TECHNIC EMP[4]	ADMIN NONPROF[5]	SERVICE/ TRADE[6]
UCT	32.8	1.0	4.5	13.7	25.5	22.5
DWV	30.1	1.1	19.3	9.6	20.6	19.3
OFS	27.7	2.5	8.5	6.5	23.7	31.1
UPE	34.8	2.9	6.7	5.4	20.3	29.9
PCH	30.7	1.0	5.2	5.7	22.5	34.9
PTA	36.1	3.4	5.9	5.6	15.0	34.0
RAU	34.8	1.3	2.6	3.2	37.8	20.3
RHU	31.7	1.5	2.9	5.4	21.4	37.1
STL	34.1	3.0	3.1	12.5	22.6	24.7
ZLD	29.3	2.7	2.2	4.0	21.7	40.1
AVERAGE:	32.2	2.0	6.1	7.2	23.1	29.4
MEDIAN:	32.3	2.0	4.9	5.7	22.1	30.5
STD DEV:	2.6	0.9	4.8	3.4	5.5	7.0

UNIV 1997	INST/RES PROF	EXEC/ADM MANPROF	SPEC/SUPP PROF	TECHNIC EMP	ADMIN NONPROF	SERVICE/ TRADE
UCT	33.0	1.0	4.4	13.6	26.3	21.7
DWV	25.1	1.9	13.9	11.2	20.5	27.4
OFS	31.2	2.7	8.1	6.7	22.6	28.7
UPE	36.6	3.1	6.8	5.3	20.8	27.4
PCH	31.7	1.2	5.5	5.7	23.2	32.7
PTA	36.0	3.6	5.0	5.6	15.4	34.4
RAU	34.0	1.1	2.5	2.6	42.8	17.0
RHU	31.5	1.4	3.0	5.3	21.4	37.4
STL	35.8	3.3	3.2	12.3	25.5	19.9
ZLD	29.5	2.8	2.3	4.3	20.1	41.0
AVERAGE:	32.4	2.2	5.5	7.3	23.9	28.8
MEDIAN:	32.4	2.3	4.7	5.7	22.0	28.1
STD DEV:	3.3	1.0	3.3	3.5	7.0	7.4

Notes: [1] Instruction/research academic professional.
[2] Executive/administrative/managerial professional.
[3] Specialist support professional.
[4] Technical employee (qualified technically).
[5] Administrative non-professional.
[6] Service and trade employee.

Table C.2. Utilisation of instruction/research professionals' full-time equivalent personpower resources by SAPSE programme 1994-97 (per cent).

UNIV	1994			1995		
	FORMAL INSTRUCT[1] %	RESEARCH[2] %	ANC SUPP/ ACD ADM[3] %	FORMAL INSTRUCT %	RESEARCH %	ANC SUPP/ ACD ADM %
UCT	49.9	38.3	11.8	48.1	40.1	11.8
DWV	74.5	14.9	10.6	71.8	15.0	13.2
OFS	63.5	25.5	11.0	61.6	24.8	13.6
UPE	64.8	26.3	8.9	63.5	27.9	8.6
PCH	60.1	28.4	11.5	60.1	27.8	12.1
PTA	53.0	24.4	22.6	53.7	23.5	22.8
RAU	65.0	24.0	11.0	66.5	22.2	11.3
RHU	67.9	25.5	6.6	71.5	20.7	7.8
STL	59.0	30.9	10.1	58.1	32.2	9.7
ZLD	73.3	19.6	7.1	74.1	18.4	7.5
AVERAGE:	63.1	25.8	11.1	62.9	25.3	11.8
MEDIAN:	64.2	25.5	10.8	62.6	24.1	11.6
STD DEV:	7.5	5.9	4.2	7.9	6.8	4.2

UNIV	1996			1997		
	FORMAL INSTRUCT %	RESEARCH %	ANC SUPP/ ACD ADM %	FORMAL INSTRUCT %	RESEARCH %	ANC SUPP/ ACD ADM %
UCT	49.2	38.3	12.5	48.9	37.7	13.4
DWV	61.6	18.9	19.5	66.2	17.6	16.2
OFS	58.5	26.3	15.2	60.7	25.2	14.1
UPE	67.0	24.2	8.8	70.1	20.3	9.6
PCH	60.0	26.4	13.6	59.0	26.0	15.0
PTA	53.6	23.2	23.2	52.5	24.1	23.4
RAU	68.1	21.0	10.9	68.3	21.0	10.7
RHU	70.2	21.5	8.3	71.0	21.5	7.5
STL	52.7	39.0	8.3	53.6	38.7	7.7
ZLD	73.6	18.4	8.0	72.5	18.7	8.8
AVERAGE:	61.5	25.7	12.8	62.3	25.1	12.6
MEDIAN:	60.8	23.7	11.7	63.5	22.8	12.1
STD DEV:	7.8	7.0	4.9	8.1	7.1	4.7

Notes: [1] Professional teaching and allied activities.
[2] Professional activities to produce research outcomes (creation, reorganisation and application of knowledge).
[3] Ancillary support (academic departments) and academic administration (non-professional administrative personnel within academic departments).

Table C.3. Utilisation of instruction/research professionals' full-time equivalent personpower resources for formal instruction by course level 1994-97 (per cent).

UNIV	1994			1995		
	UGRAD[1] %	PGRAD[2] %	PGRES[3] %	UGRAD %	PGRAD %	PGRES %
UCT	75.1	18.3	6.6	75.1	18.5	6.4
DWV	81.7	13.7	4.6	79.3	16.3	4.4
OFS	70.7	20.5	8.8	69.1	22.9	8.0
UPE	77.0	15.3	7.7	76.1	16.0	7.9
PCH	59.4	28.8	11.8	60.1	28.3	11.6
PTA	68.4	22.5	9.1	69.4	21.6	9.0
RAU	48.9	24.7	26.4	47.8	24.3	27.9
RHU	74.8	18.8	6.4	76.4	17.8	5.8
STL	82.1	12.2	5.7	81.8	11.8	6.4
ZLD	80.8	16.2	3.0	80.7	15.9	3.4
AVERAGE:	71.9	19.1	9.0	71.6	19.3	9.1
MEDIAN:	75.0	18.6	7.2	75.6	18.1	7.2
STD DEV:	10.1	4.9	6.3	10.1	4.6	6.6

UNIV	1996			1997		
	UGRAD %	PGRAD %	PGRES %	UGRAD %	PGRAD %	PGRES %
UCT	75.8	17.9	6.3	75.7	17.9	6.4
DWV	75.0	18.4	6.6	75.1	19.4	5.5
OFS	71.7	19.9	8.4	75.4	17.0	7.6
UPE	76.5	15.1	8.4	80.0	11.7	8.3
PCH	60.5	28.0	11.5	62.4	22.7	14.9
PTA	68.9	23.5	7.6	68.6	23.8	7.6
RAU	42.8	26.1	31.1	42.2	33.5	24.3
RHU	74.6	18.9	6.5	76.0	17.9	6.1
STL	81.7	13.6	4.7	80.9	13.7	5.4
ZLD	82.0	14.5	3.5	78.8	17.4	3.8
AVERAGE:	71.0	19.5	9.5	71.5	19.5	9.0
MEDIAN:	74.8	18.7	7.1	75.6	17.9	7.0
STD DEV:	11.1	4.6	7.5	11.1	5.8	5.8

Notes: [1] UGRAD – undergraduate. [2] PGRAD – post-graduate. [3] PGRES – post-graduate research (instruction).

Table C.4. Headcount of instruction/research professionals by position attained 1994-97 (per cent).

UNIV	1994		1995		1996		1997		
	PROF[1] %	LECT[2] %	PROF %	LECT %	PROF %	LECT %	PROF %	LECT %	OTHER[3] %
UCT	41.8	58.2	41.8	58.2	42.8	57.2	43.6	54.5	1.9
DWV	21.2	78.8	23.6	76.4	24.5	75.5	24.6	74.7	0.7
OFS	36.1	63.9	34.3	65.7	35.9	64.1	38.0	56.6	5.4
UPE	30.4	69.6	32.8	67.2	32.2	67.8	29.7	63.6	6.7
PCH	38.9	61.1	40.5	59.5	38.0	62.0	38.6	60.6	0.8
PTA	35.7	64.3	36.2	63.8	35.3	64.7	35.2	54.4	10.4
RAU	46.9	53.1	48.6	51.4	45.7	54.3	47.8	50.5	1.7
RHU	27.7	72.3	33.3	66.7	30.3	69.7	28.4	71.6	0.0
STL	32.1	67.9	31.9	68.1	31.9	68.1	34.4	64.8	0.8
ZLD	16.4	83.6	18.5	81.5	17.9	82.1	18.2	81.5	0.3
AVE:	32.7	67.3	34.2	65.9	33.5	66.6	33.9	63.3	2.9
MED:	33.9	66.1	33.8	66.2	33.8	66.3	34.8	62.1	1.3
SDV:	8.8	8.8	8.2	8.2	7.8	7.8	8.4	9.5	3.3

Notes: [1] Professor (including associate).
[2] Lecturer (junior to senior).
[3] Other (below junior lecturer) – (included under lecturer for 1994-96).

Table C.5. The highest relevant qualification obtained by instruction/research professionals according to level of appointment 1997 (per cent).

UNIV 1997	DOCTORAL DEGREE				MASTER'S DEGREE			
	PROF[1] %	LECT[2] %	OTHER[3] %	TOTAL %	PROF %	LECT %	OTHER %	TOTAL %
UCT	76.9	42.8	7.1	57.0	19.3	38.5	42.9	30.2
DWV	90.2	27.4	66.7	43.1	5.9	45.5	33.3	35.7
OFS	80.4	30.3	20.7	48.8	14.2	32.9	17.2	25.0
UPE	78.6	37.3	6.3	47.5	14.3	36.7	12.5	28.4
PCH	92.9	32.9	0.0	55.7	2.7	37.4	0.0	23.7
PTA	84.8	19.5	0.7	40.5	13.8	44.9	14.6	30.8
RAU	90.3	32.2	80.0	60.8	6.3	48.0	20.0	27.6
RHU	86.2	32.4	0.0	47.7	9.2	43.4	0.0	33.7
STL	86.1	40.0	33.3	55.8	9.0	35.9	0.0	26.3
ZLD	92.5	10.1	0.0	25.0	5.7	50.4	0.0	42.1
AVE:	85.9	30.5	21.5	48.2	10.0	41.4	14.1	30.4
MED:	86.2	32.3	6.7	48.3	9.1	41.0	13.6	29.3
SDV:	5.4	9.2	28.0	9.9	4.9	5.5	14.3	5.3

Notes: [1] Professor (including associate).
[2] Lecturer (junior to senior).
[3] Other (below junior lecturer).

Table C.6. Annual student classroom contact hours spent in formal instruction by course level 1994-97 (hours).

UNIV	1994			1995			1996			1997		
	HRS/ UG[1]	HRS/ PG[2]	HRS/ STUD[3]	HRS/ UG	HRS/ PG	HRS/ STUD	HRS/ UG	HRS/ PG	HRS/ STUD	HRS/ UG	HRS/ PG	HRS/ STUD
UCT	369	129	297	374	134	301	377	103	293	384	127	304
DWV	1356	206	1180	1291	357	1136	859	211	753	1160	454	1046
OFS	331	93	265	376	104	298	392	83	309	381	86	301
UPE	693	146	581	728	148	613	696	122	596	492	130	447
PCH	359	23	252	329	26	235	302	24	223	275	21	200
PTA	374	83	291	361	82	284	355	78	282	358	84	285
RAU	249	147	221	NA[4]	NA	NA	229	79	192	231	167	218
RHU	523	104	421	445	102	370	417	101	351	413	101	348
STL	1022	61	747	1012	57	726	986	53	698	969	51	680
ZLD	293	79	268	284	96	263	390	106	362	402	70	373
AVE:	557	107	452	578	123	470	500	96	406	507	129	420
MED:	372	99	294	376	102	301	391	92	330	393	94	326
SDV:	346	49	291	336	90	285	241	47	191	290	115	245

Notes: [1] Hours per undergraduate. [4] NA – data not available.
[2] Hours per post-graduate.
[3] Hours per total students.

Table C.7. Student/staff ratios (by number, full-time staff equivalent) and graduate/staff ratios 1994-97.

UNIV	1994			1995			1996			1997		
	STU/ STF[1]	STU/ FTES[2]	GRA/ STF[3]	STU/ STF	STU/ FTES	GRA/ STF	STU/ STF	STU/ FTES	GRA/ STF	STU/ STF	STU/ FTES	GRA/ STF
UCT	19.1	23.3	5.0	19.9	24.7	4.9	20.9	25.8	5.0	21.3	25.1	4.9
DWV	25.8	30.0	5.0	25.0	29.9	6.0	22.9	33.5	5.2	23.7	32.7	5.2
OFS	17.2	23.2	4.3	17.0	27.9	3.8	17.7	29.7	3.8	19.5	28.3	4.0
UPE	23.4	33.9	5.4	23.7	35.6	5.7	22.4	31.3	4.8	32.1	39.3	5.1
PCH	22.6	32.7	5.2	22.9	33.7	4.9	22.2	31.9	4.8	23.4	33.9	5.3
PTA	18.9	33.1	4.2	20.4	33.0	4.3	19.5	34.1	4.2	18.8	35.2	4.2
RAU	53.4	60.2	12.5	68.9	77.8	17.6	68.6	74.4	17.0	73.1	72.4	16.8
RHU	13.2	15.8	3.8	17.4	15.7	5.0	16.4	17.6	4.4	16.2	17.7	3.9
STL	17.0	23.1	4.5	17.6	25.8	4.3	19.5	28.4	4.7	22.1	31.6	5.3
ZLD	23.5	34.9	3.3	29.7	42.9	4.5	27.9	39.1	2.9	25.9	37.1	2.5
AVE:	23.4	31.0	5.3	26.3	34.7	6.1	25.8	34.6	5.7	27.6	35.3	5.7
MED:	20.9	31.4	4.8	21.7	31.5	4.9	21.6	31.6	4.8	22.8	33.3	5.0
SDV:	10.6	11.4	2.5	14.7	15.9	3.9	14.6	14.3	3.8	15.7	13.7	3.8

Notes: [1] Students per staff member.
[2] Students per full-time equivalent staff member.
[3] Graduates per staff member.

Table C.8. Student/staff ratios (full-time equivalent) by course level 1994-97.

UNIV	1994		1995		1996		1997	
	UGRAD/ STAFF[1]	PGRAD/ STAFF[2]	UGRAD/ STAFF	PGRAD/ STAFF	UGRAD/ STAFF	PGRAD/ STAFF	UGRAD/ STAFF	PGRAD/ STAFF
UCT	21.7	28.1	22.9	30.1	23.7	32.4	23.0	31.9
DWV	31.1	25.0	31.4	24.0	37.4	22.0	36.5	21.3
OFS	23.6	22.1	28.8	25.8	30.3	28.2	27.4	31.1
UPE	35.0	30.0	37.5	29.4	33.8	23.1	42.9	24.9
PCH	37.6	25.6	38.6	26.3	37.6	23.0	38.4	26.5
PTA	34.6	30.0	34.4	29.7	36.3	29.1	37.5	30.1
RAU	89.2	32.5	123.3	36.2	131.4	31.8	136.3	25.7
RHU	16.0	15.3	16.1	14.5	18.7	14.5	18.4	15.2
STL	20.1	37.0	22.0	42.6	24.0	47.9	26.8	52.0
ZLD	38.1	21.6	47.5	23.8	43.0	21.0	42.9	15.5
AVE:	34.7	26.7	40.3	28.2	41.6	27.3	43.0	27.4
MED:	32.9	26.9	32.9	27.9	35.1	25.7	37.0	26.1
SDV:	19.6	5.9	29.0	7.2	30.8	8.6	32.1	9.9

Notes: [1] Undergraduate students per full-time equivalent staff member.
[2] Post-graduate students per full-time equivalent staff member.

Table C.9. Research produced in units per full-time equivalent research staff 1994-97.

UNIV	1994			1995			1996			1997		
	RES Unit[1]	STF FTE[2]	RES/ STF[3]	RES Unit	STF FTE	RES/ STF	RES Unit	STF FTE	RES/ STF	RES Unit	STF FTE	RES/ STF
UCT	793.9	470.8	1.69	702.3	502.6	1.40	711.0	463.0	1.54	623.9	474.4	1.32
DWV	126.2	70.9	1.78	126.7	73.6	1.72	132.4	91.3	1.45	126.0	79.7	1.58
OFS	321.9	159.1	2.02	298.2	142.3	2.10	290.1	152.8	1.90	264.9	151.0	1.75
UPE	90.7	67.4	1.35	82.4	70.9	1.16	101.6	63.5	1.60	104.9	55.6	1.89
PCH	191.3	144.0	1.33	171.4	143.3	1.20	183.3	144.0	1.27	159.3	143.5	1.11
PTA	706.3	335.6	2.10	749.9	343.5	2.18	742.6	330.1	2.25	770.7	339.1	2.27
RAU	306.1	94.3	3.25	316.4	86.9	3.64	333.7	88.2	3.78	330.9	93.3	3.55
RHU	157.1	97.0	1.62	174.6	85.9	2.03	182.1	85.1	2.14	183.2	84.8	2.16
STL	616.9	324.0	1.90	589.2	316.5	1.86	585.6	399.4	1.47	462.3	358.4	1.29
ZLD	48.8	47.4	1.03	45.1	46.7	0.97	50.6	50.9	0.99	59.0	52.6	1.12
AVE:			1.81			1.83			1.84			1.80
MED:			1.74			1.79			1.57			1.67
SDV:			0.58			0.73			0.74			0.70

Notes: [1] Research output produced in units.
[2] Full-time equivalent research staff (in numbers).
[3] Research units per full-time equivalent research staff.

APPENDIX D

FINANCIAL STATISTICS AND RATIOS

Source: South African Post-secondary Education (SAPSE) Information System

Department of National Education, Pretoria

and

South African Universities' Vice-Chancellors' Association (research output)

Table D.1. Annual recurrent expenditure and capital employed per student and graduate 1994-97 (Rand 000's).

UNIV	1994							
	EXPEND /STUD[1]	RANK	EXPEND /GRAD[1]	RANK	CAPEM /STUD[2]	RANK	CAPEM /GRAD[2]	RANK
UCT	30.9	9	117.7	8	60.8	10	231.4	10
DWV	15.2	2	78.1	3	30.4	4	156.2	3
OFS	25.0	7	101.3	7	40.1	5	162.1	4
UPE	17.1	3	74.8	2	43.3	6	189.3	6
PCH	19.3	5	83.4	4	30.0	3	129.8	2
PTA	22.3	6	100.9	6	43.9	7	198.4	8
RAU	9.6	1	40.8	1	27.4	2	116.8	1
RHU	27.4	8	95.8	5	49.8	8	174.5	5
STL	31.4	10	118.9	9	52.4	9	198.7	9
ZLD	18.0	4	130.1	10	26.4	1	191.1	7
AVE:	21.6		94.2		40.4		174.8	
MED:	20.8		98.3		41.7		181.9	
SDV:	6.7		24.8		11.2		32.7	

UNIV	1995							
	EXPEND /STUD	RANK	EXPEND /GRAD	RANK	CAPEM /STUD	RANK	CAPEM /GRAD	RANK
UCT	32.9	10	132.2	10	64.0	10	257.4	10
DWV	17.0	3	70.9	2	32.3	4	134.2	2
OFS	24.0	7	107.0	8	42.1	5	187.9	6
UPE	19.9	5	83.6	3	47.8	7	200.3	7
PCH	22.3	6	103.0	7	30.1	3	139.3	3
PTA	19.7	4	93.2	5	45.1	6	213.4	8
RAU	8.8	1	34.5	1	24.1	2	94.1	1
RHU	25.3	8	87.7	4	47.9	8	165.8	5
STL	27.6	9	112.6	9	60.0	9	244.2	9
ZLD	14.2	2	94.3	6	21.4	1	142.3	4
AVE:	21.2		91.9		41.5		177.9	
MED:	21.1		93.7		43.6		176.8	
SDV:	6.5		25.0		13.7		49.4	

Notes: [1] Total annual recurrent expenditure expressed per student and per graduate.
[2] Capital employed (tangible fixed assets, long-term investments and working capital) expressed per student and per graduate.

Table D.1. (continued) Annual recurrent expenditure and capital employed per student and graduate 1994-97 (Rand 000's).

UNIV	1996							
	EXPEND /STUD[1]	RANK	EXPEND /GRAD[1]	RANK	CAPEM /STUD[2]	RANK	CAPEM /GRAD[2]	RANK
UCT	36.0	10	151.0	9	73.8	10	309.1	10
DWV	22.1	3	97.7	2	36.4	4	160.5	3
OFS	28.4	8	131.6	7	48.4	5	224.6	6
UPE	23.9	5	112.2	5	54.9	8	257.7	9
PCH	25.5	6	123.6	6	29.9	3	139.3	2
PTA	23.0	4	105.3	4	51.4	7	235.6	7
RAU	9.8	1	39.6	1	28.5	2	114.7	1
RHU	26.7	7	99.5	3	51.0	6	190.0	4
STL	32.3	9	134.3	8	61.5	9	256.1	8
ZLD	15.8	2	153.1	10	22.1	1	213.9	5
AVE:	24.5		114.8		45.8		210.1	
MED:	25.2		117.9		49.7		219.2	
SDV:	7.2		31.3		15.4		56.6	

UNIV	1997							
	EXPEND /STUD	RANK	EXPEND /GRAD	RANK	CAPEM /STUD	RANK	CAPEM /GRAD	RANK
UCT	40.1	10	173.7	9	83.0	10	359.9	10
DWV	29.7	7	135.6	7	35.3	4	161.1	3
OFS	31.0	9	149.6	8	53.7	6	259.5	8
UPE	18.6	2	116.5	3	42.7	5	266.9	9
PCH	28.7	5	127.2	5	29.3	2	130.0	1
PTA	25.3	4	112.3	2	58.1	8	257.3	7
RAU	10.5	1	45.4	1	33.9	3	147.2	2
RHU	29.5	6	122.3	4	56.6	7	234.5	5
STL	30.7	8	127.8	6	59.8	9	248.9	6
ZLD	19.1	3	197.5	10	21.4	1	222.2	4
AVE:	26.3		130.8		47.4		228.8	
MED:	29.1		127.5		48.2		241.7	
SDV:	7.9		38.2		17.4		64.7	

Notes: [1] Total annual recurrent expenditure expressed per student and per graduate.
[2] Capital employed (tangible fixed assets, long-term investments and working capital) expressed per student and graduate.

Table D.2. Annual recurrent expenditure by SAPSE programme shown as a percentage of total expenditure 1994-97 (per cent).

UNIV	1994			1995		
	ACADEM[1]	INSSUP[2]	OPS/MAIN/ OTHSERV[3]	ACADEM	INSSUP	OPS/MAIN/ OTHSERV
	%	%	%	%	%	%
UCT	66.9	12.7	20.4	65.8	12.9	21.3
DWV	63.3	22.7	14.0	63.2	22.4	14.4
OFS	58.4	25.5	16.1	65.8	17.1	17.1
UPE	64.1	14.5	21.4	57.5	19.9	22.6
PCH	55.0	16.0	29.0	52.1	15.6	32.3
PTA	54.5	26.9	18.6	66.2	11.0	22.8
RAU	67.7	11.8	20.5	66.5	13.7	19.8
RHU	53.2	15.4	31.4	56.2	15.5	28.3
STL	51.3	32.8	15.9	61.9	18.1	20.0
ZLD	56.9	21.8	21.3	49.4	26.0	24.6
AVE:	59.1	20.0	20.9	60.5	17.2	22.3
MED:	57.7	18.9	20.5	62.6	16.4	22.0
SDV:	5.6	6.6	5.3	6.0	4.3	4.9

UNIV	1996			1997		
	ACADEM	INSSUP	OPS/MAIN/ OTHSERV	ACADEM	INSSUP	OPS/MAIN/ OTHSERV
	%	%	%	%	%	%
UCT	66.1	14.2	19.7	65.8	13.5	20.7
DWV	64.1	23.4	12.5	62.0	23.7	14.3
OFS	64.2	18.3	17.5	66.1	17.8	16.1
UPE	58.6	20.9	20.5	62.0	17.9	20.1
PCH	51.0	15.0	34.0	53.9	15.5	30.6
PTA	67.1	10.8	22.1	64.8	12.4	22.8
RAU	66.9	14.6	18.5	64.1	16.7	19.2
RHU	55.5	17.2	27.3	56.2	16.7	27.1
STL	58.3	22.3	19.4	60.2	18.5	21.3
ZLD	45.7	28.4	25.9	47.2	26.1	26.7
AVE:	59.8	18.5	21.7	60.2	17.9	21.9
MED:	61.4	17.8	20.1	62.0	17.3	21.0
SDV:	6.9	5.0	5.7	5.8	4.0	4.8

Notes: [1] Expenditure on SAPSE programmes (instruction, research, academic support, student services, and bursaries) and here collectively referred to as academic expenditure.

[2] Institutional support expenditure (executive management, financial administration, financial aid, general administration, student records, administrative computer services, public relations and staff social/cultural development).

[3] Operation and maintenance expenditure (plant, buildings, custodial services, utilities and ground maintenance, staff housing service).

Table D.3. Annual recurrent expenditure according to individual SAPSE programmes 1994-97 (per cent).

UNIV	1994							
	INSTR[1] %	RESEAR[2] %	ACDSUP[3] %	STUSER[4] %	BURSA[5] %	INSSUP[6] %	OPS/MN[7] %	OTHSER[8] %
UCT	18.0	20.4	20.7	1.7	6.1	12.7	9.8	10.6
DWV	22.7	7.5	20.3	1.9	10.9	22.7	8.1	5.9
OFS	18.4	11.8	23.5	2.3	2.4	25.5	7.1	9.0
UPE	27.3	11.0	15.8	5.7	4.3	14.5	11.3	10.1
PCH	23.1	12.7	13.0	2.6	3.6	16.0	7.2	21.8
PTA	20.0	11.6	17.5	1.5	3.9	26.9	7.5	11.1
RAU	26.0	12.0	18.2	4.3	7.2	11.8	9.8	10.7
RHU	22.2	10.8	13.1	2.2	4.9	15.4	8.8	22.6
STL	19.2	10.8	17.1	1.6	2.6	32.8	7.9	8.0
ZLD	21.0	6.5	10.5	1.8	17.1	21.8	11.2	10.1
AVE:	21.8	11.5	17.0	2.6	6.3	20.0	8.9	12.0
MED:	21.6	11.3	17.3	2.1	4.6	18.9	8.5	10.3
SDV:	3.0	3.5	3.8	1.3	4.3	6.6	1.5	5.4

UNIV	1995							
	INSTR %	RESEAR %	ACDSUP %	STUSER %	BURSA %	INSSUP %	OPS/MN %	OTHSER %
UCT	17.5	19.5	20.2	1.6	7.0	12.9	9.9	11.4
DWV	24.8	8.7	22.8	2.3	4.6	22.4	8.8	5.6
OFS	19.7	11.6	29.1	2.3	3.1	17.1	7.3	9.8
UPE	23.6	11.0	14.4	4.2	4.3	19.9	12.1	10.5
PCH	21.0	12.3	11.9	3.5	3.4	15.6	9.8	22.5
PTA	23.5	13.6	22.5	1.8	4.8	11.0	8.7	14.1
RAU	27.2	10.3	18.6	3.6	6.8	13.7	12.8	7.0
RHU	23.0	11.3	14.0	2.4	5.5	15.5	9.7	18.6
STL	23.5	13.4	19.5	1.9	3.6	18.1	9.6	10.4
ZLD	23.7	7.3	12.1	2.1	4.2	26.0	12.7	11.9
AVE:	22.8	11.9	18.5	2.6	4.7	17.2	10.1	12.2
MED:	23.5	11.5	19.1	2.3	4.5	16.4	9.8	11.0
SDV:	2.6	3.1	5.2	0.8	1.3	4.3	1.7	4.8

Notes: [1] Instruction – professional teaching and allied service (including community/preparatory instruction).
[2] Research –professional activities to produce research outcomes (creation, reorganisation and application of knowledge).
[3] Academic support (library and educational media services, academic computing, academic administration, academic personnel development, curriculum development, ancillary support).
[4] Student services (administration, social/cultural development, career guidance and health service).
[5] Bursaries (all financial assistance provided for students).
[6] Institutional support (executive management, financial/general administration, financial aid, student records, administrative computer services, public relations and staff social/cultural development).
[7] Operation and maintenance (plant, buildings, custodial services, utilities and grounds).
[8] Other services (staff housing/food service).

Table D.3. (continued) Annual recurrent expenditure according to individual SAPSE programmes 1994-97 (per cent).

UNIV	1996							
	INSTR[1] %	RESEAR[2] %	ACDSUP[3] %	STUSER[4] %	BURSA[5] %	INSSUP[6] %	OPS/MN[7] %	OTHSER[8] %
UCT	16.9	19.6	19.7	1.6	8.3	14.2	9.6	10.1
DWV	19.0	8.4	22.3	1.9	12.5	23.4	7.8	4.7
OFS	19.1	11.2	28.0	2.1	3.8	18.3	6.9	10.6
UPE	24.0	8.6	15.2	5.4	5.4	20.9	11.4	9.1
PCH	22.9	10.6	11.7	2.3	3.5	15.0	11.7	22.3
PTA	22.1	12.4	25.7	1.9	5.0	10.8	8.7	13.4
RAU	27.6	10.3	19.7	3.6	5.7	14.6	11.8	6.7
RHU	23.1	11.0	14.1	2.5	4.8	17.2	9.6	17.7
STL	20.9	14.2	18.1	1.8	3.3	22.3	8.8	10.6
ZLD	24.3	7.8	11.5	2.1	0.0	28.4	14.1	11.8
AVE:	22.0	11.4	18.6	2.5	5.2	18.5	10.0	11.7
MED:	22.5	10.8	18.9	2.2	4.9	17.8	9.6	10.6
SDV:	3.0	3.3	5.3	1.1	3.2	5.0	2.1	4.9

UNIV	1997							
	INSTR %	RESEAR %	ACDSUP %	STUSER %	BURSA %	INSSUP %	OPS/MN %	OTHSER %
UCT	16.8	19.3	20.6	1.6	7.5	13.5	9.6	11.1
DWV	16.8	6.0	24.0	2.1	13.1	23.7	9.0	5.3
OFS	20.7	11.4	27.4	2.2	4.4	17.8	6.2	9.9
UPE	25.5	8.9	16.4	5.6	5.6	17.9	10.5	9.6
PCH	24.8	10.9	12.2	2.2	3.8	15.5	8.3	22.3
PTA	21.5	13.2	22.3	1.9	5.9	12.4	8.6	14.2
RAU	22.7	10.5	21.1	4.0	5.8	16.7	13.6	5.6
RHU	24.3	11.6	13.4	2.5	4.4	16.7	9.7	17.4
STL	20.1	15.0	19.0	2.2	3.9	18.5	9.0	12.3
ZLD	24.6	7.6	12.3	2.3	0.4	26.1	15.5	11.2
AVE:	21.8	11.4	18.9	2.7	5.5	17.9	10.0	11.9
MED:	22.1	11.2	19.8	2.2	5.1	17.3	9.3	11.2
SDV:	3.0	3.6	4.9	1.2	3.1	4.0	2.5	4.9

Notes: [1] Instruction.
[2] Research.
[3] Academic support.
[4] Student services.
[5] Bursaries.
[6] Institutional support.
[7] Operation and maintenance.
[8] Other services.

Table D.4. Expenditure on personnel compensation shown as a percentage of total annual recurrent expenditure 1994-97.

UNIV	1994		1995		1996		1997	
	PERSN[1]	OTHER[2]	PERSN	OTHER	PERSN	OTHER	PERSN	OTHER
UCT	61.8	38.2	60.2	39.8	58.2	41.8	58.6	41.4
DWV	64.6	35.4	69.8	30.2	65.6	34.4	70.2	29.8
OFS	76.1	23.9	72.2	27.8	71.7	28.3	71.9	28.1
UPE	67.0	33.0	62.2	37.8	61.1	38.9	63.7	36.3
PCH	57.8	42.2	51.9	48.1	55.4	44.6	56.8	43.2
PTA	72.5	27.5	66.3	33.7	68.6	31.4	65.6	34.4
RAU	60.6	39.4	59.2	40.8	60.0	40.0	60.4	39.6
RHU	63.6	36.4	61.7	38.3	63.3	36.7	63.5	36.5
STL	78.8[3]	21.2	62.4	37.6	65.4	34.6	64.1	35.9
ZLD	59.2	40.8	67.5	32.5	70.3	29.7	71.5	28.5
AVE:	66.0	34.0	63.0	37.0	64.0	36.0	65.0	35.0
MED:	64.0	36.0	62.0	38.0	64.0	36.0	64.0	36.0
SDV:	7.0	7.0	6.0	6.0	5.0	5.0	5.0	5.0

Notes: [1] Personnel compensation (all categories of staff).
[2] Other expenditure (supplies/services, building/equipment rentals, bursaries, items for resale).
[3] Includes an exceptional medical aid fund payment amounting to 32.0 per cent of total expenditure.

Table D.5. Annual expenditure on personnel compensation by major personnel category shown as a percentage of total personnel expenditure 1994-97.

UNIV	1994				1995			
	INSTR/ RESCH[1]	EXEC/ ADMIN[2]	SPEC SUPT[3]	TECH/ SERV[4]	INSTR/ RESCH	EXEC/ ADMIN	SPEC SUPT	TECH/ SERV
UCT	48.7	20.5	4.8	26.0	50.2	20.6	4.7	24.5
DWV	47.4	23.1	8.9	20.6	47.0	23.3	9.0	20.7
OFS	42.1	19.0	7.6	31.3	47.9	22.3	9.2	20.6
UPE	54.0	17.5	8.7	19.8	52.9	18.9	8.6	19.6
PCH	55.1	20.0	7.4	17.5	54.2	19.8	8.2	17.8
PTA	65.7	15.6	4.9	13.8	55.8	20.1	6.4	17.7
RAU	55.2	27.7	3.9	13.2	51.8	32.0	4.0	12.2
RHU	55.8	19.6	3.8	20.8	53.6	20.1	4.0	22.3
STL	51.7	21.5	4.4	22.4	52.4	22.5	4.0	21.1
ZLD	46.6	26.6	3.8	23.0	45.4	25.6	3.6	25.4
AVE:	52.2	21.1	5.8	20.8	51.1	22.5	6.2	20.2
MED:	52.9	20.3	4.9	20.7	52.1	21.5	5.6	20.7
SDV:	6.2	3.6	2.0	5.1	3.2	3.7	2.2	3.6

Notes: [1] Instruction/research professional.
[2] Executive/managerial/administrative professional and administrative non-professional.
[3] Specialist support professional (academic, student and institutional support).
[4] Technical/service – non-professional (technical, administrative, trades and services).

Table D.5. (continued) Annual expenditure on personnel compensation by major personnel category shown as a percentage of total personnel expenditure 1994-97.

UNIV	1996				1997			
	INSTR/ RESCH[1]	EXEC/ ADMIN[2]	SPEC SUPT[3]	TECH/ SERV[4]	INSTR/ RESCH	EXEC/ ADMIN	SPEC SUPT	TECH/ SERV
UCT	49.2	21.3	5.4	24.1	48.9	22.2	5.6	23.3
DWV	46.1	25.4	8.2	20.3	33.8	27.0	9.3	29.9
OFS	46.3	23.4	8.5	21.8	48.1	24.0	7.9	20.0
UPE	51.5	21.6	9.0	17.9	51.8	21.6	9.2	17.4
PCH	52.4	20.5	9.4	17.7	54.4	20.2	8.9	16.5
PTA	57.7	14.9	6.6	20.8	55.3	20.9	6.3	17.5
RAU	50.4	34.3	3.6	11.7	48.6	36.6	3.5	11.3
RHU	53.0	21.2	4.3	21.5	53.6	20.7	4.5	21.2
STL	44.6	20.2	3.2	32.0	45.0	21.7	3.2	30.1
ZLD	45.4	23.9	3.5	27.2	45.3	22.1	3.6	29.0
AVE:	49.7	22.7	6.2	21.5	48.5	23.7	6.2	21.6
MED:	49.8	21.5	6.0	21.2	48.8	21.9	6.0	20.6
SDV:	3.9	4.7	2.3	5.2	6.0	4.7	2.3	6.1

Notes: [1] Instruction/research professional.
[2] Executive/managerial/administrative professional and administrative non-professional.
[3] Specialist support professional (academic, student and institutional support).
[4] Technical/service – non-professional (technical, administrative, trades and services).

Table D.6. Research expenditure incurred per unit of research output produced 1994-96 (Rand 000's per unit).

UNIV	1994			1995			1996		
	REXP Rm[1]	ROUT UNIT[2]	REXP /UNIT[3]	REXP Rm	ROUT UNIT	REXP /UNIT	REXP Rm	ROUT UNIT	REXP /UNIT
UCT	90.0	793.9	113.3	95.5	702.3	135.9	108.0	711.0	151.9
DWV	12.1	126.2	95.9	15.5	126.7	122.6	18.5	132.4	140.1
OFS	27.0	321.9	84.0	27.5	298.2	92.2	32.1	290.1	110.6
UPE	10.6	90.7	116.8	12.5	82.4	151.8	11.29	101.6	111.1
PCH	24.5	191.3	127.9	28.6	171.4	166.9	29.3	183.3	160.1
PTA	62.8	706.3	88.9	69.7	749.9	93.0	73.9	742.6	99.5
RAU	17.6	306.1	57.6	18.5	316.4	58.4	21.6	333.7	64.8
RHU	12.1	157.1	77.0	13.4	174.6	76.7	14.4	182.1	79.2
STL	48.3	616.9	78.2	54.5	589.2	92.4	70.0	585.6	119.5
ZLD	7.2	48.8	147.4	8.3	45.1	184.4	9.8	50.6	192.9
AVE:			98.7			117.4			123.0
MED:			92.4			107.8			115.3
SDV:			25.8			39.3			36.8

Notes: [1] Research expenditure (Rand million).
[2] Research output (units).
[3] Research expenditure per unit of research output (Rand 000's per unit).

Table D.7. Research expenditure incurred per unit of research output[1] produced (showing detail), 1997 (Rand 000's per unit).

UNIV	1997						
	RESEXP Rm[2]	PATENT Units	JOURNAL Units	BOOKS Units	CONFER Units	RESOUT UNITS[3]	RESEXP /UNIT[4]
UCT	119.0	-	549.2	57.6	17.1	623.9	190.7
DWV	17.5	-	107.0	14.9	4.1	126.0	138.9
OFS	37.0	-	256.4	5.2	3.3	264.9	139.6
UPE	12.5	-	93.7	5.6	5.6	104.9	119.0
PCH	34.7	-	154.4	3.8	1.1	159.3	217.9
PTA	87.0	6.5	744.9	4.4	14.9	770.7	112.9
RAU	24.1	-	299.2	19.6	12.1	330.9	72.9
RHU	16.9	-	180.4	2.4	0.4	183.2	92.2
STL	72.1	3.0	419.4	26.3	13.6	462.3	155.9
ZLD	10.9	-	59.0	-	-	59.0	184.8
AVE:							142.5
MED:							139.2
SDV:							43.4

Notes: [1] Categories of research output include patents, articles in approved journals, book publications and conference proceedings (expressed in units).
[2] Research expenditure (Rand million).
[3] Research output (units)
[4] Research expenditure per unit of research output (Rand 000's per unit).

Table D.8. Investment in fixed assets[1] by major SAPSE programme category shown as a percentage of total investment 1994-97.

UNIV	1994			1995		
	EDUC/ GEN[2]	AUXIL ENTER[3]	OTHER[4]	EDUC/ GEN	AUXIL ENTER	OTHER
UCT	59.0	8.6	32.4	58.1	8.8	33.1
DWV	82.6	11.2	6.2	79.3	10.7	10.0
OFS	79.2	6.4	14.4	82.5	5.8	11.7
UPE	85.9	5.6	8.5	86.9	5.5	7.6
PCH	70.4	19.9	9.7	70.4	19.6	10.0
PTA	79.2	4.6	16.2	78.6	4.9	16.5
RAU	86.7	13.3	0.0	88.5	11.5	0.0
RHU	65.3	20.8	13.9	65.9	19.4	14.7
STL	72.7	10.4	16.9	72.2	11.3	16.5
ZLD	67.4	26.9	5.7	68.6	26.1	5.3
AVE:	74.8	12.8	12.4	75.1	12.4	12.5
MED:	76.0	10.8	11.8	75.4	11.0	10.9
SDV:	8.8	7.1	8.4	9.2	6.7	8.4

UNIV	1996			1997		
	EDUC/ GEN	AUXIL ENTER	OTHER	EDUC/ GEN	AUXIL ENTER	OTHER
UCT	59.1	8.0	32.9	61.8	7.2	31.0
DWV	78.9	10.5	10.6	78.8	10.1	11.1
OFS	78.0	5.3	16.7	77.4	4.6	18.0
UPE	76.5	4.8	18.7	80.5	4.7	14.8
PCH	70.2	18.3	11.5	72.0	16.8	11.2
PTA	78.0	6.8	15.2	78.2	7.4	14.4
RAU	89.5	10.5	0.0	86.5	13.5	0.0
RHU	66.0	18.3	15.7	67.0	17.1	15.9
STL	68.1	10.9	21.0	66.7	12.5	19.8
ZLD	69.0	25.3	5.7	69.9	24.5	5.6
AVE:	73.3	11.9	14.8	73.9	11.8	14.3
MED:	73.4	10.5	15.5	74.7	11.3	14.6
SDV:	8.1	6.3	8.5	7.2	6.0	8.0

Notes: [1] Fixed assets are shown in historical cost terms and no provision is made for depreciation. They include immovable assets (land, buildings and land improvements other than buildings); movable assets (equipment, library collections, museum and art collections); construction in progress (which may include immovable and movable assets).

[2] Educational and general (fixed asset investment in the programmes of: instruction, research, public service, academic support, student services, institutional support, operations and maintenance of plant, bursaries).

[3] Auxiliary enterprises (student/staff accommodation and food services, operations and maintenance of plant for auxiliary enterprises and, other special services e.g. bookshops, banks).

[4] Other (hospitals – teaching or health science centre; independent operations – unrelated to the primary programmes of instruction, research and public service).

Table D.9. The division of educational and general fixed asset investment by main categories 1994-97 (per cent).

UNIV	1994				1995			
	EDUC L/B[1]	EDUC EQUIP[2]	LIBRY[3]	EDUC OTHER[4]	EDUC L/B	EDUC EQUIP	LIBRY	EDUC OTHER
UCT	40.4	37.4	22.0	0.2	37.1	39.2	23.7	0.0
DWV	75.3	15.8	8.9	0.0	76.9	13.3	9.8	0.0
OFS	33.3	37.3	21.3	8.1	29.8	40.9	20.9	8.4
UPE	49.3	25.9	15.3	9.5	54.8	27.0	16.1	2.1
PCH	58.0	18.9	23.0	0.1	53.3	21.6	24.7	0.4
PTA	26.6	43.0	13.7	16.7	26.6	43.7	14.4	15.3
RAU	52.3	26.3	20.3	1.1	44.3	26.8	18.6	10.3
RHU	39.6	37.0	23.1	0.3	38.4	37.0	23.6	1.0
STL	54.5	31.6	13.4	0.5	55.7	30.1	13.7	0.5
ZLD	57.9	17.9	24.1	0.1	57.9	17.1	25.0	0.0
AVE:	48.7	29.1	18.5	3.7	47.5	29.7	19.1	3.8
MED:	50.8	29.0	20.8	0.4	48.8	28.6	19.8	0.7
SDV:	13.4	9.1	5.0	5.5	14.4	9.9	5.1	5.2

UNIV	1996				1997			
	EDUC L/B	EDUC EQUIP	LIBRY	EDUC OTHER	EDUC L/B	EDUC EQUIP	LIBRY	EDUC OTHER
UCT	33.1	42.0	24.6	0.3	35.8	40.2	24.0	0.0
DWV	74.4	14.9	10.6	0.1	71.8	16.6	11.6	0.0
OFS	33.3	42.6	21.5	2.6	30.4	41.1	21.6	6.9
UPE	57.4	17.6	18.6	6.4	48.0	19.6	17.5	14.9
PCH	50.5	23.0	26.2	0.3	46.2	24.3	27.6	1.9
PTA	25.9	42.9	15.5	15.7	31.9	43.5	16.8	7.8
RAU	40.1	29.0	19.4	11.5	40.2	30.9	20.2	8.7
RHU	36.1	37.9	25.1	0.9	33.7	37.5	25.9	2.9
STL	55.0	29.3	15.4	0.3	55.7	27.4	16.4	0.5
ZLD	55.8	18.4	25.7	0.1	53.1	20.3	26.5	0.1
AVE:	46.2	29.8	20.3	3.8	44.7	30.1	20.8	4.4
MED:	45.3	29.2	20.5	0.6	43.2	29.2	20.9	2.4
SDV:	14.1	10.5	5.0	5.3	12.4	9.4	5.0	4.8

Notes: [1] Educational investment in land/buildings and land improvements other than buildings (covering the educational and general SAPSE programmes – see note [2] in Table D.8).
[2] Educational equipment (all categories of movable property).
[3] Library collections (various items of movable educational material).
[4] Other (construction in progress, museum and art collections).

Table D.10. Annual recurrent expenditure per graduate in constant money terms[1] 1994-97 (Rand 000's).

UNIV	1994	1995	1996	1997
UCT	150.3	157.3	166.2	173.7
DWV	99.7	84.4	107.6	135.6
OFS	129.4	127.4	144.9	149.6
UPE	95.5	99.6	123.5	116.5
PCH	106.5	122.6	136.1	127.2
PTA	128.8	110.9	115.9	112.3
RAU	52.1	41.1	43.6	45.4
RHU	122.3	104.4	109.6	122.3
STL	151.8	134.0	147.9	127.8
ZLD	166.2	112.2	168.6	197.5
AVE:	120.3	109.4	126.4	130.8
MED:	125.6	111.6	129.8	127.5
SDV:	31.7	29.7	34.5	38.2

Note: [1] All expenditure restated in 1997 constant money terms. Current expenditure for the years 1994-96 are adjusted by a 'composite index of inflation' comprising: 65 per cent of the Public Authorities' wage/salary index plus 35 per cent of the consumer price index. This split reflects the high proportion of personnel expenditure.

APPENDIX E

FIRST EMPLOYMENT EXPERIENCES OF GRADUATES

AND

THE PUBLIC ACCOUNTANTS' AND AUDITORS' BOARD QUALIFYING EXAMINATION RESULTS

Table E.1. Immediate first employment experiences of graduates by major field of study (per cent).

UNIV 1997	IMMEDIATE EMPLOYMENT			DELAYED EMPLOYMENT		
	HUMANITIES[1]	SCIENCES[2]	ALL GRAD[3]	HUMANITIES	SCIENCES	ALL GRAD
UCT	57	43	**56**	30	70	**44**
DWV	59	41	**46**	24	76	**54**
OFS	47	53	**64**	25	75	**36**
UPE	33	67	**60**	25	75	**40**
PCH	43	57	**54**	22	78	**46**
PTA	50	50	**70**	37	63	**30**
RAU	18	82	**67**	91	9	**33**
RHU	13	87	**61**	8	92	**39**
STL	43	57	**65**	34	66	**35**
ZLD[4]	-	-	-	-	-	-
ALL UNIV:	44	56	**62**	26	74	**38**

Notes: [1] Includes Humanities, Arts, Economics and Management Sciences, Education and Law.
[2] Includes Engineering, Agriculture, Health and Natural Sciences.
[3] Percentages shown for Humanities and Sciences in the categories 'Immediate and Delayed Employment' are the proportions of the ALL GRAD (all graduate) percentages.
[4] Insufficient number of respondents for results to be statistically significant.
Source: First Employment Experiences of Graduates, HSRC 1999.

Table E.2. Periods of unemployment before securing a position (per cent).

UNIV 1997	PERIODS OF UNEMPLOYMENT[1]			
	0 – 3 MONTHS	4 – 6 MONTHS	7 – 12 MONTHS	OVER 1 YEAR
UCT	32	26	15	27
DWV	19	33	37	11
OFS	34	46	14	6
UPE	44	22	22	12
PCH	28	34	24	14
PTA	29	37	29	5
RAU	42	27	19	12
RHU	33	42	9	16
STL	40	30	16	14
ZLD[2]	-	-	-	-
ALL UNIV:	33	34	21	12

Notes: [1] For those graduates who did not secure immediate employment.
[2] Insufficient number of respondents for results to be statistically significant.
Source: First Employment Experiences of Graduates, HSRC 1999.

Table E.3. The extent to which a degree assisted in securing employment (per cent).

UNIV	EXTENT OF ASSISTANCE			
1997	NOT AT ALL	SMALL EXTENT	SOME EXTENT	GREAT EXTENT
UCT	3	10	22	65
DWV	12	5	16	67
OFS	14	9	27	50
UPE	8	5	21	66
PCH	7	12	22	59
PTA	7	8	26	59
RAU	11	16	21	52
RHU	3	6	30	61
STL	8	10	27	55
ZLD[1]	-	-	-	-
ALL UNIV:	8	10	24	58

Notes: [1] Insufficient number of respondents for results to be statistically significant.
Source: First Employment Experiences of Graduates, HSRC 1999.

Table E.4. The Public Accountants' and Auditors' Board's qualifying examination results for 1997 (per cent).

UNIV	PART 1[1]		PART 2[2]		OVERALL[3]
1997	PASS	FAIL	PASS	FAIL	PASS
UCT	86.7	13.3	82.5	17.5	84
DWV	47.8	52.2	21.7	78.3	38
OFS	54.6	45.4	24.2	75.8	45
UPE	56.3	43.7	50.0	50.0	53
PCH	53.8	46.2	64.7	35.3	60
PTA	83.9	16.1	48.6	51.4	69
RAU	80.9	19.1	57.7	42.3	70
RHU	47.8	52.2	38.0	62.0	43
STL	79.4	20.6	51.3	48.7	67
ZLD[4]	-	-	-	-	-
TOTAL[5]:	64.8	35.2	51.0	49.0	55[6]

Notes: [1] Accounting examination.
[2] Auditing examination.
[3] Average pass rate for part 1 and part 2.
[4] No candidates from the university of Zululand.
[5] Total pass rate for all 14 universities offering candidates.
[6] An estimated pass rate for candidates successfully completing both parts.
Source: Public Accountants' and Auditors' Board.

APPENDIX F

CORRELATION COEFFICIENTS FOR INPUT AND OUTPUT VARIABLES

AND

GRAPHS AND DIAGRAMS

Table F.1. The relationships between selected input and output variables using correlation coefficients, 1997.

VARIABLE:	STUDENT NUMBERS	STAFF NUMBERS	FTE STAFF NUMBERS	FIXED ASSET INVESTMENT	EDUCATIONAL FIXED ASSET INVESTMENT[1]	ADJUSTED EXPENDITURE[2] PER STUDENT	GRADUATE NUMBERS	DEGREE CREDITS
DENOTED BY:	B	C	D	E	F	G	I	J

VARIABLE:	NON-FAIL RATE[3]	RESEARCH UNITS	CAPITAL EMPLOYED	FTE RES STAFF[4] NUMBERS	TOT EXPEND-ITURE[5] PER STUDENT	TOTAL EXPEND-ITURE[5]	ADJUSTED EXPEND-ITURE[2]	RESEARCH ADJUSTED EXPEND[6]	INSTRUCTION ADJUSTED EXPEND[7]
DENOTED BY:	K	L	M	N	O	Q	R	S	T

Notes: [1] Educational and general SAPSE programmes. [2] Total annual recurrent expenditure less expenditure not directly attributable to instruction/research.
[3] Percentage of students not exiting the university. [4] Full-time equivalent research staff. [5] Total annual recurrent expenditure covering all SAPSE programmes.
[6] Adjusted recurrent annual expenditure less annual instruction programme expenditure. [7] Adjusted recurrent annual expenditure less research programme expenditure.

CORRELATION COEFFICIENT MEASURES								
r =	B:C 0.7284	B:D 0.7406	B:E 0.7171	B:F 0.7940	B:G - 0.1688	B:I 0.9824	B:J 0.9273	B:L 0.8181
r =	B:M 0.8437	B:Q 0.7042	B:R 0.7152	B:T 0.7433	C:I 0.7237	C:J 0.8929	C:L 0.8874	D:I 0.7676
r =	D:J 0.9016	D:L 0.9702	D:M 0.9540	D:R 0.9717	D:S 0.9640	D:T 0.9572	E:F 0.9771	E:G 0.4913
r =	E:I 0.7395	E:J 0.8872	E:L 0.9563	E:M 0.9554	E:O 0.4925	E:Q 0.9767	E:R 0.9762	F:I 0.8050
r =	F:L 0.9471	F:J 0.9414	F:R 0.9528	G:I - 0.0778	G:J 0.1351	G:K 0.1211	G:L 0.3245	G:M 0.2919
r =	I:J 0.9437	I:K 0.0071	I:L 0.8391	J:K 0.1021	J:L 0.9100	J:M 0.9184	J:O 0.1557	K:L 0.0260
r =	L:M 0.9924	L:N 0.8824	M:I 0.8565	M:Q 0.9253	M:R 0.9320	M:S 0.9293	O:I - 0.0628	O:L 0.3361
r =	Q:I 0.7325	Q:J 0.8809	Q:L 0.9255	Q:R 0.9974	R:I 0.7417	R:J 0.8806	R:L 0.9283	S:L 0.9250
r =	S:R 0.9959	T:I 0.7622	T:J 0.9021	T:M 0.9162	T:R 0.9927			

Figure F.1. The relationship between student numbers and fixed asset investment , 1997.

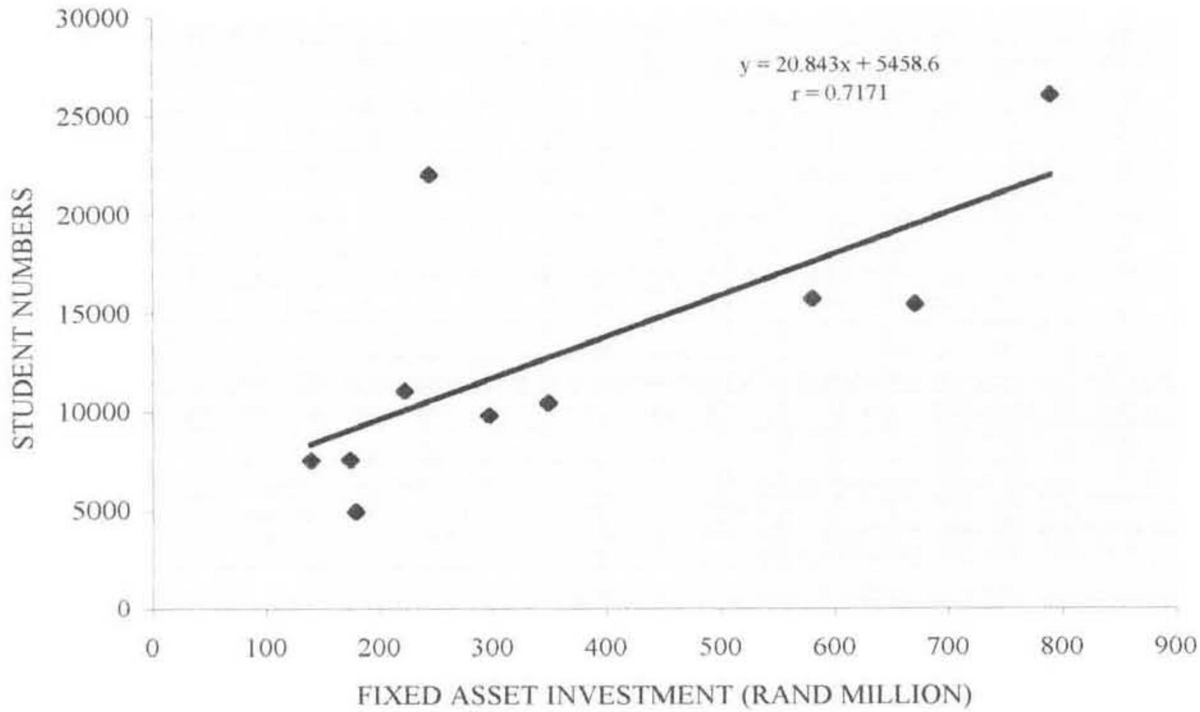


Figure F.2. The relationship between student numbers and educational fixed asset investment, 1997.

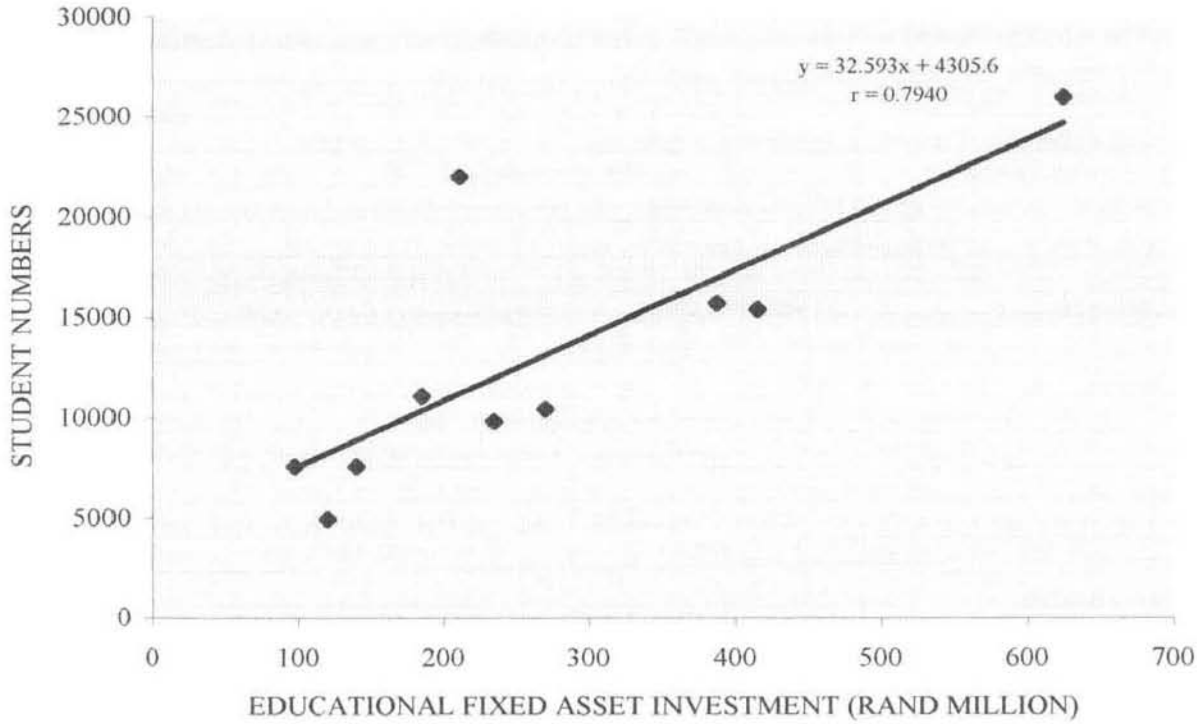


Figure F.3. The relationship between student numbers and total recurrent annual expenditure, 1997.

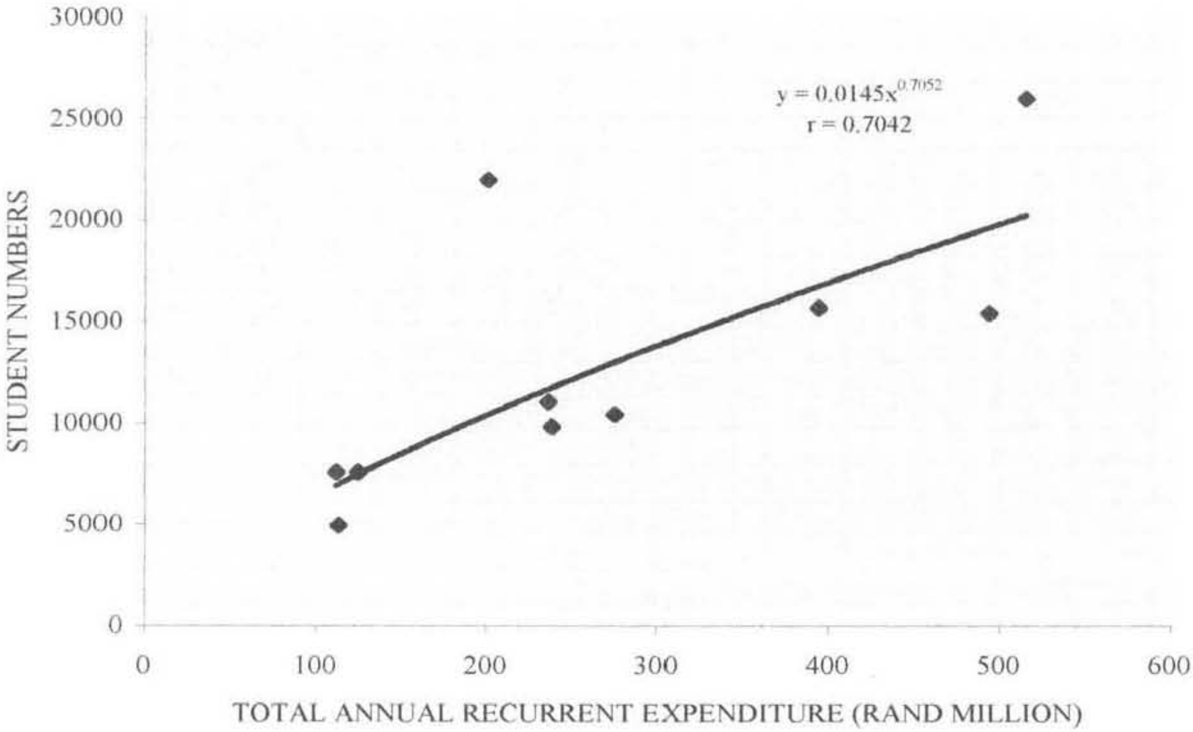
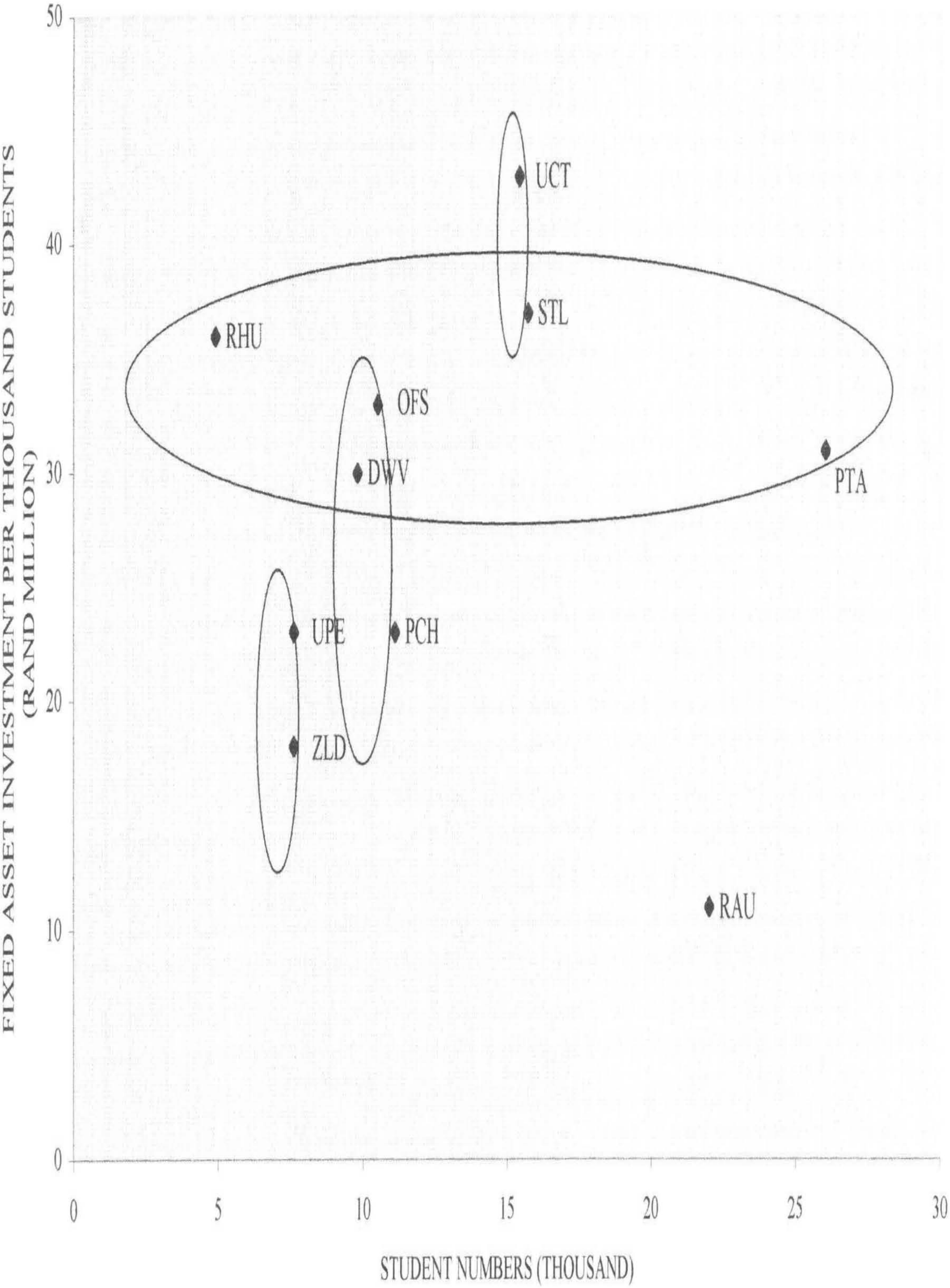


Figure F.4. Plot of fixed asset investment per thousand students against total student numbers, 1997.



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