HUMAN CAPITAL AND THE SOUTH AFRICAN KNOWLEDGEBASE

NATIONAL ADVISORY COUNCIL ON INNOVATION (NACI)
SOUTH AFRICA

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CONTENTS

EXECUTIVE SUMMARY AND RECOMMENDATIONS

1 Total annual production of **scientific articles** in most fields has stabilized with little to no significant growth. Annual average increase in production is slightly less than 1%. The most disturbing declines have been recorded for the agricultural sciences, the field of law and other humanities and arts and – to a lesser extent – the health sciences. On a more positive note, article production in the engineering sciences and applied technologies has increased.

2 **Regenerating** the national researcher work force has been recognized as a high priority. Our analysis of the three key "regeneration indicators" – gender, race and age – reveals that the challenge remains huge. **Female representation** in article authorship has improved across the vast majority of scientific fields and especially in the life and agricultural sciences and engineering. **Black representation** in scientific authorship has also improved across most fields of sciences with significant proportions in the social sciences and especially Education. The **aging** of the publishing workforce continues to be a major concern with more than half of article production in 8 out of the 20 scientific fields now being produced by authors over the age of 50.

3 Total annual production of **scientific books and reports** has been declining steadily since the mid- to late nineties. This decline in book production might be due to capacity constraints (ageing of productive scientists, outmigration of senior academics), but could also reflect structural constraints in the scientific publishing industry in South Africa. The dominance of publishing houses directly and indirectly funded by the state (science councils and university publishing house) suggests that the market of scientific books in South Africa is not hugely attractive or particularly lucrative for commercial publishing houses. Our analysis shows that only 7 major commercial house publish scientific books on a regular and substantive basis.

4 Total annual production of **doctoral dissertations** has been growing steadily but slowly (at an average annual rate of 3.9%). Our system produces about 0.05 doctorates per 1000 of the population (more specifically the 25 – 34 age group). This compares very unfavourably with the EU average of 0.42 per 1000. From the perspective of regenerating the future scientific workforce, the gender and race indicators as far as doctoral production are concerned, are much more positive. In most fields, female and black proportions of doctoral graduates have increased significantly over the past 15 years.

5 South African science is **strong** – measured as weighted article output - in those fields associated with our biodiversity, as well as the health and social sciences. However, strength (capacity of production) does not automatically translate into international visibility as none of the health sciences faculties recorded significant scores on any of the citation measures used in our analysis.

6 **International scientific collaboration**, as measured in terms of co-authorship of scientific articles, has increased in most fields of science. More than threefold increments in the proportion of foreign co-authorship have been recorded for research in agriculture, biological sciences, chemical sciences, earth sciences and all the health sciences. Although not to the same extent, substantive increases in foreign collaboration have also occurred for the social sciences (psychology, sociology).

7 The **visibility and impact** of South African science for 36 strategic fields when compared to 10 benchmarking countries is confined to a small number of fields: mostly in health sciences (oncology, obstetrics and gynecology, infectious diseases and virology), life sciences (microbiology, genetics and heredity), veterinary science and also in the field of food sciences and technology.

8 South Africa has **strong and international visible institutions** in a number of scientific fields. In the health sciences research conducted by UCT, Wits and UKZN is of high international standing. Similarly in the field of Materials Science, Stellenbosch University compares very favourably with similar institutions in the field. Traditional strengths in Astronomy and Astrophysics are housed at UCT and the South African Astronomical Observatory, Geosciences at the Geosciences Council and Wits University. Rhodes University and SAIAB remain internationally competitive in marine and freshwater biology.

9 On the negative side, **no South African institution presents an internationally competitive profile** in any the following fields: Biochemistry, Molecular & Cell Biology; Dairy & Animal Sciences; Information Technology; Plant Sciences and Zoology.

10 This study has highlighted a **number of (policy) areas** that require further attention. (1) The stagnation of both article and book output signals that the underlying human capital is being stretched to the limit. It is our contention that the current system of subsidizing article and book output is merely keeping in check a major decline in production. It is, in itself, not sufficient to generate any significant increase in our scientific output. **The challenge of regenerating the scientific workforce at all levels remains the biggest challenge to our science system**. (2) The production of doctoral graduates is growing slowly. At current rates, South Africa will take between six and seven years to increase its current output to about 1500 doctorates per year. We do not believe that this relatively low production – compared to EU standards – is due to inherent inefficiencies in the higher education system. **More likely causes of the current low production rates are overburdened supervisors, insufficient research preparation for doctoral students, insufficient financial support and a strong motivation for a future academic or scientific career**. (3) South African remains strong and internationally competitive in a relatively small number of fields. At the same time, the decline of output in certain fields, most notably some health sciences fields and agriculture, is cause for concern. The latter is clearly linked to institutional changes at the ARC as it has been a traditional leader in scientific production in this field. Our research shows again that strategic fields in small sciences systems remain vulnerable to big institutional shifts and the constraints of a small human capital pool. **It is essential that South Africa protect the human capital base as well as the institutional infrastructure in these fields**.

OVERALL ASSESSMENT

In our view, the national knowledgebase is not in a healthy state. It is not vigorously growing or expanding, its international visibility and impact (even compared to similar sizes science systems) is confined to traditional niche areas with little evidence that of new, emerging fields of science, participation in knowledge production is still confined to a relatively small core of active scientists and our reproductive capacity and output remains very limited. In short: We have to accept that, despite recent efforts to invigorate and revitalize the knowledgebase, that it is not a robust system. It remains fragile and urgently requires more intensive and extensive interventions.

RECOMMENDATIONS

We make three recommendations: one about further research and analysis and two related to strategic interventions.

R

Further research

There are at least five areas in which this study should be taken forward:

- More detailed, participative and expert-driven field studies. We recommend that NACI commission studies that focus on specific scientific fields and bring together experts in those fields to discuss and further analyse the results produced in this study. Such expert-driven discussions would be able to look more closely at the causes behind stagnating output or low international visibility.
- More detailed studies of scientific book and report production in South Africa.
- More systems-level research that link knowledge production factors with other S&T parameters (e.g. expenditure on S&T per field).
- This study has not explicitly look at the current contribution of the science councils in the national system of innovation. Given evident mission-drift and increasing commercialisation of some of the councils, we believe a study dedicated to an assessment of the contribution of the science councils to national knowledge production is overdue.
- Further methodological research to develop an overall index of the “health of the national knowledgebase” that could be used as a regular monitoring tool to identify future areas of concern or possible intervention.

Regenerating the scientific workforce

R2

The current steady state of scientific production in the country, the unacceptably low levels of participation by black and female scientists and scholars in scientific publishing together with the continuing ageing of the active scientific workforce, are clear indications that South African science has to regenerate its scientific workforce. Unless we mobilize the talent and productive capacity of broader base of scientists, it is very likely that current scientific production will soon start to decline and South Africa will lose capacity in critical areas of science. **Since this is a complex and multi-facetted challenge, we recommend that NACI convenes a national task team to address this challenge in a systematic and – together with other key stakeholders in the national system of**

innovation – co-ordinated manner. Such a task team would need to consider initiatives and programmes that would achieve the following:

- Ways in which young and emerging scientists could be trained and supported to produce their first national and international scientific publications. Tied to such initiatives would be a recognition and reward system for young scientists who publish internationally and regularly.
- Initiatives aimed at increasing the participation and completion rates of doctoral students in all fields. Some of these initiatives would be aimed at providing research methodology and project management training to doctoral students (the idea of a National Doctoral Academy), while others would aim at training and supporting young and inexperienced doctoral supervisors. Another initiative would be to create a new category of doctoral contract appointments funded by the NRF that would allow doctoral students to be appointed to research and teaching positions while completing their studies.
- Programmes that would encourage doctoral students to remain in the science system. One such programme could be a national fund for post-doctoral support. South African universities support less than 700 post-doctoral students per year. This number needs to be increased three- or fourfold in order to provide a new stream of possible scientists for the future.

R3

Strengthening current pockets of scientific capacity and excellence

This study has shown that South Africa has a relatively small number of relatively strong centres and departments in certain scientific fields. However, recent history has also shown that major institutional declines (such as at the ARC) can impact very negatively on scientific production. We need to recognize that the South African science system is fragile in many areas where scientific production is currently maintained by a very small number (2 or 3 at most) of institutions. Unless these existing pockets of strength and excellence are protected, we could witness further erosion of our national knowledgebase. Recent initiatives by the NRF and DST (most notably the initiatives around Centres of Excellence and Research Chairs) constitute excellent starting points to strengthen existing centres of excellence. **However, our second strategic recommendation is that NACI considers a special programme (which should be linked to our Research recommendation above), that would (1) identify further national areas to be strengthened and protected; and (2) ways of further expanding existing initiatives in this regard.** Some of the issues to be addressed are:

- Expanding the number of Centres of Excellence and Research Chairs through additional local and international funding.
- Considering the establishment of an additional number of National Research Facilities. It is clear that our strength in Marine Biology and related fields have benefitted greatly from redisgnating SAIAB at Grahamstown as a national facility. The expansion of the number of national research facilities in other key areas with ring-fenced financial support, should be considered for some of the areas identified in this support where the current capacity needs to be strengthened (e.g. some areas of agricultural research for instance veterinary and animal sciences; some areas in the health and life sciences, e.g. infectious diseases; ICT and computer sciences and some of the more applied social policy domains).
- Strengthening the linkages between existing university-based centres of excellence and other scientific institutions in the science system (science councils, industry-based laboratories, and so on).

THE BRIEF

The detailed brief for this study required that the study addresses the following elements:

(1) Investigate the relationship between the different layers/sources of information (R&D surveys/NRF grants database/NRF rating systems/Sarima studies/SA Knowledgebase) and to identify and explain points of convergence and divergence as and when they arise.

(2) Provide a detailed conceptual/theoretical justification and framework around the meaning of the "national knowledgebase" concept by interrogating the latest literature in S&T policy studies and knowledge production.

(3) Provide a quantitative profile of the knowledgebase in terms of critical "knowledge entities" such as:

   a. Peer reviewed articles
   b. Scientific books
   c. Monographs
   d. Patents[1]
   e. Doctoral dissertations
   f. And other related knowledge products.

   This profile should look at a relatively long period of time (1990 -) and focus on breakdowns by, *inter alia*, scientific field, knowledge producer profiles (gender/race/age) and institution.

(4) Produce a more detailed profile of the key institutions producing knowledge in highly strategic fields (strategic to be defined in terms of the notion of "competitiveness" and innovation imperatives). Such a profile will identify the "centres of critical mass" where there are long-standing and well-established capacities of knowledge production.

(5) Deliver a bibliometric profile of the international 'visibility' of South Africa's knowledgebase and a comparison with similar economies in terms of world share in knowledge production. The first part will be based on an extensive analysis of citation profiles of scientific fields (both ISI and non-ISI).

(6) Generate a network analysis of patterns of scientific collaboration and networking of the top 20 scientific fields in the country.

(7) Align this study with the HR model exercise currently being developed by NACI and other NACI studies such as skill shortage advice, utilisation of research findings[2].

(8) Assess the capacity of the knowledgebase in attaining the goals as set in national priorities. This will also include introducing qualitative leavers such as quality of education system.

[1] Given that this area has been comprehensively addressed in a separate study for NACI, no analysis of patents is included in this report

[2] After further consultations with the service provider on the HR model, it was jointly concluded that no alignment between this study and the HR model is currently possible

ELABORATION ON THE BRIEF

The notion of a South African knowledgebase in this study is taken to refer exclusively to the public science system in South Africa. This means that this study focuses on the knowledgebase as it exists within South African higher education institutions, science councils, national research facilities and government-based units. This implies excluding science undertaken within industry and business. We comment below on how we have interpreted the specific elements of the brief.

Information sources and their interrelationship

To investigate the relationship between the different layers/sources of information (R&D surveys / NRF grants database / NRF rating systems / SARIMA studies) and to identify and explain points of convergence and divergence as and when they arise.

The Brief mentions a number of existing databases, information resources and recent studies that are regarded as being relevant to the study. There are indeed a number of "standard" information sources that have been utilised in the proposed study:

- The NRF NEXUS database on completed research
- The recent SARIMA study on a Directory of Research and Innovation Centres in South Africa (Study undertaken by CREST)
- The Department of Education HEMIS-database

In addition to these more standard databases, we have also added the following:

- The South African National Library Database on Books
- The Union Catalogue of Theses and Dissertations (accessible under SA Studies)
- CREST's *SA Knowledgebase* – a database on scientific production in SA since 1990.

The most obvious methodological challenge in this area was to reconcile the data entities in these different databases. The data in these different sources do not conform to a standard classification in key areas (such as scientific field), nor is the coverage of data at all levels (from the individual to the institutional level) equally comprehensive. We have, for example, found in our SARIMA study that the names of basic research performing entities – university departments, centres and institutes – vary extensively. A key task in this area therefore involved an extensive standardisation exercise both within and across sectors. We comment in more detail below on how we have addressed this challenge through the development of a new classification framework of scientific fields.

A quantitative profile of the South African knowledgebase

Provide a quantitative profile of the knowledge base in terms of critical "knowledge entities" such as: peer reviewed articles, scientific books, monographs, patents, doctoral dissertations and other related knowledge products. This profile should look at a relatively long period of time (1990-) and focus on breakdowns, by inter alia, scientific field, knowledge producer profiles (gender/race/age) and institution.

Another issue that is highlighted in the Brief and which applies to the whole study concerned the definition of "scientific field". This meant that a *detailed science field classification* (similar to the classification system used by NSF) was required. No such standard classification system is currently in use in South Africa. Various studies and organisations (R&D Survey/ NRF system/ DoE's CESM system) use quite different classification frameworks. It was therefore another methodological priority identified for this study, viz. to develop a scientific field classification framework that (1) aims to reconcile the best local systems, and (2) are consistent with international frameworks, such as the ISI classification of fields.

The key issues to be addressed under this heading then were the following:

- Capture and editing/verification of outstanding data categories (Books/ dissertations)
- Analysis of SAK article data as follows:
- Detailed science field breakdowns (by gender/race/age/institutions) for the total SAK
- Detailed science field breakdowns (by gender/race/age/institutions) for a subset of SAK (only authors identified as established/expert researchers)
- Analysis of the data on scientific books and doctoral dissertations by scientific and strategic field as well as by institution.

A network analysis of scientific collaboration patterns

To generate a network analysis of patterns of scientific collaboration and networking of the top 20 scientific fields in the country.

We considered the following to be feasible under this specific brief:

- An analysis of inter-institutional and inter-sectoral collaboration within South Africa within the selected 20 fields. This includes both ISI and non-ISI papers in SA Knowledgebase. Such an analysis would provide insight into possible "cluster" of scientific capacity in the country.

A bibliometric profile of the visibility of the South African public science

To deliver a bibliometric profile of the international 'visibility' of SA's knowledge base and a comparison with similar economies in terms of world share in knowledge production. The first part will be based on an extensive analysis of citation profiles of scientific fields (both ISI and non-ISI).

This section of the study raised at least two very labour-intensive and methodological challenges. First, the notion of "similar economies" against which to compare South Africa required a clear operational definition. What counts as a "similar economy" would need to be clearly defined and motivated. The second challenge was to include also non-ISI papers in the citation analysis. Our view was that to do this analysis for the whole period (1990 – 2003) for both ISI and non-ISI papers, would be too time consuming and hence too costly. We therefore proposed a slightly different approach:

- To first identify the "top" scientific fields in South African science for the period 1990 – 2003 based on a first level bibliometric analysis (mostly on output) and including both ISI and non-ISI papers. "Field" is defined here in terms of a journal-based classification but will most likely be aggregated to higher level fields. (CREST)
- To conduct a detailed citation analysis of all South African ISI-papers for the period 1990 - 2004 in the identified fields. (CWTS)

- To compare these citation profiles with no more than 10 benchmarking countries. The latter category would include 5 countries selected on the basis of key R&D indicators and being as similar to the South Africa system of innovation as possible. In addition 5 other "ideal" benchmarking countries will be selected on the basis of expert interviews with key stakeholders. These 5 countries will be selected as constituting ideal-typical countries that have properties to which the SA NSI should aspire.

A profile of key institutions

To produce a more detailed profile of the key institutions producing knowledge in highly strategic fields (strategic to be defined in terms of the notion of "competitiveness" and innovation imperatives). Such a profile will identify the "centres of critical mass" where there are long-standing and well-established capacities of knowledge production.

In its recent study for SARIMA, CREST developed a South African Research and Innovation Directory (SARID) which includes, inter alia, information on all the major R&D performing institutions in the country. The current version of the directory, for example, includes the following:

- Higher Education Research Units (1096 entities)
- Science Councils (59 entities – at the level of institutes and business units)
- National Research Facilities (7)
- Government based research units (20)
- Museums (13)
- Industry-based research units (9)

No attempt has thus far been made to consolidate and validate the information in SARID against other measures including bibliometric (output/ citation/impact) data. Our aim here would be to use an iterative process using multiple indicators in order to come to a "final" list of major research performing units. This process would involve the following steps:

- CWTS to generate a list of South African institutional address information for the period 1990-2004 (covering ISI papers) by scientific field (journal category).
- CREST to compare and verify this list against SARID and SA Knowledgebase
- Production of list of institutions in descending order in terms of scientific knowledge production and by (aggregate) field.
- CWTS to produce citation profiles of "top" institutions in selected fields.

Assessment of the SA knowledgebase in terms of national goals

To assess the capacity of the knowledgebase in attaining the goals as set in national priorities. This will also include introducing qualitative leavers such as quality of education system.

This final component of the brief brings us back to the notion of "strategic research fields". The results of this proposed study would identify for each of the top scientific fields the following basic profiles:

- Scientific output (measured in terms of articles, books and doctoral dissertations)
- International scientific visibility
- The HR capacity in that field (as measured by HEMIS/ R&D Surveys and other sources)
- The expenditure in that field (if available from the R&D Surveys)
- The institutional capacity (existing research centres/ national facilities/networks) in that field

PART A

BACKGROUND

CHAPTER 1
DEFINING SCIENTIFIC AND STRATEGIC FIELDS

1.1 INTRODUCTION

In the original brief reference is made in various places to "scientific fields, "top scientific fields" and "strategic fields". No definitions were offered for these different terms. In our response to the original brief, CREST indicated that it would address both these "requests" but in different ways. The methodological challenge that we faced was twofold: on the one hand, we needed to develop a classification framework that could address the very different demands that an interest in "scientific" versus "strategic" field generate. On the other hand, such a classification framework needed ideally to be able to "talk to" existing classification frameworks used in the science system. Let us elaborate on each.

The notion of "scientific field", although not unproblematic, when applied to measuring scientific output (as opposed to other applications), is pretty much standardized within the ISI-classification system. The *ISI Web of Knowledge* by *Thomson Scientific* has a list of 243 field-specific journal categories (e.g. Acoustics, Biophysics, Folklore). Each ISI journal gets assigned to any number of these categories. In most cases the ISI assigns a journal to a single category but there are many instances of journals being assigned to two or more categories. As a classification framework to classify scientific output, the ISI-framework is arguably the most comprehensive, widely used and most credible. In addition, any citation analysis of output will have to use this classification system. CREST has therefore incorporated the ISI journal category information into *SA Knowledgebase* (SAK)[3] in order to develop a hierarchical scientific field classification framework that best summarises the South African article output data as well as make it possible to compare our analyses with ISI-analyses.

The notion of "strategic field" is much less clear. For the purposes of this study, we have defined "strategic" scientific fields, as those areas of research activity that are aligned with the various S&T initiatives and objectives in the national system of innovation and expressed in recent national policy documents. The most important of these documents are the Advanced Manufacturing Technology Strategy, the National Biotechnology Strategy, the National Nanotechnology Strategy, and the National Research & Development Strategy. In our selection of which strategic fields to include in our analysis, we also took into consideration the six areas in which the DST aims to establish strong innovation chains over the next five years (Cf. its Corporate Strategy for 2006/2007). These areas are: Biotechnology, Nanotechnology, the Hydrogen Economy, Space Science, Information Technology, and Manufacturing. From these examples, it should be clear that a simple alignment between a classification of scientific fields and strategic fields is not possible. The strategic field of "poverty reduction", for example, has no single referent in the ISI-classification system.

In addition to the challenge of aligning the classification frameworks for scientific and strategic fields of science, there is also the problem of aligning such systems to other existing classification frameworks. For our purposes, with the focus on human capital, the HEMIS

[3] *SA Knowledgebase* (SAK) is a database of primarily journal article output in South Africa, developed by CREST. See Chapter 3, Section 3.2, for a detailed description of SAK.

system (of CESM categories) used by the Department of Education is a critical classification system. In order to align human capital information on student and staff with research production data, it was always going to be necessary to develop a "logical" interface between the ISI-based framework of scientific fields and the HEMIS-classification system.

In order to address these very different concerns and challenges, CREST has developed a new classification framework. In this study we utilize two "versions" of the framework:

- A classification of 20 scientific fields that enables us to align our analyses of scientific output with the HEMIS system of CESM categories
- A classification of 36 strategic fields that forms the basis for our citation and institutional profile analyses and which enables us to comment on questions about national priorities.

1.2 THE TWO FIELD CLASSIFICATION FRAMEWORKS ILLUSTRATED

The following tasks were performed to develop a scientific field classification:

(1) The ISI journal categories were linked to the ISI journals in SAK

(2) Each South African journal (non-ISI) was assigned to at least one ISI journal category by a team of researchers.

Tasks (1) and (2) resulted in about 90% of the 7 000 journals in SAK (up to 2005/2006) being linked to an ISI journal category.

(3) The percentage distribution of SAK article output per journal category was produced. On the basis of these figures the 243 ISI journal categories were grouped into 34 scientific fields ('level-3 categories'). The 34 categories, in turn, were grouped into a smaller number of 20 scientific fields ('level-2 categories'), which, in turn, have 5 broad underlying scientific fields ('level-1 categories').

The scientific field framework is illustrated in Table 1.1. A total of 101 847 of the 107 400 articles (i.e. 95%) for the period 1990-2004 have been linked to the scientific field classification framework. In this report we use both the level-1 and level-2 categories as the basis for reporting. We consistently refer to Level 1 categories as broad scientific field.

Table 1.1: Scientific field classification framework of article output, developed by CREST

Level-1 categories	Level-2 categories	Level-3 categories
Natural & agricultural sciences	Agricultural science	Plant sciences
		Veterinary sciences
		Other agricultural sciences
	Biological sciences	Zoology
		Marine & freshwater biology
		Entomology
		Ornithology
		Other biological sciences
	Chemical sciences	Chemical sciences

Level-1 categories	Level-2 categories	Level-3 categories
	Earth sciences	Ecology
		Geosciences
		Other earth sciences
	Mathematical sciences & ICCT	Mathematical sciences
		Information, computer & communication technologies
	Physical sciences	Astronomy & astrophysics
		General physics
	Multidisciplinary sciences*	Multidisciplinary sciences
Engineering & applied technologies	Engineering sciences & applied technologies	Mechanical engineering
		Mining engineering
		Electrical & electronic engineering
		Other engineering & applied technologies
		Materials sciences
Health sciences	Basic health	Basic health
	Clinical health	Clinical health
	Public / community health	Public / community health
Social sciences	Economic & management sciences	Economic & management sciences
	Education	Education
	Psychology	Psychology
	Sociology & related studies	Sociology & related studies
	Other social sciences	Other social sciences
Humanities	Language & linguistics	Language & linguistics
	Law	Law
	Religion	Religion
	Other humanities & arts	Other humanities & arts

* Multidisciplinary Sciences includes resources of a very broad or general character in the sciences. It covers the spectrum of major scientific disciplines such as Physics, Chemistry, Mathematics, Biology, etc. *Nature* and *Science* are the pre-eminent resources in this category and serve as typical examples. The *South African Journal of Science* is another example.

In order to finalise our selection of the top and strategic fields from the original ISI journal categories, a four-step procedure was followed:

- Step 1: The Centre for Science and Technology Studies (CWTS – at the University of Leiden in the Netherlands) provided CREST with a dataset of the total article output of the top 10 South African institutions in each of the 243 ISI journal categories, for the period 1992 to 2005. In this dataset each organisation's article output was expressed as a fraction of the total article output in the journal category concerned. [Only ISI journal articles in the CWTS Web of Science database were considered because the eventual objective was to produce citation profiles for South African institutions in each of the top / strategic fields, and citations can only be performed on ISI articles.]

- Step 2: CREST ranked the ISI journal categories in descending order of total article output (ignoring the breakdown by organisation) in order to produce the most productive disciplines. In other words, the fractions of the top 10 institutions per ISI journal category were summed in order to produce the total article output for that category.[4] The output threshold was set at a minimum of 300 articles during the total period. Altogether 58 ISI journal categories met this criterion.
- Step 3: An inspection of the 58 ISI journal categories showed that this number could be significantly reduced by combining categories that are logically related. For instance, Analytical Chemistry, Inorganic Chemistry, Multidisciplinary Chemistry, etc, all emerged as separate categories within the list of 58 ISI journal categories but could be meaningfully combined into a single category, called "Chemistry".
- Step 4: After reducing the 58 categories to a smaller number, all ISI journal categories with an article output of less than 300 were revisited. This was done for two reasons: first, to include smaller (i.e. less productive) disciplines that are of strategic relevance and, second, to merge some of the smaller journal categories with those already identified as top or strategic fields in cases where there is a logical or cognitive link. An example of the first is the field of Information Technology – all ISI journal categories relating to ICT (e.g. Artificial Intelligence, Cybernetics, Telecommunications, etc) were combined regardless of the fact that none of these categories on their own had met the threshold criterion of 300 articles. An example of the second instance is the merging of Immunology, Infectious Diseases, and Virology (three categories which have been combined in Step 3 and which individually meets the 300+ threshold) with Tropical Medicine and Parasitology (two categories which do not meet the threshold individually).

The end result was a list of 36 top / strategic fields as shown in Table 1.2. The 36 field-classification is non-exhaustive in the sense that it does not utilise all 243 ISI journal categories. Only 158 of the original ISI journal categories have been used in generating the 36 fields. The last column in the Table indicates the number of ISI journal categories used per field.

Moreover, Table 1.2 reports on two sets of output figures. The first, referring to the period 1992-2005, was the only set available at the time of producing the 36 fields. These figures informed the generation of the 36 fields. More specifically, the 1992-2005 output figures were derived from the CWTS dataset of article output for the top 10 institutions in each of the original 243 ISI journal categories (see Steps 1 & 2 of the four-step procedure above). Each institution received a fraction of the total article output in the journal category concerned, and the various fractions were added to produce the total article output for a field.

In contrast, the 1990-2005 output figures represent the total number of South African articles - i.e. all articles with at least one South African author address – in a particular field. These figures were added *ex post facto* because they were not available beforehand to inform the generation of the top and strategic fields. They were only produced as part of the production of the citation profiles for this report.

There are two obvious reasons for the variation between the two sets of figures in Table 1.2. The first reason refers to the difference in the time period being covered. Another reason is the difference in the computation method being used (for 1992-2005 it is the sum of the

[4] Obviously this method did not give the full South African article output per ISI journal category because only the contributions of the top 10 institutions apply. That being said, it must be remembered that, according to Lotka's Law, a small number of publishing entities normally produce the larger share of article output.

fractional counts for only the top 10 institutions in each of the ISI journal categories that constitute that field; and for 1990-2005 it is the total number of articles in that field).

Table 1.2: 36 Top / strategic fields

Field	ISI article equivalents / articles in CWTS database		Number of ISI journal categories
	1992-2005	1990-2005	
General & Internal Medicine	5305.17 [1]	7059 [1]	6
Social Sciences	3198.38 [2]	4675 [2]	38
Chemistry	2872.47 [3]	4609 [3]	6
Plant Sciences	2316.75 [4]	3507 [4]	1
Humanities	1782.07 [5]	2281 [10]	32
Biochemistry, Molecular & Cell Biology	1746.62 [6]	3150 [6]	3
Physics (Excl Condensed Matter & Nuclear)	1742.00 [7]	2552 [8]	6
Geosciences	1696.48 [8]	2532 [9]	4
Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine	1688.90 [9]	2628 [7]	5
Ecology & Environmental Sciences	1601.82 [10]	3459 [5]	2
Veterinary Sciences	1430.00 [11]	1806 [14]	1
Astronomy & Astrophysics	1384.33 [12]	1540 [18]	1
Mathematics	1206.13 [13]	1670 [16]	3
Zoology	1164.67 [14]	2110 [11]	1
Materials Science	1157.87 [15]	1746 [15]	9
Surgery	1095.17 [16]	1859 [13]	1
Obstetrics, Gynecology & Pediatrics	945.00 [17]	1529 [19]	2
Public, Environmental & Occupational Health (Incl Nutrition & Dietetics)	920.82 [18]	1451 [21]	2
Water Resources & Biodiversity Conservation	825.58 [19]	1866 [12]	2
Information Technology	811.08 [20]	1195 [22]	10
Marine & Freshwater Biology	810.67 [21]	1578 [17]	1
Pharmacology & Pharmacy	765.50 [22]	1502 [20]	1
Entomology	697.83 [23]	1090 [24]	1
Microbiology	680.25 [24]	1151 [23]	1
Dairy & Animal Science	674.58 [25]	825 [31]	1
Genetics & Heredity	654.18 [26]	837 [29]	1
Nuclear Physics & Nuclear Science & Technology	647.87 [27]	1072 [25]	2
Condensed Matter Physics	567.70 [28]	844 [28]	1
Oncology	556.67 [29]	703 [34]	1
Economics & Management Sciences	531.50 [30]	786 [32]	6
Electrical & Electronic Engineering	468.92 [31]	831 [30]	1
Chemical Engineering	437.08 [32]	980 [26]	1

Field	ISI article equivalents / articles in CWTS database		Number of ISI journal categories
	1992-2005	1990-2005	
Mechanical Engineering & Mechanics	395.95 [33]	713 [33]	2
Metallurgy & Metallurgical Engineering	385.08 [34]	901 [27]	1
Ornithology	371.00 [35]	489 [36]	1
Food Science & Technology	341.58 [36]	620 [35]	1

The classification framework of the 36 strategic fields is completely embedded in the classification framework of the 20 scientific fields (Cf. Appendix A).

CHAPTER 2
THE NOTION OF A NATIONAL KNOWLEDGEBASE

2.1 INTRODUCTION

The notion of a national 'knowledgebase' has largely emerged as a result of the OECD's work on knowledge-based economies (e.g. OECD, 1996) and studies of innovation systems at various levels – national, regional, sectoral and technological (e.g. Carlsson et al., 2002, Malerba, 2002). Both the 'knowledge-based economy' and 'innovation system' literature emphasises, among other things, the importance of networks and linkages for interactive learning and knowledge distribution. Scientific and technological knowledge in this context includes 'both codified and highly abstract information and tacit knowledge of a very practical kind concerning methods of organizing and carrying out productive tasks' (OECD, 1994:10).

Already in this OECD definition of scientific knowledge we find reference to a key aspect of scientific knowledge, namely the codified/tacit interplay. Codification (which implies publicly documented outputs by scientists and scholars) has partly determined our choice of knowledge entities to be investigated in this report. However, before explaining our choice of knowledge entities we will first provide clarity on the kinds, properties and dimensions of knowledge entities in a national knowledgebase.

2.2 KNOWLEDGEBASE ENTITIES

Scientific research or inquiry produces outputs of at least two kinds: (1) epistemic or knowledge outputs and (2) non-epistemic outputs or knowledge applications.

Epistemic outputs include all forms of new knowledge: new theories, interpretations, insights, models, hypotheses, conjectures, facts, data as well as instrumentation and techniques. Epistemic outputs (or new knowledge) can be divided into codified or tacit/embodied knowledge.

- Codified knowledge refers to knowledge that has been 'written up' and which is usually transmitted to a particular audience in a standard form such as a scientific presentation, paper, book, report, electronic communication and so on.
- Embodied knowledge refers to the knowledge (including skills, competencies) that is embodied in people (scientists, researchers, doctoral students).

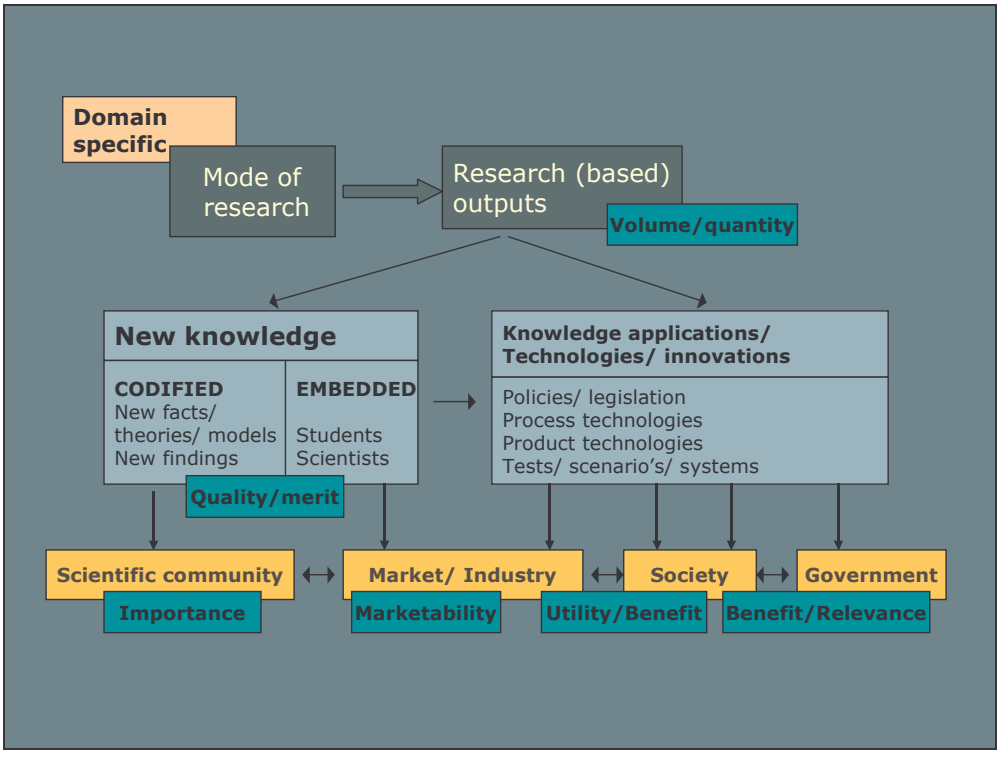
One could further distinguish at least three types of knowledge: theoretical knowledge (knowledge embedded in theories and models that purport to explain and interpret some phenomena in the world), empirical knowledge (knowledge embedded in empirical results and findings, i.e. data) and methodological or instrumental knowledge (knowledge embedded in scientific measurement – physical and social measures).

Non-epistemic outputs include all forms of application and technology that flow from the research process. These include process and product technologies and artefacts as well as social science applications such as policies, programmes, interventions, tests, scenarios, strategies, plans, systems, and many more.

The distinction between knowledge entities and knowledge applications are incorporated into a heuristic framework (see Figure 2.1), which also demonstrates the relationship between modes of knowledge production and utilisation. Different modes of knowledge production clearly have different intended or unintended audiences (or target groups, beneficiaries, user groups) in mind. We expand this principle in the framework by including the most important audiences of research: the scientific community, the market/industry, society and government.

And finally, we also introduce in the framework reference to the various properties of scientific research outputs: volume or quantity, quality or merit, importance, marketability, utility or benefit and relevance. These six properties are often encountered in R&D evaluation studies where the focus is on evaluating or assessing research in terms of one or more of its properties. So, for instance, we might wish to assess the volume of research output of an individual scientist or centre over time.

Figure 2:1: Framework of the production and utilisation of knowledge



One way of unpacking the different types of research output in Figure 1.1 is to focus on the modes of scientific communication. In a survey conducted for the NACI study on Knowledge Utilisation in 2004 (Boshoff & Mouton, 2005), CREST asked project leaders at science councils, universities and technikons to indicate how they have communicated the results of

their research. The respondents had to do so by selecting from 27 modes of communication, grouped together in six broad categories. The responses are summarised in Table 2.1.

Table 2.1: Communication of research results, per sector

	All three sectors		Sector					
			Science council sector		University sector		Technikon sector	
Mode of communication	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Articles in refereed scientific journals	983	54.5	214	39.7	715	66.1	54	29.5
Articles in refereed technical journals	129	7.2	54	10.0	65	6.0	10	5.5
Articles in popular journals	400	22.2	158	29.3	223	20.6	19	10.4
Contract reports	690	38.3	342	63.5	319	29.5	29	15.8
Books/ monographs	204	11.3	43	8.0	142	13.1	19	10.4
Chapters in books	274	15.2	63	11.7	196	18.1	15	8.2
Published conference proceedings	843	46.8	265	49.2	495	45.8	83	45.4
Written input to official policy documents	165	9.2	60	11.1	91	8.4	14	7.7
Technical manuals	194	10.8	105	19.5	81	7.5	8	4.4
Academic audiences	1294	71.8	331	61.4	837	77.4	126	68.9
Non-academic audiences	639	35.4	247	45.8	343	31.7	49	26.8
Expert committees/ panels	452	25.1	191	35.4	232	21.5	29	15.8
Public hearings	112	6.2	40	7.4	64	5.9	8	4.4
Fairs/ exhibitions/ road shows	203	11.3	98	18.2	88	8.1	17	9.3
Through patenting	78	4.3	33	6.1	39	3.6	6	3.3
Through licensing	31	1.7	19	3.5	12	1.1	0	0.0
Training through workshops	499	27.7	162	30.1	283	26.2	54	29.5
Training through coursework	384	21.3	74	13.7	275	25.4	35	19.1
Supervision of masters/ doctoral students	593	32.9	86	16.0	468	43.3	40	21.9
Consultations/ technical assistance to potential users	608	33.7	250	46.4	300	27.8	58	31.7
Personnel exchanges/ secondments	329	18.2	142	26.3	160	14.8	27	14.8
Informal meetings with potential users/ teams	713	39.5	281	52.1	357	33.0	75	41.0
Through participation in consortia	212	11.8	112	20.8	87	8.0	13	7.1
Through science parks	19	1.1	6	1.1	13	1.2	37	20.2
Through spin-off companies	52	2.9	21	3.9	30	2.8	1	0.5
Through technology transfer offices	52	2.9	36	6.7	15	1.4	1	0.5
Through technology incubators	23	1.3	12	2.2	9	0.8	2	1.1

Source: Boshoff & Mouton (2005:24-26, Tables 3.13 & 3.14)

As can be seen in Table 2.1 the five most important modes of communication are:

- Presentations to predominantly academic audiences
- Articles in refereed scientific journals
- Published conference proceedings
- Informal meetings with potential users and teams
- Contract reports

The only mode of communication that constitutes one of the top three in all the sectors is presentations to predominantly academic audiences. Contract reports as a way of dissemination are mostly of importance to the science council sector. Articles in refereed scientific journals particularly apply to the university sector.

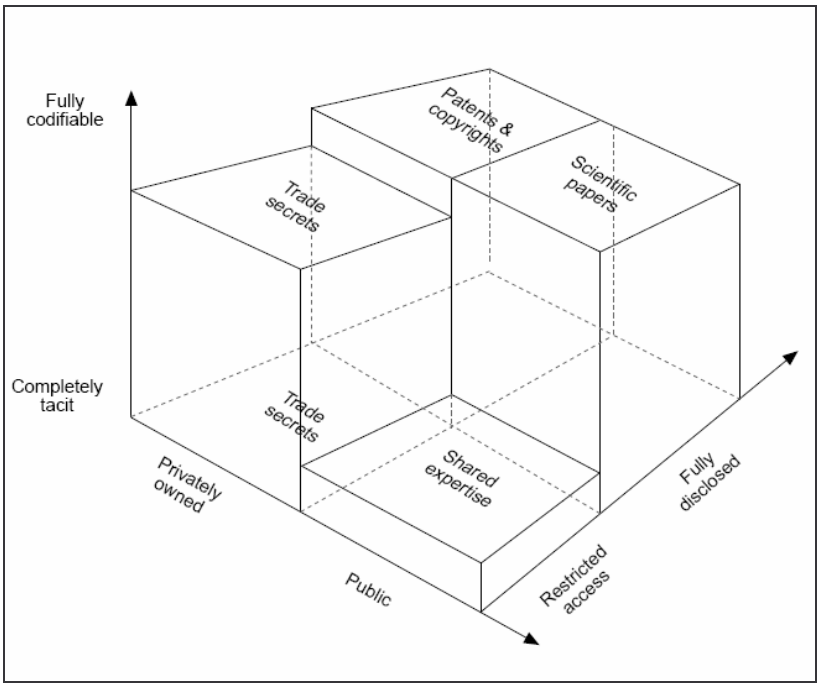
The figures in Table 2.1 show, amongst others, the diverse ways in which research outputs are packaged and communicated. In the modern-day knowledge society, it has become imperative to transmit and disseminate knowledge in as many ways as possible in order to reach different audiences in different contexts.

The focus of this report, however, is on *knowledge entitie*s (new knowledge / epistemic outputs) as opposed to knowledge applications (non-epistemic outputs). The focus is further restricted to knowledge entities that represent *codified products*. In addition, we have selected knowledge entities that meet the following criteria:

- It is possible – although in some cases with great difficulty – to *access* sufficient information about the individual research output units for the purposes of analysis.
- It is possible to demonstrate (at least to some degree) the existence and application of peer review mechanisms to assure *quality* of output

With regard to the accessibility of knowledge entities, if one considers the 'knowledge-product space' diagramme used by the OECD to classify economically relevant S&T knowledge (see Figure 2.2), scientific papers or journal articles are the single most important knowledge entity in terms of accessibility. The reason is because the knowledge contained in articles is both fully disclosed and available in the public domain. Patents and copyrights are other entities in Figure 2.2 that also involve fully codifiable knowledge that is fully disclosed. However, patents and copyrights were not considered in this report because they are associated with knowledge applications, not knowledge entities.

Figure 2:2: 'Knowledge-product space' –
A 3-dimensional visualisation of economically relevant S&T knowledge



Source: OECD (1994:31)

In addition to journal articles we have included two other categories of knowledge entities for analysis, namely books and reports and doctoral dissertations. These were included because they both represent codified knowledge products that are publicly documented (and thus accessible) and also meet the peer-review criterion. Our argument was that since quality/merit is an important property of new knowledge production (see again Figure 2.1), a quality assurance mechanism had to be added as an additional criterion in selecting the knowledge entities. In Section 2.3 we substantiate our reliance on peer review as such a quality assurance mechanism.

TEXT BOX: TYPES OF SCIENTIFIC LITERATURE

The scientific literature is made up of different publication types. One relatively common classification distinguishes between four main categories of publications:

- Journal publications (research articles, reviews, notes and letters)
- Books (including monographs, chapters in edited books)
- Conference proceedings
- Technical or research reports

The significance of these different components of the literature varies between disciplines and has changed over time. As of 2006, peer-reviewed **journal articles** remain the predominant publication type, and have the highest prestige. However, journals vary enormously in their prestige and importance, and the value of a published article depends on the journal.

The significance of **books**, also sometimes called research monographs, depends on the subject. Generally books published by university presses are usually considered more prestigious than those published by commercial presses. The status of working papers and conference proceedings depends on the discipline; they are typically more important in the applied sciences. The value of publication as a preprint or scientific report on the web has in the past been low, but in some subjects, such as mathematics or high energy physics, it is now an accepted alternative.

In library and information science, a book is called a monograph to distinguish it from serial publications such as magazines, journals or newspapers. It is a work of non-fiction, usually written by a scientitst, scholar or researcher.

Usually these books are written for a wide audience not presumed to have any scientific education, as opposed to the very narrow audience that a scientific paper would have, and are therefore referred to as popular science.

A **monograph** is a scholarly book or a treatise on a single subject or a group of related subjects, usually written by one person. It is a one-time publication that is complete in itself. It may refer to a detailed, well-documented work on a limited subject or a person. In library and information science, a monograph is a nonserial publication complete in one volume or a finite number of volumes. Thus it differs from a serial publication such as a magazine, journal or newspaper. It is what is commonly known as a book.

For the entire 20th century most librarians concerned with offering proper library services to the public (or a smaller subset such as students) worried about keeping track of the books being added yearly to the Gutenberg Galaxy. Through a global society called the International Federation of Library Associations and Institutions (IFLA) they devised a series of tools such as the International Standard Book Description or ISBD.

Besides, each book is specified by an International Standard Book Number, or ISBN, which is unique to every edition of every book produced by participating publishers, world wide. It is managed by the ISBN Society. It has four parts. The first part is the country code, the second the publisher code, and the third the title code. The last part is a checksum or a check digit and can take values from 0–9 and X (10). The EAN Barcodes numbers for books are derived from the ISBN by prefixing 978, for Bookland and calculating a new check digit.

Many government publishers, in industrial countries as well as in developing countries, do not participate fully in the ISBN system. They often produce books which do not have ISBNs. In certain industrialized countries large classes of commercial books, such as novels, textbooks and other non-fiction books, are nearly always given ISBNs by publishers, thus giving the illusion to many customers that the ISBN is an international and complete system, with no exceptions.

A **technical report** (also: **scientific report**) is a document that describes the progress or results of technical or scientific research, or the state of a technical or scientific research problem. Such reports are often prepared for sponsors of research projects. Technical reports are today a major source of scientific and technical information. They are prepared for internal or wider distribution by many organizations, most of which lack the extensive editing and printing facilities of commercial publishers. Unlike other scientific literature, such as scientific journals and the proceedings of some academic conferences, technical reports rarely undergo comprehensive independent peer review before publication. Where there is a review process, it is often limited to within the originating organization.

Many organisations collect their technical reports into a formal series. Reports are then assigned an identifier (report number, volume number) and share a common cover-page layout. The entire series might be uniquely identified by an ISBN.

2.3 PEER REVIEW AND THE SELECTED KNOWLEDGEBASE ENTITIES

As far as codified knowledge products are concerned, the key issue relates to the credibility of the knowledge contained in such entities. Stated differently, what processes and mechanisms are in place to ensure that the product is of reasonable or acceptable scientific quality? It is generally accepted that some form of peer review is still – despite many well-documented critiques – the best mechanism to assure quality in public science. For this reason, most R&D evaluation exercises, such as the UK RAE, the Dutch review of research programmes, the Australian Quantum, only recognise research output that has been subjected to some form of peer review. This usually means that scholarly presentations at conferences are not included in such reviews. Even the area of conference proceedings constitutes a grey area as some disciplines (e.g. Computer Sciences) has a long tradition of rigorous peer review of such proceedings, whereas most other disciplines cannot demonstrate the same rigour or consistency of peer review as far as conference proceedings are concerned. The issue, to be clear, is not only the fact of peer review, but demonstrable peer review. It is necessary that one can demonstrate that a review of scientific products has been subjected to fair and rigorous peer review.

Peer review as a mechanism of quality assurance and control, is pretty much institutionalised in the domain of scientific or scholarly journal articles. Within the South African science system, the system of accrediting scientific journals by the Department of Education (DoE) is in fact a second layer of quality assurance – in addition to the first layer of editorial peer review processes. All things being equal, one would assume that all articles accepted for publication in any one of the journals 'accredited' by the DoE, have been properly peer reviewed.

Peer-reviewed articles still remain the most widely regarded category in most systems of research performance evaluation. The priority given to peer-reviewed articles is clearly illustrated in a survey conducted at the University of Western Australia (Tognolini et al., 1994) where heads of departments were asked to consider various performance indicators and rate them on a scale from 1 (inappropriate) to 6 (absolutely critical). The results are listed in Table 2.2 below.

Table 2.2: Rating of research output categories at the University of Western Australia

Performance indicators	Average rating (Scale 1 – 6)	% of departments nominating it at least as important
Number of articles in refereed journals of repute	5.13	91%
Number of books	4.61	83%
Reputation of a department	4.56	80%
Journal article quality	4.45	76%
Number of monographs	4.43	80%
Selection to editorial boards, scientific panels, research councils and advisory boards	4.33	80%
Number of chapters	4.28	80%
Invitations to deliver keynote address at conference	4.22	80%
Election to learned academies or select societies	4.04	70%
Number of invited and guest lectures given	4.00	76%

Thesis examination	3.76	63%
Value of internal research grants	3.75	56%
Research expenditure over reference period	3.71	50%

Demonstrating peer review for knowledge products other than journal articles is not as straightforward. For the categories of books and chapters in books, one assumes that reputable publishers do use systems of peer review to scrutinise manuscripts submitted for publication. However, again various factors, such as the nature of the publication, print run, intended audience of the publication and so on all impact on peer review in scientific book publishing.

Peer review of a different kind is institutionalised in the examination of doctoral dissertations. Most South African universities use at least two (but more realistically three) external examiners to assess the quality of doctoral dissertations. Although it is common knowledge that the small size of our science system and specifically of certain sub-fields, the existence and influence of schools of thought and the prevalence of paradigms especially in the humanities and social sciences, and the role of small personal networks all impact negatively on rigorous and fair examinations, there is no reason to believe that this system is necessarily any worse than peer review of journal articles. In fact, the semi-public nature of doctoral examinations (in the case of oral defenses), probably acts to eliminate or reduce the effects of gross unfairness and non-virtuous practices.

2.4 CONCLUDING REMARKS

Our discussion in this chapter has highlighted three aspects of a national knowledgebase:

- The diverse range of types of knowledge entities that 'populate' a national knowledgebase, including specifically both codified and embodied knowledge entities
- The different properties of knowledge entities (quality, quantity, importance, relevance, etc)
- The issue of the credibility of knowledge entities (peer reviewed vs. non-peer reviewed)

Moreover, the study contributes to our understanding of the South African knowledgebase in the sense that books, reports and doctoral studies will be added and analysed as new 'knowledge entities', in addition to the more standard category of journal articles.

Chapter 2 will now, among other things, discuss the data sources for the three selected categories of knowledge entities, together with an explanation of the various methodological issues and the indicators used in the analyses.

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CHAPTER 3
DATA SOURCES AND METHODOLOGY

3.1 INTRODUCTION

As discussed in Chapter 2, three categories of knowledgebase entities have been selected for analysis in this report. They are peer-reviewed journal articles, scientific books and reports, and doctoral dissertations. The data sources for these three knowledgebase entities are discussed in Sections 3.2 to 3.4.

Peer-reviewed journal articles were also used to generate the profile of scientific collaboration in the national knowledgebase (Section 3.5), as well as to profile the visibility of South African science (citation analysis) and to determine the key institutions in particular fields (citation analysis). The citation analyses were performed by the Centre for Science and Technology Studies (CWTS) at the University of Leiden, and their methodology is explained in Sections 3.6 and 3.7.

Lastly, the quantitative profiles of peer-reviewed journal articles, books and reports, and doctoral dissertations, respectively, have been structured according to the field categories in the scientific field classification framework. The framework was also used to structure the results of the analysis of scientific collaboration. In the case of the citation analyses, however, the reporting structure is in terms of the strategic field classification framework (see again Chapter 1).

3.2 PROFILE OF PEER-REVIEWED JOURNAL ARTICLES (KNOWLEDGE ENTITY 1)

The data source for our analysis of peer-reviewed journal articles is *SA Knowledgebase* (SAK). SAK is a database of research output in South Africa, developed by the Centre for Research on Science and Technology (CREST) at Stellenbosch University. SAK aims to deliver a comprehensive, accurate and up to date database of article output from 1990 onwards. At present more than 116 000 articles are included in SAK. The database collects bibliographic information (excluding citations) on articles with South African author addresses, which appeared in journals accredited by the South African Department of Education (DoE). Information on the article title, article keywords, authorships, journal title, journal publishing detail and journal field in SAK is captured from two bibliographic indexes – the *Index of South African Periodicals* (ISAP) and the internationally acclaimed *Web of Science.*[5]

Whereas SAK includes ALL articles with a South African address appearing in the *Web of Science*, it does not include all articles appearing in ISAP. It only includes articles from ISAP

[5] ISAP is published by the National Library of South Africa and contains the article details of all South African periodicals. The *Web of Science*, on the other hand, forms part of the *ISI Web of Knowledge* by *Thomson Scientific*, and consists of three databases: the *Science Citation Index Expanded* (SCI-Expanded), the *Social Sciences Citation Index* (SSCI), and the *Arts & Humanities Citation Index* (A&HCI). SCI-Expanded, SSCI and A&HCI respectively covers 6 563, 1 926 and 1 151 of all scientific journals in the world. The three ISI databases are not mutually exclusive, so that their combined coverage is about 8 400 journals.

in cases where the article appears in a journal that has been approved by the DoE. The DoE's first list of accredited South African journals was introduced in 1985 and, by the end of 1997, contained 210 locally produced journals. Thereafter the list was "frozen", until January 2005 when a new list of approved South African journals was introduced. The latter list contains 255 locally produced journals.[6] SAK, for the purpose of this report, uses the South African journals that were on the DoE's list between 1990 and 2004, in addition to all ISI journals.[7]

Although the focus of SAK is on DoE accredited journals (i.e. South African journals approved by the DoE and all journals indexed by the *Web of Science*), SAK is not limited to articles produced by the South African higher education sector. It also includes, among others, articles produced by the science councils, national research facilities and government-based research institutions. The database also provides author-specific information by disaggregating the article output in terms of selected demographic variables (gender, race, year of birth, highest qualification and institutional affiliation). The linking of these demographic data to the article authors is an on-going task. Since 1998 CREST has utilised a variety of sources [including its own national surveys; requests for demographic information from South African universities, technikons and science councils; as well as web searches] to add the demographic information of the authors of these articles. The more than 116 000 articles have been produced by more than 50 000 unique individual authors. Of these authors, the database currently contains some demographic information (gender, race and birth year) for approximately 45%.

SAK contains, for the period 1990 to 2004, altogether 107 400 articles. Since an article can list more than one author address (from which the institutional affiliation and author demographics are derived), the working dataset is an authorship dataset and not an article dataset. The 'article x author' combination uniquely defines each record in an authorship dataset. In other words, the number of times that an article appears in the authorship dataset corresponds to the number of authors listed for that article. For instance, in Table 3.1, the first article has two authors; hence the article appears twice in the authorship dataset but each time in combination with a different author (see Table 3.2).

Table 3.1: Article dataset

Article	Author information
Article 1	Author A @ UCT; Author B @ UFH
Article 2	Author X @ Rhodes; Author Y @ Rhodes; Author Z @ UKZN

Table 3.2: Authorship dataset

Article	Author	Institution	Fractional count
Article 1	Author A	UCT	0.50
Article 1	Author B	UFH	0.50
Article 2	Author X	Rhodes	0.33
Article 2	Author Y	Rhodes	0.33
Article 2	Author Z	UKZN	0.33

[6] The history of journal accreditation in South Africa has been documented in the following publication: Mouton, J., Boshoff, N. & Tijssen, R. (2006). "A comprehensive analysis of South African journals". Chapter 3 (pp. 29-59) in *Report on a Strategic Approach to Research Publishing in South Africa*. Pretoria: Academy of Science of South Africa.

[7] The journals listed in the *Web of Science* are also referred to as ISI journals.

The 107 400 articles in SAK for the period 1990-2004 translated into an authorship dataset of 255 225 records. For each record a fractional count (also referred to as an article equivalent) has been computed. The calculation of fractional counts is illustrated in Table 3.2. Each fractional count expresses an author's relative contribution to an article. For instance, three researchers co-authored Article 2, and because only one author has a UKZN address, the latter university received an article equivalent of 0.33. Moreover, two of the three authors have a Rhodes affiliation, which is why Rhodes received a fractional count of 0.66 in this example.

If one adds all the fractional counts in the authorship dataset of 255 225 records, the grand total will equal the original number of articles, namely 107 400. Table 23.3 shows that altogether 77% of the total number of articles, reconstructed from the fractional counts in the authorship dataset, was produced by authors affiliated with a South African institution, and only 8% by authors with a foreign affiliation. Moreover, for 15% of articles we do not know the author affiliation.

Table 3.3: Distribution of articles in SAK by country affiliation and by year of publication

Year of publication	Country affiliation (Percentages add up to 100% in rows)			Total number of articles
	South African	Foreign	Unknown	
1990	81%	4%	15%	6623
1991	79%	5%	17%	6813
1992	80%	5%	15%	6846
1993	81%	5%	14%	6751
1994	80%	5%	14%	7055
1995	79%	6%	16%	7285
1996	79%	6%	15%	7119
1997	78%	7%	15%	7118
1998	76%	9%	15%	7021
1999	76%	10%	14%	7407
2000	76%	11%	13%	7764
2001	75%	11%	14%	7533
2002	76%	12%	12%	7648
2003	71%	14%	15%	7515
2004	70%	15%	15%	6902
Total	**77%**	**8%**	**15%**	**107400**

The small percentage of "unknown" author affiliations is mostly because of ISAP which does not list any author addresses. That being said, it must be remembered that, between 1990 and 2004, altogether 29 South African journals were also indexed by the *Web of Science*. Thus, 29 journals appeared in both the ISI and ISAP indices. Articles in these 29 journals do contain the names and addresses of all authors. This additional authorship information, together with the affiliations listed for South African authors in foreign (i.e. non-South African) ISI journals, have been used to "fill the gaps" in cases where author addresses had originally been lacking.

The author affiliation information in SAK includes many name variations for the same institution – mostly because of spelling and abbreviation fluctuation but also because of recent name changes and institutional mergers. The list of South African institutions in SAK therefore had to be standardised before data analysis could proceed. We have used, as far as possible, the latest known name of a particular institution.

The following indicators have been produced from SAK in order to compile the profile of peer-reviewed journal articles:

- Articles and article equivalents (i.e. fractional counts) per scientific field and per year period[8]
- Article equivalents per scientific field and per year period, by gender of authors
- Article equivalents per scientific field and per year period, by race of authors
- Article equivalents per scientific field and per year period, by age of authors
- Article equivalents per scientific field and per year period, by age of top 20% of authors[9]

3.3 PROFILE OF SCIENTIFIC BOOKS OR REPORTS (KNOWLEDGE ENTITY 2)

There is no standard database of scientific books or reports in South Africa. The National Library of South Africa compiles and maintains a database of all books published in South Africa. CREST acquired a copy of this database from the National Library as the primary initial database for this project[10]. Subsequent to receiving this database, CREST has invested much time in editing, standardizing and expanding the database into a dedicated database of scientific books and reports published in South Africa[11]. In order to achieve a workable database for the purposes of this study, we engaged in various activities which are listed below.

- Identifying scientific books and report in the current database
- Adding additional titles to the database

As far as identifying scientific titles in the database, we employed the following strategies:

- We excluded all titles refer to works of fiction. This was made easier because the database included the Dewey classification number of all books.
- We excluded titles that obviously referred to popular topics including “coffee-table” type publications
- We excluded self-publications, i.e. where the author and the publisher were identical

In this process of screening and selecting titles, we were also guided by two other criteria: first, whether the publisher or publishing house is a well-known and reputable publisher; and second, whether the author is attached to a scientific or academic institution. In the former case, we were guided by the list of publishers who are members of the Publishing

[8] Five 3-year periods were used: 1990-1992, 1993-1995, 1996-1998, 1999-2001 and 2002-2004.
[9] For instance, the field of Agriculture, produced 5 383 unique authors between 1990 and 2004. Each author’s total number of article equivalents for this period was calculated, and the authors sorted in descending order in terms of that total. The first 1 077 authors on the sorted list comprised the top 20% of authors in Agriculture
[10] We wish to express our appreciation to the National Library for making this database available to us for the purposes of this study.
[11] We must stress that this database does not include publications published by SA authors outside of South Africa.

Association of South Africa (PASA). In the latter case, we compared the names of all book authors with the biographical table in SAKnowledgebase which contains the names of more than 55 000 individuals who have published at least one paper over the past 15 years. The end-result of this editing process was that we reduced an initial database of more than 33 000 unique titles to 5 540 unique titles.

The working file which has been produced for this analysis contains various kinds of book and report publications. These are:

- Monographs
- Textbooks for higher education institutions
- Anthologies or edited works
- Research reports (mainly produced by science councils and universities)

Finally, in our analysis of publication trends, we also took into account two further features of book publications: editions of a title and translations. We have decided to follow standard practice in this regard[12] by counting unique titles only and listing separately any additional translations and further editions of that title.

As far as coverage is concerned, the original master database received from the National Library was obviously less complete in its coverage of the past 3-4 years. This is undoubtedly due to lag times in indexing new titles. In order to address this, but also as part of a general attempt to improve overall coverage, database assistants in CREST searched various websites for additional titles. In this respect, attention was focussed mostly on the large publishing houses as well as university presses.

Further improvement and refinement of this database will remain a priority for CREST especially to include titles published by South African authors overseas. However, at this stage we would estimate the current coverage of local publications to be in the order of 70-80%.

Special features of the current CREST book database include the following:

- Standardisation of publisher information (not the case in the master database)
- Inclusion of a classification framework for scientific fields that is compatible with other research output classification frameworks (and used in this report)
- Inclusion of basic demographic data of authors (obtained through linking the names of authors to the demographic data in SAKnowledgebase)

Our current book database includes a total number of 5540 unique titles (excl different editions and translations) for the period 1990-2004. The number of revised editions, student editions and paperback editions sum to 428, whereas we also include 172 Afrikaans translations of tiles.

The book database produced the following set of indicators for this report:

[12] Butler, L. & Vissser, M.S. 2006. Extending citation analysis to non-source items *Scientometrics, 66*(2), 327-334.)

- Number of books per scientific field and per year

3.4 PROFILE OF DOCTORAL DISSERTATIONS (KNOWLEDGE ENTITY 3)

Two sources were used to develop a dedicated dataset of doctoral dissertations produced by South African universities for the period 1990-2004. First, with the close co-operation of the NRF, we were given access to the NEXUS database of completed research. Second, we subsequently added new titles based on a verification process of the UCTD database (Union Catalogue of Theses and Dissertations), which is available through NISC's SA Studies database. Finally, we were able to verify the annual output numbers with the official HEMIS figures provided by the department of Education.

A comparison between the dataset compiled at CREST and the official HEMIS figures (Table 3.4) shows only small differences. The fact that some institutions have supplementary graduation ceremonies scheduled for the year following the academic year for which the qualifying candidates were enrolled for, could have contributed to the differences. Sometimes, due to personal circumstances, a degree is awarded to a candidate only a year or even two after the academic year in which the candidate actually fulfilled all the requirements for the degree. This could also explain some of the differences.

Table 3.4: Breakdown of CREST and HEMIS doctoral dissertation figures per scientific field, 1990-2004

Broad fields	Scientific field	CREST	%	HEMIS	%
Natural & Agricultural Sciences	Agricultural sciences	536	4.8%	413.1	3.6%
	Biological sciences	1161	10.3%	1186.6	10.4%
	Chemical sciences	532	4.7%	534.3	4.7%
	Earth sciences	435	3.9%	243.7	2.1%
	Mathematical sciences & ICCT	426	3.8%	342.4	3.0%
	Physical sciences	252	2.2%	366.4	3.2%
	Subtotal	**3342**	**29.70%**	**3086.5**	**27.00%**
Engineering	**Engineering & applied technologies**	**874**	**7.8%**	**910.3**	**8.0%**
Health Sciences	Basic health	503	4.5%	434.9	3.8%
	Clinical & public health	594	5.3%	820.8	7.2%
	Subtotal	**1097**	**9.80%**	**1255.7**	**11.00%**
Social and Economic Sciences	Economic & management sciences	783	7.0%	844.0	7.4%
	Education	1352	12.0%	1400.8	12.3%
	Psychology	599	5.3%	618.6	5.4%
	Sociology & related studies	279	2.5%	279.5	2.4%
	Other social sciences	487	4.3%	604.0	5.3%
	Subtotal	**3500**	**31.10%**	**3746.9**	**32.80%**
Humanities	Language & linguistics	652	5.8%	677.2	5.9%
	Law	274	2.4%	263.0	2.3%
	Religion	973	8.6%	946.4	8.3%
	Other humanities & arts	538	4.8%	522.3	4.6%

	Subtotal	**2437**	**21.60%**	**2408.9**	**21.10%**
	Grand Total	**11250**	**100.0%**	**11408.3**	**100.0%**

The HEMIS figures in the original data source add up to 11514 for the period 1990-2004 – however the figure reported here (11408) is lower because it excludes students of unknown gender, race and scientific field.

The CREST dataset of doctoral dissertations and the HEMIS figures produced the following three indicators for this report:

- Share of doctoral dissertations per scientific field and per year period, by data source[13]
- Race-by-gender distribution of doctoral dissertations per scientific field and per year period (based on HEMIS figures)
- Proportional contribution of top 5 universities to doctoral dissertations per scientific field and per year period (derived from CREST dataset of doctoral dissertations)

3.5 PROFILE OF SCIENTIFIC COLLABORATION

The ISI journal articles in SAK were used to compile a profile of scientific collaboration for each scientific field. The analysis has been confined to country-level co-authorships. The key problem experienced was that the ISI does not uniquely link each author in a multi-authored paper, to a country or institution. Where there are two authors only and one is from a South African institution and the other from an American institution, assignment to country and institution is straightforward, However, in cases where there are many authors (10+) and only 5 or 6 institutions listed (since some are from the same institution), the index only lists the name of each individual institution once.

The following indicators have been produced:

- Share of foreign co-authorship per scientific field and per year period
- Share of countries co-authoring per scientific field, 1990-2004

3.6 PROFILE OF THE VISIBILITY OF SOUTH AFRICAN PUBLIC SCIENCE

The purpose of the bibliometric analysis is to compare, within each of the 36 top / strategic fields, the citation profile of South Africa to that of 10 benchmarking countries. Benchmarking national science systems is not a straightforward matter. Benchmarking any number of entities requires some degree of similarity on key indicators. When comparing science systems, one needs to look both at indicators pertaining to the science system itself (e.g. GERD), but also at country level indicators (e.g. population size). In addition other more strategic considerations could come into play, most notably which countries one would wish to be compared to. Our final selection of benchmarking countries was thus informed by the following considerations:

- Forefronting S&T indicators (cf Table 3.5 below)
- Considering the size of the countries and science systems concerned

[13] 'Data source' refers here to either the dataset compiled by CREST, or HEMIS

- Selecting countries representing different regions of the world
- Selecting 5 countries that "perform better" than South Africa on GERD and 5 that "perform worse"

A summary of the indicators chosen and South Africa's relative position on these in relation to the 10 benchmarking countries are presented in Table 3.5.

Table 3.5: S&T indicators for South Africa and 10 benchmarking countries

Country	R&D expenditure as % of GDP, 1997-2002[(a)]	Total population in millions, 2003[(a)]	Researchers in R&D per million people, 1990-2003[(a)]	Researchers in R&D per million people, 1994-2004[(b)]	Technology Achievement Index, 2001[(c)]	ISI Article output, 2003[(d)]
Singapore	2.2	4.2	4352	4745	0.585	3122
Spain	1.0	42.1	2036	2195	0.481	16826
Brazil	1.0	181.4	324	344	0.311	8684
Portugal	0.9	10.4	1745	1949	0.419	2625
Turkey	0.7	71.3	345	341	no data	6224
South Africa	**0.7**	**46.9**	**192**	**307**	**0.340**	**2364**
Malaysia	0.7	24.4	294	299	0.396	520
Chile	0.5	16.0	419	444	0.357	1500
Mexico	0.4	104.3	259	268	0.389	3747
Argentina	0.4	38.0	715	720	0.381	3086
Egypt	0.2	71.3	no data	no data	0.236	1720

Data refer to the most recent year available during the period specified

Sources

[(a)] Human Development Report: http://hdr.undp.org/statistics/data/countries.cfm

[(b)] World Bank: http://devdata.worldbank.org/wdi2006/contents/Section5.htm

[(c)] Human Development Report: http://hdr.undp.org/reports/global/2001/en/pdf/techindex.pdf

[(d)] National Science Foundation: http://www.nsf.gov/statistics/seind06/append/c5/at05-41.pdf

(Includes: SCI = Science Citation Index; and SSCI = Social Sciences Citation Index)

The following bibliometric indicators[14] of article output and citation impact were produced by the CWTS for South Africa as well as for the benchmarking countries in the top / strategic fields:

- Total annual publication output per top / strategic field (P)
- Citation frequency (C+sc)
- Citation rate or average number of citations per paper (CPP)
- Journal normalised citation rate (CPP/JCS)

[14] Based on the technical notes compiled by Robert Tijssen, CWTS (31 August 2006). The CWTS produced the results of the citation analysis.

- Field normalised citation rate (CPP/FCS)
- Share of author self-citations (% sc)
- Share of articles not cited within the specified time-interval (% Pnc)

The logic and meaning of these indicators are as follows:

Indicator 1: Total annual publication output per field (P)

"P" is the total number of papers published by a group during the entire period (1990-2005). We considered only normal articles, letters, notes, and reviews. Meeting abstracts, corrections and editorials are not included. In a few cases we found papers published in a journal for which no citation data are available, or in a journal that is not assigned to any field of science. Such papers are not considered in the calculation of the indicators.

The output frequencies are based on integer counting of publications, where each publication is attributed in full to the institution irrespective of the other main institutions that are (or might be) listed in the author addresses information.

Indicator 2: Citation frequency (C+sc)

"C+sc" indicates the total number of citations received, including self-citations. A self-citation to a paper is a citation given in a publication of which at least one of the authors (either first author or a co-author) is also an author of the cited paper (again either first author or a co-author).

Indicator 3: Citation rate or average number of citations per paper (CPP)

"CPP" indicates the average number of citations per publication, or citation per publication ratio. Self-citations are excluded.

Indicator 4: Citation rate or average number of citations per paper (CPP+sc)

"CPP+sc" indicates the average number of citations per publication, or citation per publication ratio. Self-citations are included.

Indicators 5 & 6: Journal normalised citation rate (CPP/JCS) and Field normalised citation rate (CPP/FCS)

"CPP/JCS" and "CPP/FCS" are relative citation impact indicators. These indicators constitute an international average of a specific (combination of) journals or field(s), respectively. In this way, we can obtain an indication of the international position of a research institute/group, in terms of its impact compared to a world average of its relevant research environment. We compare the average number of citations to an institute/group's oeuvre (CPP) to the relevant journal citation score and field citation score (JCS and FCS, respectively).

The mean (world-wide) citation rate of the journals in which the institute/group has published (the mean journal citation score), takes into account the type of paper (e.g., normal article, review) as well as the years in which the institute/group's papers were published. For instance, the number of citations received in 2003-2005 by a review published by an institute/group in 2003 in journal X, is compared to the average number of citations received during the same period (2003-2005) by all reviews published in the same journal (X) in the same year (2003). Generally, an institute/group publishes its papers in several journals rather than one. Therefore, we calculated a weighted average with the weights determined by the number of papers published in each journal.

The second relative indicator is represented by the mean citation rate of the fields in which the institute/group is active (the mean field citation score). FCS is calculated in the same fashion as the JCS, where journals are replaced by fields. In most cases, an institute/group is active in more than one field of science. In those cases, we calculate a weighted average value, the weights being determined by the total number of papers the institute/group has published in each field.

If the ratio CPP/JCS is above 1.0, the mean impact of an institute/group's papers exceeds the mean impact of all articles published in the journals in which the particular institute/group has published its papers. The CPP/FCS indicator enables us to observe whether the performance of a research institute/group or institute is significantly far below (indicator value < 0.5), below (indicator value 0.5 - 0.8), about (0.8 - 1.2), above (1.2 - 2.0), or far above (>2.0) the international (western world dominated) impact standard of the field. Note that the 'world' average is dominated by the Western world; some 80% of all indexed papers are (co)authored by scientists and scholars from the United States, Canada, Western Europe, and Japan.

It is also important to keep in mind that the value of this indicator is related to the aggregation level of the entity under study, owing to statistical properties of publication output distributions. At higher aggregation levels, with larger volumes of publications, it becomes more difficult to surpass an average impact significantly above the international level. In the extreme case, the world as level of aggregation, the score is equal to worldwide average by definition. Hence, on average CPP/FCS values of main institutions tend to be lower than those of units or sub-units. At meso levels (e.g., a large institute, or faculty, about 500 – 1,000 publications per year), a CPP/FCS value above 1.2, such as in this case, means that the institute's impact as a whole is significantly above (western-) world average. The institute can be considered as a scientifically strong organisation, with a high probability to find very good to excellent groups. Therefore, it is important to split large institutes into smaller groups.

In summary: CPP/FCS indicates the impact of an institute/group's articles, compared to the world citation average in the (sub-)fields in which the institute/group is active. Self-citations

are excluded. CPP/JCS indicates the impact of an institute/group's articles, compared to the average citation rate of the institute/group's journals. Self-citations are excluded.

Indicator 7: Share of author self-citations (% sc)

"% sc" is the percentage of self-citations, i.e. the quantity of citations received from the author's successive publications relative to the total number of citations. The percentage of self-citations to an institute/group's oeuvre is influenced by a number of factors. Important factors are: research field; type of articles; age distribution of the articles published by an institute/group; size of the institute/group and number of articles published by the institute/group; and the extent to which the papers published by an institute/group are cognitively related.

A self-citation is defined as a citation in which the citing and the cited paper have at least one author in common (first author or co-author).

Indicator 8: Share of articles not cited within the specified time-interval (% Pnc)

"% Pnc" is the percentage of articles not cited during the time period considered, self-citations excluded.

Lastly, it needs to be remembered that article output is but one of many research-related characteristics that reflect an institution's scientific activities and research performance. A more thorough benchmarking exercise should also include other performance characteristics, such as scientific prizes, number of research staff, PhD students, citation impact, or other types of publication output (books, articles in local journals, etc.).

A further cautionary note relates to the fact that the collection of these publication output quantities is based on the current standardisation of those institutes within the CWTS WoS database. Although CWTS has invested considerable resources and efforts in recent years to attribute as many publications as possible to the corresponding organisational entities (focusing mostly at the aggregate level of 'main institutions', or 'institutes'), an unknown share of publications were not identified due to incomplete or lacking information in the author affiliate addresses (and address variants) referring to those institutions. Hence, in some case the quantities are likely to be lower than the actual output. This bias does not apply, or much less so, in the case of the South African institutes, where meticulous address cleaning and standardisation has been carried out by CWTS (partly in cooperation with CREST).

Lastly, in order to control for differences in the number of researchers per country, a weighting procedure was implemented. The number of researchers in South Africa was expressed as a standard score of 1, and each country's number of researchers expressed as a fraction of 1. For instance, in Table 3.6, Singapore has an average of 4 549 researchers compared to an average of 249.5 for South Africa. Therefore, to control for the difference in the number of researchers, any publication output by Singapore must be multiplied by a weight of 0.05. The latter was computed by the following formula: [South African average / benchmarking country average], which, in this case, would be [249.5/4 549]. Thus, by applying the weight for each country to the output figures (P), **a new indicator was produced [P*Weight], which gives the expected output for the benchmarking country assuming that it had the same number of researchers as South Africa**.

Table 3.6: Figures used to calculate weights to control for differences in the number of researchers per country

Country	Researchers in R&D per million people, 1990-2003 (HRD)	Researchers in R&D per million people, 1994-2004 (WB)	Average of HRD and WB figures	Weight
Singapore	4352	4745	4549	0.05
Spain	2036	2195	2116	0.12
Brazil	324	344	334	0.75
Portugal	1745	1949	1847	0.14
Turkey	345	341	343	0.73
South Africa	**192**	**307**	**249.5**	**1.00**
Malaysia	294	299	297	0.84
Chile	419	444	432	0.58
Mexico	259	268	264	0.95
Argentina	715	720	718	0.35
Egypt	493	493	493	0.51

Sources

[a] Human Development Report: http://hdr.undp.org/statistics/data/countries.cfm

[b] World Bank: http://devdata.worldbank.org/wdi2006/contents/Section5.htm

Notes

Figure for Egypt obtained from: http://info.worldbank.org/etools/docs/library/232715/VC2_Egypt_KE.pdf

Figure for Egypt is for the period 1998-2000

3.7 PROFILE OF KEY INSTITUTIONS

The CWTS produced for 25 of the 36 top / strategic fields a citation analysis per institution. The 25 fields, together with the number of top South African institutions included per field, are shown in Table 3.7.

Table 3.7: Top / strategic fields used in institutional citation analysis

Top / strategic field		Number of top SA institutions selected
Engineering & Applied Technologies	Chemical Engineering	3
	Materials Science	6
Health Sciences	General & Internal Medicine	9
	Genetics & Heredity	3
	Obstetrics, Gynecology & Pediatrics	4
	Pharmacology & Pharmacy	4
	Public, Environmental & Occupational Health	4
	Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine	7
Natural & Agricultural	Astronomy & Astrophysics	3

Top / strategic field		Number of top SA institutions selected
Sciences	Biochemistry, Molecular & Cell Biology	6
	Chemistry	8
	Dairy & Animal Science	4
	Ecology & Environmental Sciences	5
	Entomology	7
	Geosciences	7
	Information Technology	4
	Marine & Freshwater Biology	3
	Microbiology	3
	Nuclear Physics & Nuclear Science & Technology	3
	Ornithology	1
	Physics (Excl Condensed Matter & Nuclear)	7
	Plant Sciences	8
	Veterinary Sciences	3
	Water Resources & Biodiversity Conservation	3
	Zoology	7

Two CWTS bibliometric indicators have been reported for the profile of key institutions, namely:

- Total annual publication output per top / strategic field (P)
- Journal normalised citation rate (CPP/JCS) per top / strategic field

PART B

MAIN RESULTS

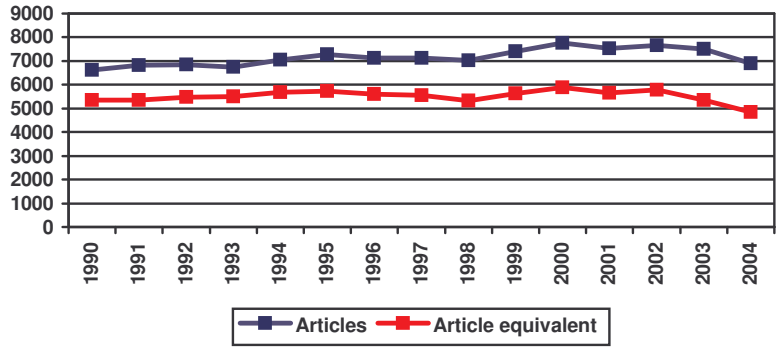
CHAPTER 4
Scientific production and visibility: Key findings

4.1 PRODUCTION OF THE SCIENTIFIC KNOWLEDGEBASE

4.1.1 Total scientific article output (1990-2004)

South Africa's production of scientific articles has remained quite stable over the past 15 years with a small increase over the past five years (Figure 4.1). The seeming decline in output over the past two years (2003 and 2004) is probably due to data capture issues rather than an actual decline in output.

Figure 4.1: Total article output, 1990-2004



4.1.2 Article output by sector

The higher education sector accounted for 78% of the total South African peer-reviewed article output during 1990-2004[15]. The top 5 universities produced, in combination, about 68% of the article output in this sector. Eight more universities each produced about 2%-6% of the total sector output. The combined output of the remaining universities comprised only 3% during that period.

The seven research performing science councils accounted for just over 6% of the total South African article output in peer-reviewed journals during 1990-2004, with three science councils dominating the sector. They are the Agricultural Research Council, the Council for Scientific and Industrial Research, and the Medical Research Council, which respectively produced 44%, 21% and 20% of the total sector output during this period.

[15] This percentage is based on calculating total articles (rather than article equivalents) produced by authors affiliated to a SA university as proportion of total article output. One can also calculate this based on article equivalents. This percentage also refers to share of total public and private scientific output. As a share of public science, the proportion increases to 85%.

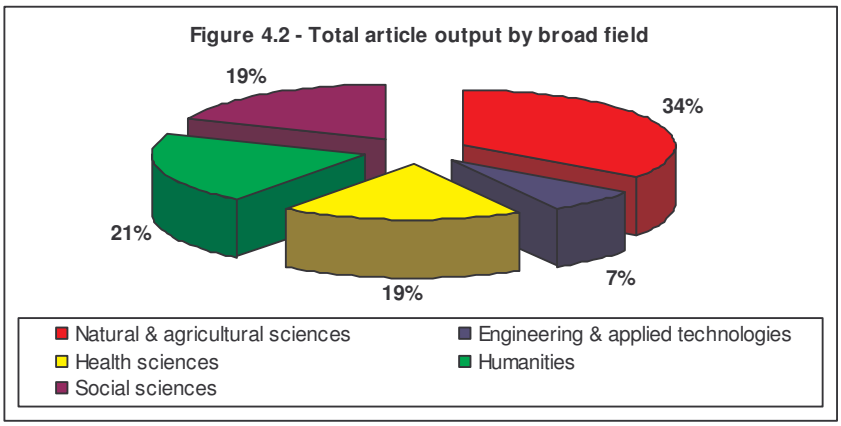
The six national research facilities produced approximately 1.2% of the total South African article output in peer-reviewed journals during 1990-2004. The two most prominent facilities are the South African Astronomical Observatory and the iThemba Laboratory for Accelerator Based Sciences. They respectively accounted for 43% and 30% of the total article output of research facilities over the period of interest.

The remaining 8% of article output is produced by government-based research units, research NGO's and the private and business sector.

4.1.3 Article output by scientific field

Overall output shows that the Natural and Agricultural Sciences produced 34% of total output. The Humanities and Social Sciences together constituted 40%, the Health Sciences 19% and Engineering Science and Applied Technologies 7% of all article output (see Figure 4.2).

Figure 4.2 - Total article output by broad field



Output over time has not shifted significantly with regard to broad field.

The breakdown by journal index shows that the majority of articles in the natural sciences, health sciences and engineering sciences are published in ISI-journals, whereas the majority of articles in the social sciences and humanities are published in non-ISI journals. There has been a small shift in the social sciences towards publishing in ISI-journals over this period. It should, of course, be kept in mind, that the majority of South African journals indexed in the ISI (17 out of 24) are in the natural and health sciences.

Some of the more significant shifts (increases and decreases) in field-specific output are:

- Agricultural sciences losing its "market" share (from 11% to 9%) which is a 15% decline in output
- Engineering and applied technologies increasing it share from 5% to 7% (25% increase in share of national output)
- Basic and clinical health both declining slightly
- Law with a decrease in its share from 7% to 5% (20% loss)
- Other humanities and arts also with a decrease in its share of South Africa's output (from 6% to 4%)

4.1.4 Author demographics of article output: Race and gender

As far as Gender of publishing author is concerned, we have seen a general increase in the number of female authors across ALL FIELDS but one (Psychology). Female authors are best represented in the fields of Education and Public and Community Health (50%) followed by substantive (more than 33) proportions in Language and Linguistics, Sociology and other Social Sciences. The biggest increases in female representation have been in the Health Sciences as well as in the Agricultural, Biological and Engineering Sciences (see Table 4.1).

As far as Race of publishing author is concerned, we have also witnessed a general increase in the number of black authors in ALL FIELDS. Given the small proportions of black authors in all fields in 1990, it is not surprising that some fields have recorded high percentage increases. The fields of Chemical Sciences, Basic Health, Education, Social Sciences and Language and Linguistics now (2004) now have the highest proportions of black authors.

Table 4.1: Summary of author gender and race demographics per scientific field, 1990-1992 and 2002-2004

	Gender		Race	
	% of article equivalents by female authors		% of article equivalents by African/ coloured/ Indian authors	
Scientific field	1990-92	2002-04	1990-92	2002-04
Agricultural Sciences	14%	24%	1%	7%
Biological Sciences	15%	25%	3%	8%
Chemical Sciences	10%	19%	4%	16%
Earth Sciences	15%	25%	1%	5%
Mathematical Sciences & ICCT	9%	13%	5%	9%
Physical Sciences	5%	7%	6%	12%
Multidisciplinary Sciences	13%	22%	2%	4%
Engineering & Applied Technologies	6%	11%	3%	10%
Basic Health	20%	30%	8%	17%
Clinical Health	14%	27%	8%	16%
Public / Community Health	26%	50%	6%	15%
Economic & Management Sciences	11%	21%	4%	11%
Education	27%	50%	7%	21%
Psychology	29%	26%	7%	11%
Sociology & Related Studies	27%	34%	10%	12%
Other Social Sciences	32%	33%	6%	16%
Language & Linguistics	29%	38%	5%	15%
Law	24%	29%	3%	9%
Religion	4%	9%	3%	9%
Other Humanities & Arts	21%	26%	2%	6%

4.1.5 Author demographics of article output: Age

All twenty fields have witness a significant ageing of publishing scientists over the period 1990 to 2004 (see Table 4.2). In nine of these fields, more than HALF of all outputs are now being produced by authors over the age of 50. The majority of these fields are in the Humanities and Social Sciences and the Health Sciences. This general trend also means that production of output by authors under the age of 30 has declined significantly in ALL fields except for Mathematics (where the small sample might have an effect on these trends).

Table 4.2: Summary of author age demographics per scientific field, 1990-1992 and 2002-2004

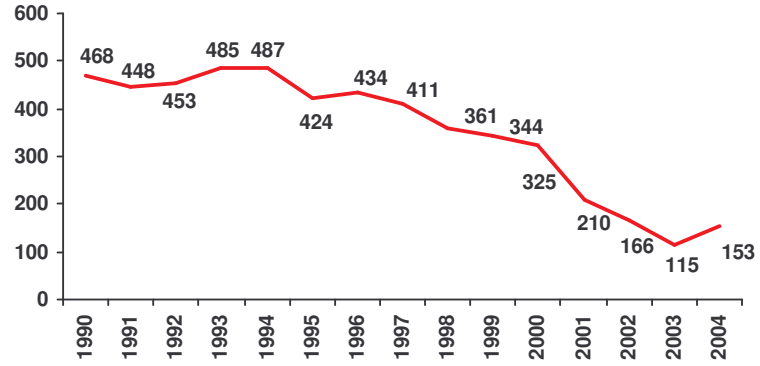
Scientific field	All authors				Top 20% of authors			
	% of article equivalents by persons <30 years		% of article equivalents by persons 50+ years		% of article equivalents by persons <30 years		% of article equivalents by persons 50+ years	
	1990-92	2002-04	1990-92	2002-04	1990-92	2002-04	1990-92	2002-04
Agricultural Sciences	8%	3%	23%	42%	7%	1%	24%	46%
Biological Sciences	7%	5%	20%	41%	7%	3%	21%	44%
Chemical Sciences	6%	7%	32%	47%	6%	5%	34%	**53%**
Earth Sciences	7%	3%	18%	42%	5%	1%	18%	47%
Mathematical Sciences & ICCT	8%	2%	21%	34%	6%	22%	0%	37%
Physical Sciences	8%	5%	34%	49%	7%	2%	35%	**54%**
Multidisciplinary Sciences	8%	2%	25%	53%	6%	<1%	23%	**61%**
Engineering & Applied Technologies	10%	5%	26%	39%	8%	3%	27%	42%
Basic Health	5%	4%	27%	42%	4%	2%	29%	48%
Clinical Health	2%	2%	31%	48%	2%	1%	32%	**54%**
Public / Community Health	6%	3%	32%	46%	6%	2%	31%	**55%**
Economic & Management Sciences	6%	5%	21%	36%	3%	<1%	22%	44%
Education	2%	1%	19%	52%	1%	0%	12%	**74%**
Psychology	5%	3%	15%	32%	4%	0%	15%	33%
Sociology & Related Studies	9%	4%	17%	38%	8%	2%	17%	43%
Other Social Sciences	7%	3%	19%	41%	6%	<1%	19%	45%
Language & Linguistics	4%	<1%	23%	51%	2%	0%	22%	**55%**
Law	7%	5%	17%	38%	6%	1%	17%	47%
Religion	1%	<1%	28%	64%	<1%	0%	27%	**68%**
Other Humanities & Arts	4%	2%	25%	52%	4%	<1%	24%	**59%**

4.1.6 Total scientific book production

Our current book database includes a total number of 5 540 unique titles (excl different editions and translations) for the period 1990-2004. The number of revised editions, student editions and paperback editions sum to 428, whereas we also include 172 Afrikaans translations of titles.

Figure 4.3 presents the distribution of unique book titles by year. The data suggest a disturbing decline since the mid-nineties. Even if one takes into account that coverage of the later years might not be as complete as in the early years the trend is clearly downward.

Figure 4.3: Book output, 1990-2004



4.1.7 Scientific books by scientific field

As one would expect, book production is dominated by the humanities, social and economic sciences (more than 70% of total production – Table 4.3). However, significant proportions (out of total production) of books are also published in the health sciences (3.3%), biological sciences (4.6%), earth sciences (8.6%) and engineering and applied technologies (8.6%).

Table 4.3: Book titles by scientific field

Scientific field	N	Col %
Agricultural sciences	112	2.0%
Biological sciences	255	4.6%
Chemical sciences	6	0.1%
Earth sciences	477	8.6%
Mathematical sciences & ICCT	54	0.9%
Physical sciences	40	0.7%
Engineering & applied technologies	476	8.6%
Basic health	17	0.3%
Clinical health	91	1.6%
Public/ community health	79	1.4%
Economic & management sciences	817	14.7%
Education	419	7.6%
History	326	5.9%
Psychology	71	1.3%
Other social sciences	1768	31.9%
Language & linguistics	41	0.7%

Law	352	6.3%
Other humanities & arts	140	2.5%
All fields	**5541**	**100%**

4.1.8 Publisher information

The 5 540 unique book titles were published by 723 individual publishers or publishing houses. However, nearly half of all titles (46%) were published by 10 publishing houses. In total the "top" 30 publishers produced approximately 65% of all titles (Table 4.4).

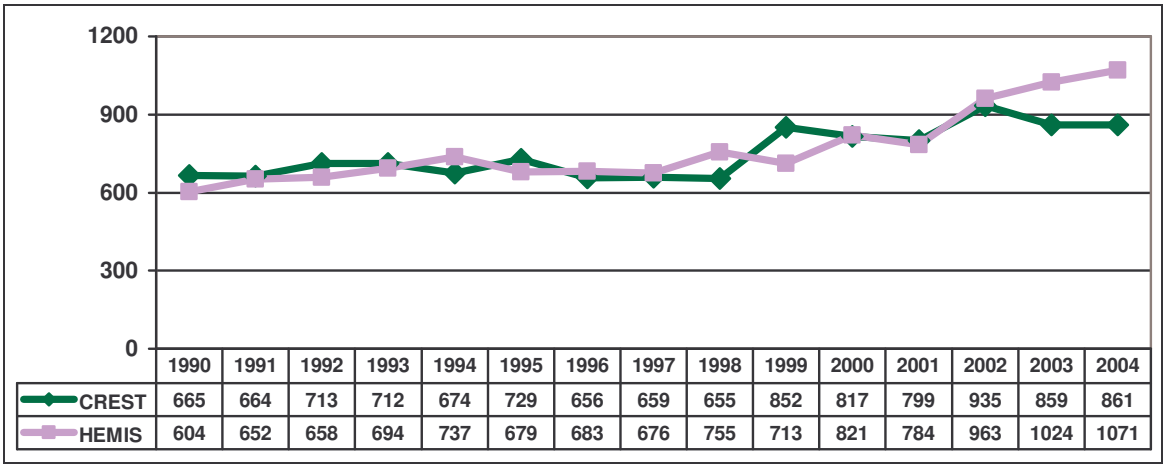
Table 4.4: Book titles by 10 top publishers

Publishers	Book titles	Col %
HSRC	505	8.2%
Juta	495	8.1%
WRC	446	7.3%
University of Cape Town	291	4.7%
Witwatersrand University Press	273	4.4%
University of Natal/ UKZN Press	211	3.4%
University of Port Elizabeth	180	2.9%
UNISA	173	2.8%
Van Schaik	150	2.4%
University of Pretoria	126	2.1%

4.1.9 The production of doctoral graduates

The importance of the doctoral study and doctoral graduates for a national science system has been forefronted in South Africa in recent years against the discourse of regenerating our scientific workforce. The well-established fact of the greying of the active scientific workforce also means that it becomes even more imperative that we produce ever-increasing numbers of doctoral graduates. The official Department of Education (HEMIS) data show a gradual increase in numbers of doctoral graduates over the past fifteen years (Figure 4.4). The average annual increase is in fact 3.9%.

Figure 4.4: Annual distribution of CREST and HEMIS doctoral dissertation figures, 1990 to 2004[16]

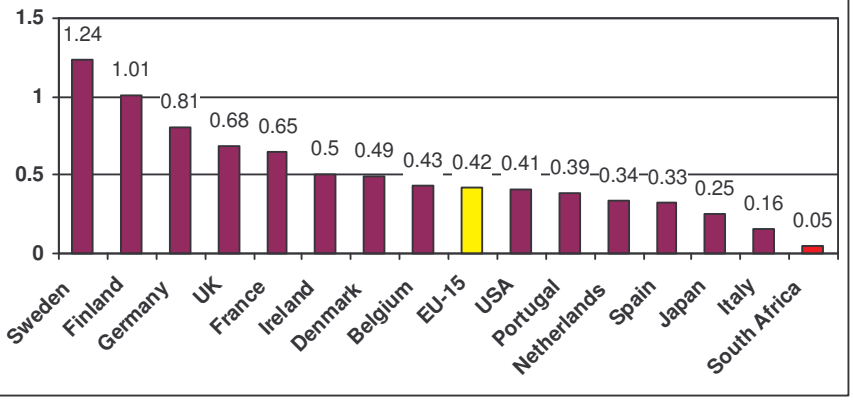


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CREST	665	664	713	712	674	729	656	659	655	852	817	799	935	859	861
HEMIS	604	652	658	694	737	679	683	676	755	713	821	784	963	1024	1071

4.1.10 International comparison of doctoral graduates

A comparison with international data, however, clearly shows that South Africa is producing too few doctoral graduates. In the *Third European Report on S&T Indicators* produced by the European Commission in 2003, statistics is produced on the ratio of PhD's in science and engineering per 1000 of the age group 25-34 for the year 2000 (Figure 4.5).

Figure 4.5: PhD's in S&E per 1000 in the 25-34 age group (2000)



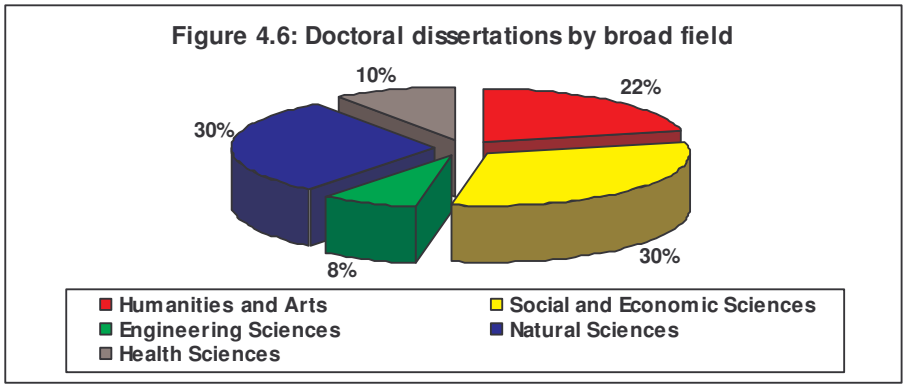
[16] This figure presents the official annual figures of doctoral graduates as released by the DoE. In addition, we present the number of dissertation titles that CREST has managed to obtain for the respective years (cf. Section 3.4). With the exception of the past two years – where it is very difficult still to get information on dissertation titles from all universities – the two data sets are very similar.

In 2000 South Africa produced 370 PhD's in the Sciences and Engineering. This translates into a ratio of 0.05 PhD's per 1000 of the population in the age group. As Figure 4.5 shows, this does not compare well with the EU-15 average of 0.42 or with smaller countries like Portugal.

4.1.11 Doctoral dissertations by scientific field

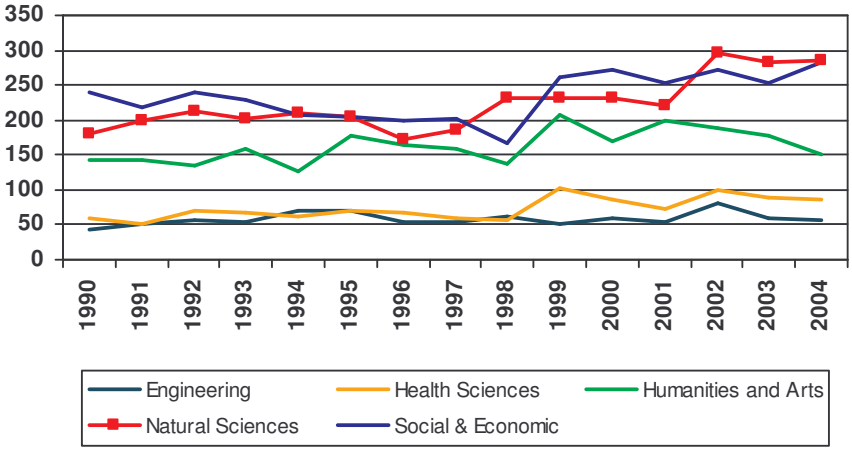
The output of doctoral dissertations by broad scientific field (Figure 4.6) shows that slightly more than half (52%) of all doctoral studies has been in the humanities and social sciences. This is in line with the field distribution of article output.

Figure 4.6: Doctoral dissertations by broad field



The annual doctoral dissertation output by broad scientific field (Figure 4.7) reveals smaller shifts over years (which are to be expected given the relatively small annual output) and a general increase in output for the natural and social sciences over the fifteen year period.

Figure 4.7: Dissertations by broad field per year



4.2 INTERNATIONAL VISIBILITY OF THE SOUTH AFRICAN KNOWLEDGE-BASE: NATIONAL BENCHMARKING RESULTS

4.2.1 Selection of the benchmarking countries

The objective of the study was also to compare, within each of the 36 top / strategic fields, the citation profile of South Africa to that of 10 benchmarking countries. Benchmarking national science systems is not a straightforward matter. Benchmarking any number of entities requires some degree of similarity on key indicators. When comparing science systems, one needs to look both at indicators pertaining to the science system itself (e.g. GERD), but also at country level indicators (e.g. population size). In addition other more strategic considerations could come into play, most notably which countries one would wish to be compared to.

Our final selection of benchmarking countries was thus informed by the following considerations:

- Forefronting S&T indicators
- Considering the size of the countries and science systems concerned
- Selecting countries representing different regions of the world
- Selecting 5 countries that "perform better" than South Africa on GERD and 5 that "perform worse"

A summary of the indicators chosen and South Africa's relative position on these in relation to the 10 benchmarking countries are presented in Table 4.5.

Table 4.5: S&T indicators for South Africa and 10 benchmarking countries

Country	R&D expenditure as % of GDP, 1997-2002 [a]	Total population in millions, 2003 [a]	Researchers in R&D per million people, 1990-2003 [a]	Researchers in R&D per million people, 1994-2004 [b]	Technology Achievement Index, 2001 [c]	ISI Article output, 2003 [d]
Singapore	2.2	4.2	4352	4745	0.585	3122
Spain	1.0	42.1	2036	2195	0.481	16826
Brazil	1.0	181.4	324	344	0.311	8684
Portugal	0.9	10.4	1745	1949	0.419	2625
Turkey	0.7	71.3	345	341	no data	6224
South Africa	**0.7**	**46.9**	**192**	**307**	**0.340**	**2364**
Malaysia	0.7	24.4	294	299	0.396	520
Chile	0.5	16.0	419	444	0.357	1500
Mexico	0.4	104.3	259	268	0.389	3747
Argentina	0.4	38.0	715	720	0.381	3086
Egypt	0.2	71.3	no data	no data	0.236	1720

Data refer to the most recent year available during the period specified

Sources

[a] Human Development Report: http://hdr.undp.org/statistics/data/countries.cfm

[b] World Bank: http://devdata.worldbank.org/wdi2006/contents/Section5.htm

[c] Human **Development** Report: http://hdr.undp.org/reports/global/2001/en/pdf/techindex.pdf

[(d)] National Science Foundation: http://www.nsf.gov/statistics/seind06/append/c5/at05-41.pdf

(Includes: SCI = Science Citation Index; and SSCI = Social Sciences Citation Index)

4.2.2 Benchmarking in terms of total weighted article output

South African institutions occupy the top 3 ranks in 11 of the 36 fields, when we compare the total weighted article output of South Africa to that of the benchmarking countries. With the exception of General & Internal Medicine, Economics & Managements Sciences, Social Sciences, and Humanities, all top ranking fields reflect research activities into the country's natural resource base.

4.2.3 Benchmarking in terms of average citations per paper

Our analysis reveals that the average number of citations per paper is highest in the fields of Oncology, Genetics & Heredity, and Microbiology. South African ranks among the top 3 countries in 22 of the 36 fields, and in 8 of these 22 fields it occupies the first rank.

4.2.4 Benchmarking in terms of journal normalised citation rates

However, if one normalises the average number of citations per paper by taking into account variations in the journals in which the country publishes, it appears that South Africa has a journal normalised citation rate of "good international standing" in only four fields. South Africa ranks among the top 3 countries in these fields, with journal normalised citation rates greater than 1[17]. The fields are as follows:

- Oncology
- Food Science & Technology
- Obstetrics, Gynecology & Pediatrics
- Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine

4.2.5 Benchmarking in terms of field normalised citation rates

The last, and most important, set of results is the one that throws light on the relative position of South Africa to the benchmarking countries in terms of the field normalised citation rate. The latter relates the performance of a country to the international (western world dominated) impact standard of the field. The performance of South Africa is significantly above the international impact standard in only ONE field, namely in Food Science & Technology.

There are seven more fields in which South Africa's performance is on a par with the international average and where the country also occupies one of the top three ranks (compared to the benchmarking countries). The fields are:

- Oncology
- Geosciences
- Microbiology
- Genetics & Heredity
- Veterinary Sciences
- Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine
- Obstetrics, Gynecology & Pediatrics

[17] CPP/JSC ≥ 1.0 [The mean impact of a country's articles **equals** (if 1) **or exceeds** (if > 1) the mean impact of all articles in the journals in which the country published its articles]

4.3 INTERNATIONAL VISIBILITY OF THE SOUTH AFRICAN KNOWLEDGE-BASE: KEY INSTITUTIONS

In order to benchmark the top performing South African institutions we focused on the field normalised citation rates of ALL South African institutions that have been identified as being productive in a particular field. The field normalised citation rates should be interpreted as follows:

CPP/JSC >2.0 [The mean impact of an organisation's articles is **significantly far above** the international impact standard of the field]
CPP/JSC between 1.2 and 2.0 [The mean impact of an organisation's articles is **significantly above** the international impact standard of the field]
CPP/JSC between 0.8 and 1.2 [The mean impact of an organisation's articles is **about** the international impact standard of the field]
CPP/JSC between 0.5 and 0.8 [The mean impact of an organisation's articles is **significantly below** the international impact standard of the field]
CPP/JSC < 0.5 [The mean impact of an organisation's articles is **significantly far below** the international impact standard of the field]

The analyses reveal that the performance of South African institutions is on a par with the international impact standard in the following fields. The fields and institutions are:

- University of Cape Town – Materials Science; Obstetrics, Gynecology & Pediatrics; Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine; and Astronomy & Astrophysics
- Stellenbosch University – Materials Science
- University of the Witwatersrand – Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine; Chemistry; Ecology and Environmental Sciences; and Geosciences
- University of Kwazulu Natal – Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine
- Rhodes University – Marine & Freshwater Biology
- South African Astronomical Observatory – Astronomy & Astrophysics
- Council for Geosciences – Geosciences

In five fields none of the most productive South African institutions has a field normalised citation rate that reflects good international standing. In other words, the citation rates of the institutions in these five fields are all below 0.8. The fields are:

- Biochemistry, Molecular & Cell Biology
- Dairy & Animal Sciences
- Information Technology
- Plant Sciences
- Zoology

Lastly, there are some instances where one would have expected a field normalised citation rate that is at least on a par with the international impact standard of the field. An example is

Nuclear Physics and Nuclear S&T where a good international standing for iThemba LABS is to be expected. However, its citation rate is significantly below the international impact standard of that field. Similarly, in the field of General & Internal Medicine (with the exception of Groote Schuur Hospital), none of the major health school universities has a field normalised citation rate that equals the international average for that field.

CHAPTER 5
SUMMARY PROFILES OF SCIENTIFIC FIELDS

5.1 INTRODUCTION

The summary profiles in this chapter present a list of human capital and knowledgebase indicators for each of the 20 scientific fields and embedded 36 strategic fields. These indicators capture some of the most important features and trends of human capital and knowledge production in these fields. The detailed information and analyses that "inform" these indicators are presented in Section C of this report. Each summary profile consists of the following clusters of indicators:

- Human capital – publishing scientists
  - Comparative gender representation (measured as % female authors in 1990 and 2004)
  - Comparative racial representation (measured as % black authors in 1990 and 2004)
  - Comparative age profile of all scientists publishing in the field (measured as % scientists over the age of 50 in 1990 and 2004)
  - Comparative age profile of the most productive (20%) scientists publishing in the field (measured as % over the age of 50 in 1990 and 2004)
  - Comparative size of the knowledgebase (measured as the number of top 20% of scientists publishing in 2004 compared to 1990)
- Human capital – doctoral graduates
  - Comparative doctoral output (measured as average annual percentage increase over the period 1990-2004)
  - Comparative gender representation (measured as % of female doctorates in 1990 and 2004)
  - Comparative racial representation (measured as % of black doctorates in 1990 and 2004)
- Human capital – institutional human capital (universities producing each more than 10% of doctorates in the field)
- Knowledgebase – scientific output as measured in terms of journal article output (1990 – 2004)
- Knowledgebase – scientific output as measured in terms of scientific and scholarly books[18] (1990 -2004)
- Knowledgebase – scientific collaboration as measured in terms of scientific co-authorship (% foreign co-authorship 1990 and 2004)
- Knowledgebase – national scientific visibility in the strategic fields selected within the particular scientific field (relative position of South Africa compared to 10 benchmarked countries)
- Knowledgebase – institutional impact in the strategic fields selected within the particular scientific field (field-normalised citation rates of South African institutions)

[18] Given that we have set the threshold for total books in a scientific field at 100, only 10 of the 20 fields – mostly in the social sciences and humanities – include this indicator

5.2 AGRICULTURAL SCIENCES

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
14%	24%	1.4%	7.4%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
23.3%	42.3%	24.3%	46%

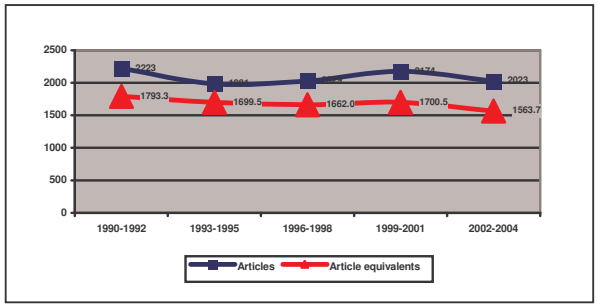
Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
5383	8419	421	368	1077	69.8&

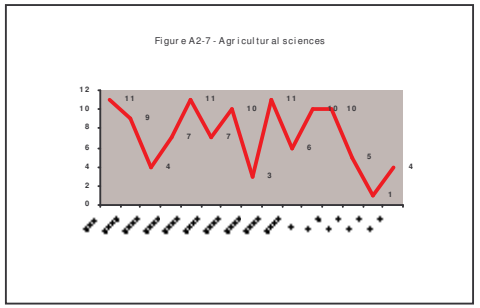
No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
73	146	413	4.7%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
7%	24%	5%	55%

Institutional capacity		
UP	185	34%
UFS	131	24%
SU	97	18%

KNOWLEDGEBASE





INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
3.7%	16.4%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Brazil	Chile	Egypt	Mal	Mex	Port	Sing	Spain	Turkey
Dairy & animal science	2		1				3				
Food science & technology			2				3				1
Plant sciences	1		2				3				
Veterinary sciences	3		1								2

INSTITUTIONAL VISIBILITY

Plant sciences		
Institution	p	CPP/FCS
UCT	347	0.69

Veterinary sciences		
Institution	p	CPP/FCS
ARC	169	1.21
ARC (Onderstepoort)	309	0.9
UP	801	0.85

5.3 BIOLOGICAL SCIENCES

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
15%	25%	3.4%	8.3%

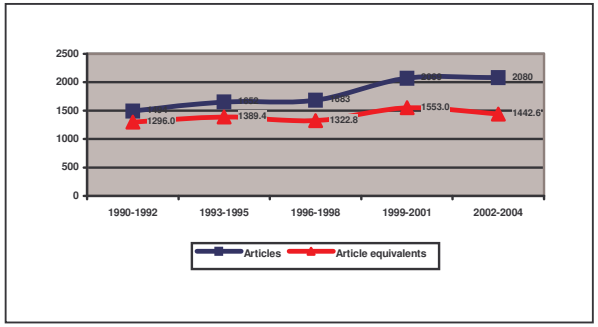
Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
20.4%	41%	21.2%	43.7%

Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
5697	7004	333	397	1139	70.2%

No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
239	291	1187	1.6%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
33.1%	45.2%	4.2%	34.9%%

Institutional capacity		
UCT	215	18%
UKZN	164	14%
RU	136	12%



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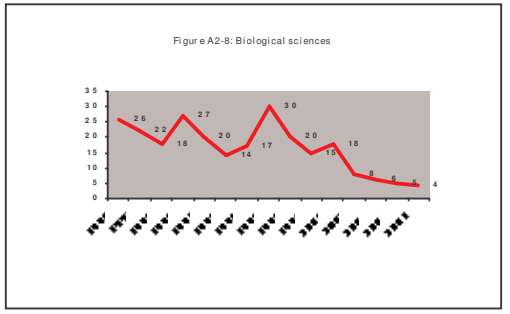

INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
7.5%	25.6%

COMPARATIVE NATIONALVISIBILITY

BIOLOGICAL SCIENCES (Cont)

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Entomology	3		1				2				
Marine & freshwater biology	2		3				1				
Microbiology	3		1				2				
Ornithology	1		3				2				
Zoology	1		2				3				

CPP/JSC >2.0 [The mean impact of an organisation's articles is **significantly far above** the international impact standard of the field]

CPP/JSC between 1.2 and 2.0 [The mean impact of an organisation's articles is **significantly above** the international impact standard of the field]

CPP/JSC between 0.8 and 1.2 [The mean impact of an organisation's articles is **about** the international impact standard of the field]

CPP/JSC between 0.5 and 0.8 [The mean impact of an organisation's articles is **significantly below** the international impact standard of the field]

CPP/JSC < 0.5 [The mean impact of an organisation's articles is **significantly far below** the international impact standard of the field]

INSTITUTIONAL VISIBILITY

Entomology

Institution	p	CPP/FCS
WITS	90	1.02

Marine and Freshwater Biology

Institution	p	CPP/FCS
M&CM	293	0.97
UCT	371	0.92
RHODES	206	0.88

Microbiology

Institution	p	CPP/FCS
SU	208	1.02
WITS	219	0.97

Ornithology

Institution	p	CPP/FCS
	NONE	

Zoology

Institution	p	CPP/FCS
	NONE	

5.4 CHEMICAL SCIENCES

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
10%	19%	4.2%	16.1%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
31.6%	46.8%	34.2%	52.8%

Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
2819	3615	169	193	564	69.7%

No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
53	194	534	12.1%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
43.3%	40.9%	15.3%	40%

Institutional capacity		
WITS	97	18%
UCT	75	14%
UP	69	13%

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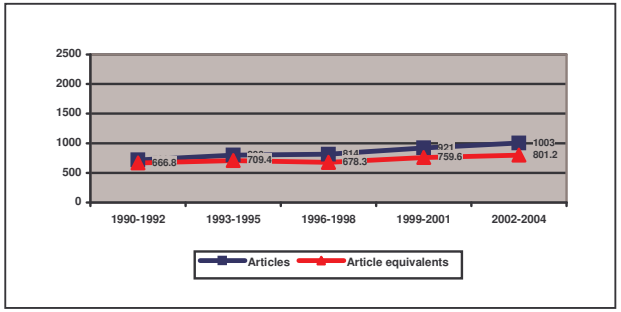


INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
5.4%	18.3%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Chemistry			1							2	3

INSTITUTIONAL VISIBILITY

Chemistry		
Institution	p	CPP/FCS
UCT	582	0.88
SU	244	0.88
WITS	715	0.82

5.5 EARTH SCIENCES

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
15%	25%	1%	4.8%

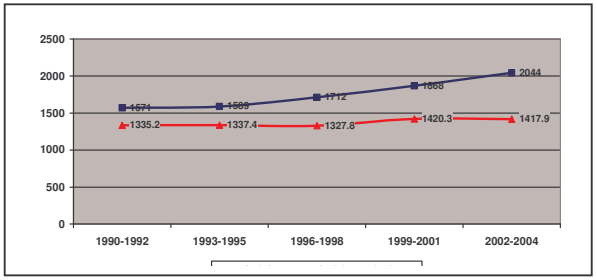
Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
18.3%	42.3%	18.5%	46.6%

Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
4933	6839	348	329	987	68.5%

No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
57	57	244	0%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
12.4%	29.2%	3.5%	20.4%

Institutional capacity		
UCT	79	18%
WITS	73	17%
UP	59	13%



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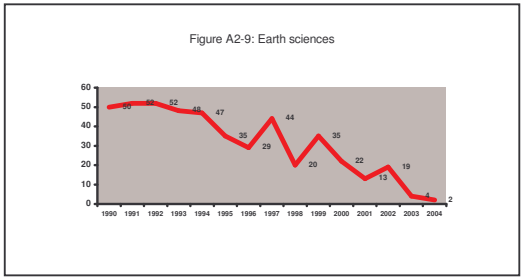


INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
7.0%	24.2%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Ecology & environmental sciences	1		2				3				
Geosciences	1		2				3				
Water resources & biodiversity conservation	1						2				3

INSTITUTIONAL VISIBILITY

Ecology & Environmental Sciences

Institution	p	CPP/FCS
UCT	755	1.01
WITS	269	0.93

Water resources & Biodiversity

Institution	p	CPP/FCS
UCT	295	1.11

Geosciences

Institution	p	CPP/FCS
UCT	482	1.27
UJ	163	1.15
WITS	533	0.96
CGS	176	0.82

5.6 MATHEMATICAL SCIENCES & ICCT

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
9%	13%	4.9%	9.1%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
20.6%	34.3%	22%	37.2%

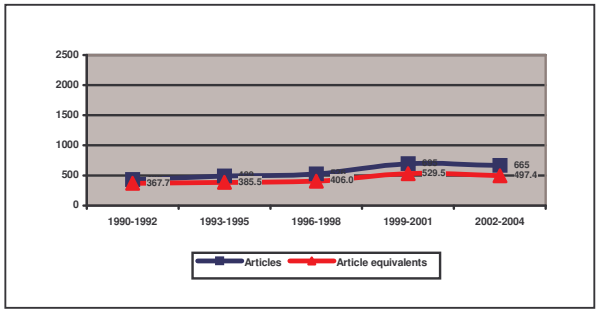
Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
1256	2186	66	85	251	66.2%

No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
40	108	342	6.8%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
17.5%	31.4%	14.2%	41.5%

Institutional capacity		
UCT	74	17%
UP	73	17%
UKZN	56	13%

KNOWLEDGEBASE



INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
8.2%	21.1%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Information technology			1				3				2
Mathematics	3		1				2				

INSTITUTIONAL VISIBILITY

ICCT		
Institution	p	CPP/FCS
	NONE	

Mathematics		
Institution	p	CPP/FCS

5.7 PHYSICAL SCIENCES

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
5%	7%	5.6%	12.4%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
33.7%	48.6%	35.4%	54.4%

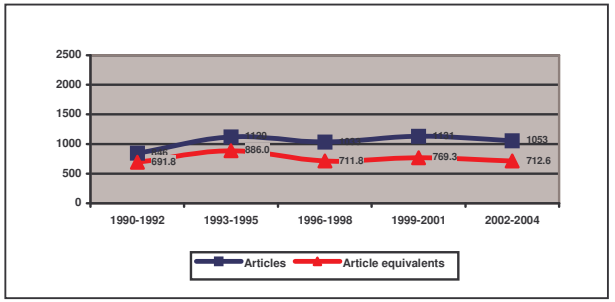
Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
2264	3771	181	173	453	73.7%

No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
62	73	366	1.1%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
12.9%	31.4%	3.3%	49.1%

Institutional capacity		
WITS	52	21%
UKZN	36	14%
UCT	34	13%

KNOWLEDGEBASE



INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
16.1%	30.4%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Astronomy & astrophysics	3		1				2				
Condensed matter physics			1				2				3
Nuclear physics & nuclear science & technology	3		1				2				
Physics (excl condensed matter &											

INSTITUTIONAL IMPACT

Astronomy

Institution	p	CPP/FCS
UCT	410	0.87
SAAO	628	0.81

Physics (excl. condensed matter physics)

Institution	p	CPP/FCS
UCT	409	0.83

Nuclear Physics

Institution	p	CPP/FCS
UCT	144	0.93

5.8 MULTIDISCIPLINARY SCIENCES

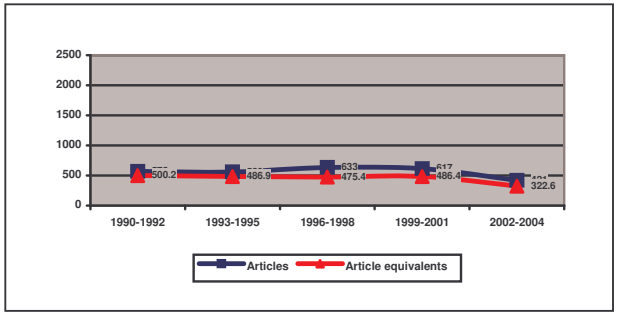
HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
13%	22%	2%	4.5%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
24.9%	52.6%	23.2%	61.1%

Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
2885	2272	105	57	577	573%

KNOWLEDGEBASE



INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
4.2%	15.8%

5.9 ENGINEERING & APPLIED TECHNOLOGIES

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
6%	11%	3.4%	10.4%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
26.2%	39%	26.7%	42.2%

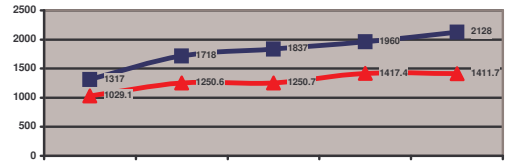
Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
5130	6359	204	276	1026	65.7%

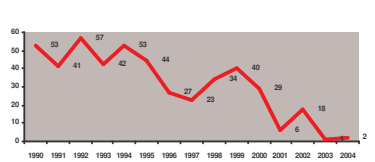
No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
143	229	910	3.2%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
0.7%	11.8%	1.4%	15.8%

Institutional capacity		
WITS	220	25%
US	163	18%
UCT	154	17%

KNOWLEDGEBASE





INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
6.2%	14.4%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Chemical engineering			2				3				1
Electrical & electronic engineering			1				3				2
Materials science			1				3				2
Mechanical engineering			2				3				1
Metallurgy & metallurgical engineering	1		2				3				

INSTITUTIONAL IMPACT

Chemical engineering

Institution	p	CPP/FCS
UCT	143	1.14

Materials Science

Institution	p	CPP/FCS
CSIR	136	2.22
SU	148	0.88
UCT	164	0.86

5.10 BASIC HEALTH

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
20%	30%	7.9%	17.1%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
26.9%	41.8%	28.6%	48%

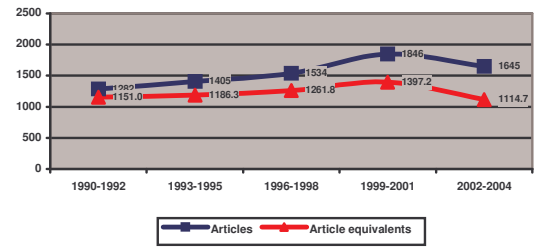
Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
6963	6111	427	361	1393	65.1%

No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
69	123	435	3.9%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
37.7%	57.7%	8.6%	40.7%

Institutional capacity		
UCT	167	33%
WITS	144	28%
US	56	11%

KNOWLEDGEBASE



INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
7.1%	25.5%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Biochemistry, molecular & cell biology			1				2			3	
Genetics & heredity	3		1				2				

INSTITUTIONAL IMPACT

Genetics and heredity		
Institution	p	CPP/FCS
WITS	182	1.09
UCT	220	0.82

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
General & internal medicine	1									3	2
Obstetrics, gynecology & pediatrics	2		3								1
Oncology	3		2								1
Pharmacology & pharmacy			1				3				2
Surgery	3		2								1
Virology, infectious diseases, immunology, parasitology & tropical medicine	2		1				3				

5.11 CLINICAL HEALTH

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
14%	27%	7.5%	16.2%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
30.6%	48.3%	31.6%	54.1%

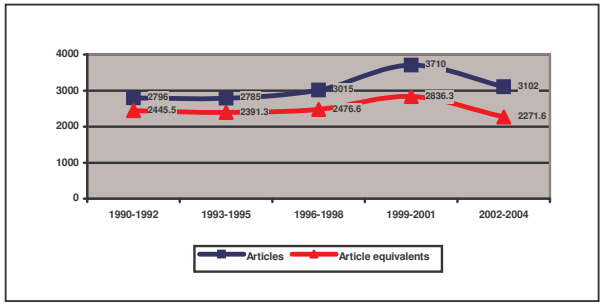
Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
9860	12421	759	611	1972	71.5%

No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
125	211	821	3.6%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
39.2%	58.7%	8.8%	30.9%

Institutional capacity		
UCT	64	19%
NWU	46	14%
US	46	14%

KNOWLEDGEBASE



INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
4.1%	18.7%

COMPARATIVE NATIONAL VISIBILITY

5.11 CLINICAL HEALTH (Cont)

INSTITUTIONAL IMPACT

General & Internal Medicine

Institution	p	CPP/FCS
HOSP G SCHUUR	595	1.03

Obstetrics, gynecology & pediatrics

Institution	p	CPP/FCS
SU	278	0.91
UCT	313	0.89

Pharmacology

Institution	p	CPP/FCS
WITS	201	0.86

Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine

Institution	p	CPP/FCS
NHLS	229	1.30
MRC	293	0.90
UKZN	306	0.84
WITS	491	0.82
UCT	412	0.80

5.12 PUBLIC & COMMUNITY HEALTH

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
26%	50%	6.2%	14.8%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
32.1%	46..2%	30.8%	54.5%

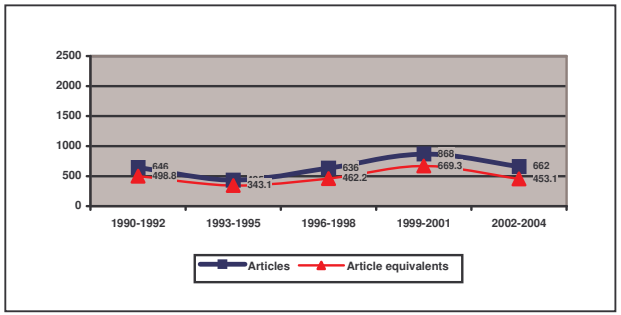
Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
2645	2426	134	125	529	58.2%

No of PhDs		
1990 - 1992	2002 - 2004	Total

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
			%

Institutional capacity		
UJ	46	17%
UNISA	41	15%
NWU	29	11%

KNOWLEDGEBASE



INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
3.2%	19.1%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Public, environmental & occupational health	3		1				2				

INSTITUTIONAL IMPACT

Public Health		
Institution	p	CPP/FCS
MRC	288	1.14

5.13 ECONOMICS & MANAGEMENT SCIENCES

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
11%	21%	4.4%	11.4%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
21.4%	35.9%	21.8%	43.5%

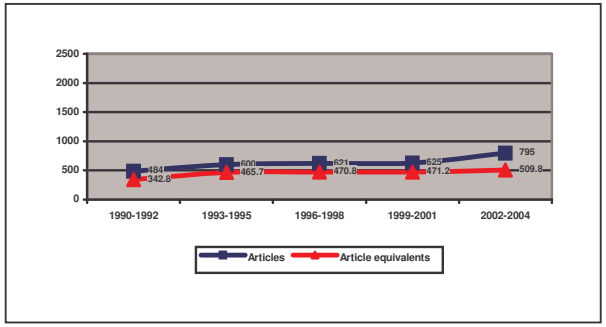
Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
1428	2260	69	76	286	60.5%

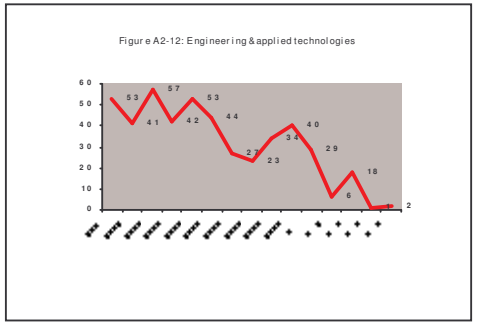
No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
151	296	844	4.6%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
14.6%	28.1%	5.3%	40.8%

Institutional capacity		
UP	168	20%
UNISA	129	16%
UJ	94	11%

KNOWLEDGEBASE





INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
3.1%	8.7%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Economics & management sciences	1						3				2

5.14 EDUCATION

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
27%	50%	7.2%	20.9%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
19.2%	51.6%	12.3%	74%

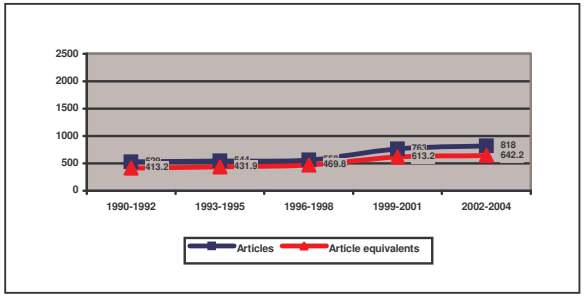
Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
1726	2570	61	96	345	57.8%

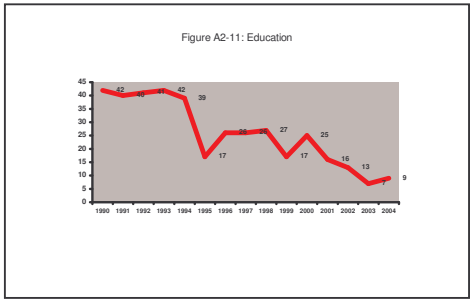
No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
242	334	1401	2.2%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
35.5%	47.3%	13.2%	57.2%

Institutional capacity		
UNISA	316	23%
UP	240	17%
UJ	179	13%

KNOWLEDGEBASE





INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
1.4%	4.3%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Social sciences	1		2				3				

5.15 PSYCHOLOGY

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
29%	26%	7.1%	10.6%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
15.3%	32.2%	15.1%	32.8%

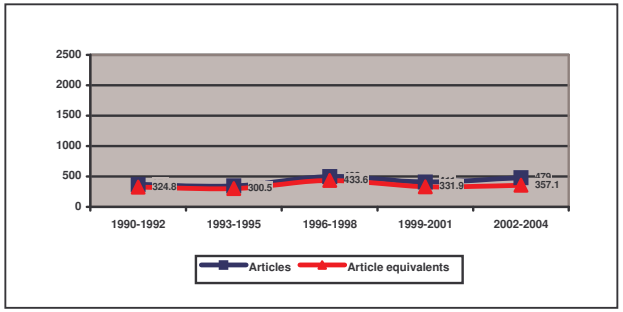
Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
1420	1748	69	75	284	67.1%

No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
84	154	619	4.1%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
28.6%	66.4%	7.1%	18.4%%

Institutional capacity		
UNISA	100	17%
UP	92	15%
UFS	84	14%

KNOWLEDGEBASE



INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
3.0%	17.1%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Social sciences	1		2				3				

5.16 SOCIOLOGY & RELATED STUDIES

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
27%	34%	9.8%	12%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
17.4%	37.8%	17.3%	43.3%

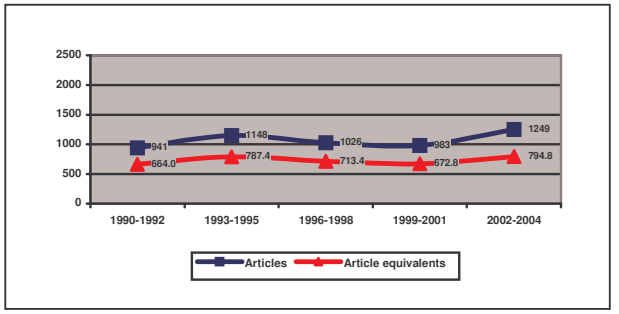
Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
1954	3633	97	98	391	61.1%

No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
55	94	280	3.6%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
40.4%	42.0%	11.0%	42.6%

Institutional capacity		
UNISA	50	17%
UKZN	31	11%
UP	31	11%

KNOWLEDGEBASE



INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
2.8%	10.0%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Social sciences	1		2				3				

5.17 OTHER SOCIAL SCIENCES

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
32%	33%	5.8%	16.2%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
18.5%	41.4%	19%	45.3

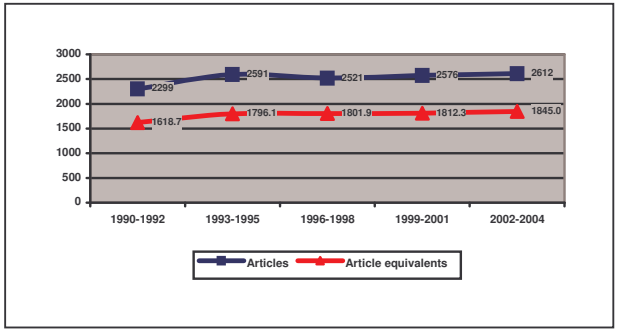
Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
6127	8874	282	272	1225	61.6%

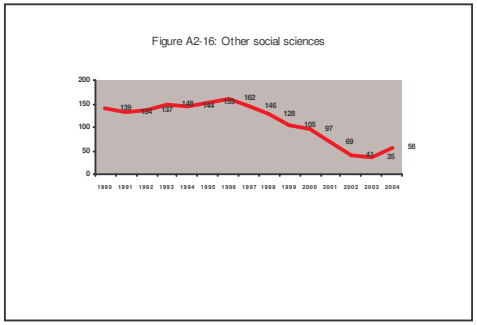
No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
125	165	604	1.8%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
46.6%	52.2%	12.9%	37.2%

Institutional capacity		
UP	102	20%
UNISA	66	13%

KNOWLEDGEBASE





INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
3.0%	10.8%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Social sciences	1		2				3				

5.18 LANGUAGE & LINGUISTICS

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
29%	38%	5.3%	14.7%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
23.5%	50.9%	27.7%	55.3%

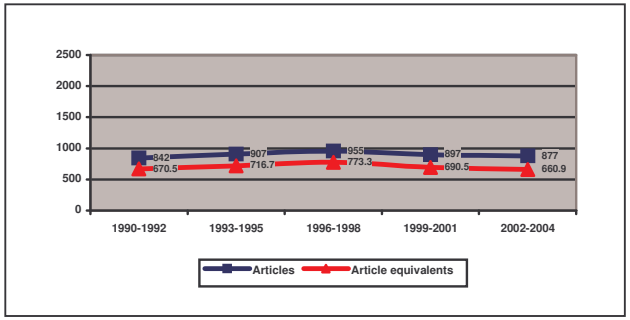
Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
1229	3512	88	68	246	58.6%

No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
95	164	677	3.7%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
49.5%	46.8%	8.4%	46.2%

Institutional capacity		
UNISA	122	18%
UCT	89	13%
NWU	64	10%

KNOWLEDGEBASE



INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
0.2%	2.9%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Humanities	1						2				3

5.19 LAW

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
24%	29%	2.7%	8.7%

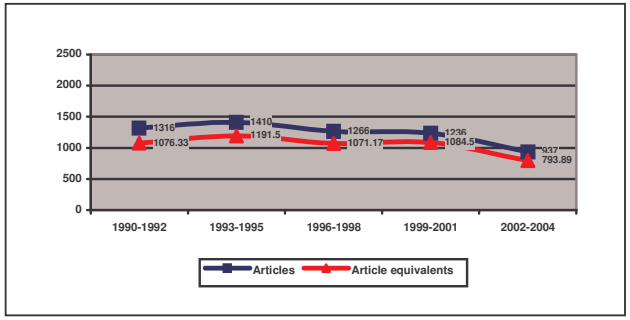
Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
16.6%	37.8%	17.1%	46.8%

Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
892	5217	100	43	178	70%

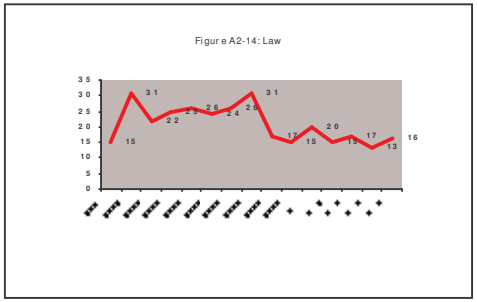
No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
51	54	263	0.4%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
25.5%	42.6%	3.9%	27.8%

Institutional capacity		
UNISA	78	27%
UP	51	18%



KNOWLEDGEBASE



INTERNATIONAL CO-OPERATION

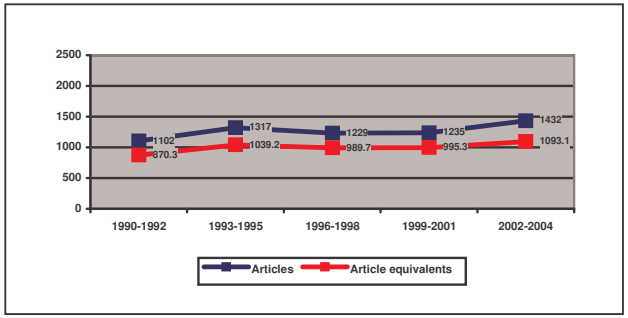
Foreign co-authorship	
1990 - 1992	2002 - 2004
1.9%	2.6%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Humanities	1						2				3

5.20 RELIGION

KNOWLEDGEBASE



HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
4%	9%	3.2%	8.6%

Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
27.7%	63.5%	26.6%	67.8%

Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
1059	4988	104	105	212	69.2%

No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
135	269	946	4.7%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
6.7%	12.5%	12.6%	36.5%

Institutional capacity		
UNISA	266	27%
UP	199	20%
US	158	16%

INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
0.7%	3.7%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Humanities	1						2				3

5.21 OTHER HUMANITIES & ARTS

HUMAN CAPITAL BASE

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
21%	26%	1.7%	5.8%

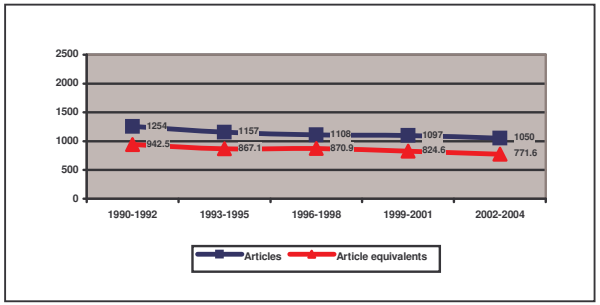
Age all authors (% >50)		Age of top20%(above 50)	
1990	2004	1990	2004
24.8%	52.2%	51%	59%

Unique authors	Art equiv	Top 20% SA authors			
Total	Total	1990	2004	Total	% art equiv
2006	4277	135	95	401	58.5%

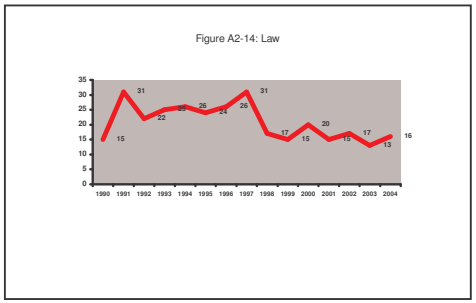
No of PhDs			Average annual increase
1990 - 1992	2002 - 2004	Total	
104	96	522	-0.5%

Gender (% Female)		Race (% Black)	
1990	2004	1990	2004
27.9%	42.2%	11.5%	31.3%

Institutional capacity		
US	83	15%
UCT	73	13%
UP	71	13%



KNOWLEDGEBASE



INTERNATIONAL CO-OPERATION

Foreign co-authorship	
1990 - 1992	2002 - 2004
2.5%	6.7%

COMPARATIVE NATIONAL VISIBILITY

Top / strategic field	RSA	Arg	Braz	Chile	Egypt	Ma	Mex	Por	Sing	Spain	Turk
Humanities	1						2				3

PART C

DETAILED RESULTS

NAVIGATION TABLE TO THE FIELD-BY-FIELD ANALYSIS IN CHAPTERS 6 TO 11

LOCATION IN PART C OF THE REPORT	RESULTS PROVIDED
AGRICULTURAL SCIENCES	
Chapter 6, Section 6.4.1	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.1	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 7, Section 7.4	* Book output by year, 1990-2004
Chapter 8, Section 8.3.1	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.1	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
Chapter 10, Sections 10.2.17; 10.2.20; 10.2.30; & 10.2.31	* International benchmarking (citation profiles) in the following strategic fields: ▪ Dairy & animal science (10.2.17) ▪ Food science & technology (10.2.20) ▪ Plant sciences (10.2.30) ▪ Veterinary sciences (10.2.31)
Chapter 11, Section 11.2	* Impact (citation) of top institutions compared to international impact standard in the following strategic fields: ▪ Dairy & animal science ▪ Plant sciences ▪ Veterinary sciences

LOCATION IN PART C OF THE REPORT	RESULTS PROVIDED
BIOLOGICAL SCIENCES	
Chapter 6, Section 6.4.2	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.2	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 7, Section 7.4	* Book output by year, 1990-2004
Chapter 8, Section 8.3.2	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.2	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
Chapter 10, Sections 10.2.19; 10.2.23; 10.2.25; 10.2.26; & 10.2.33	* International benchmarking (citation profiles) in the following strategic fields: ▪ Entomology (10.2.19) ▪ Marine & freshwater biology (10.2.23) ▪ Microbiology (10.2.25) ▪ Ornitholoy (10.2.265) ▪ Zoology (10.2.33)
Chapter 11, Section 11.2	* Impact (citation) of top institutions compared to international impact standard in the following strategic fields: ▪ Entomology ▪ Marine & freshwater biology ▪ Microbiology ▪ Ornitholoy ▪ Zoology

LOCATION IN PART C OF THE REPORT	RESULTS PROVIDED
CHEMICAL SCIENCES	
Chapter 6, Section 6.4.3	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.3	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 8, Section 8.3.3	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.3	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
Chapter 10, Section 10.2.16	* International benchmarking (citation profiles) in the following strategic field: ▪ Chemistry (10.2.16)
Chapter 11, Section 11.2	* Impact (citation) of top institutions compared to international impact standard in the following strategic field: ▪ Chemistry

EARTH SCIENCES	
Chapter 6, Section 6.4.4	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.4	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 7, Section 7.4	* Book output by year, 1990-2004
Chapter 8, Section 8.3.4	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.4	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
Chapter 10, Sections 10.2.18; 10.2.21; & 10.2.32	* International benchmarking (citation profiles) in the following strategic fields: ▪ Ecology & environmental sciences (10.2.18) ▪ Geosciences (10.2.21) ▪ Water resources & biodiversity conservation (10.2.32)
Chapter 11, Section 11.2	* Impact (citation) of top institutions compared to international impact standard in the following strategic fields: ▪ Ecology & environmental sciences ▪ Geosciences ▪ Water resources & biodiversity conservation

MATHEMATICAL SCIENCES & ICCT	
Chapter 6, Section 6.4.5	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.5	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 8, Section 8.3.5	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.5	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
Chapter 10, Sections 10.2.22 & 10.2.24	* International benchmarking (citation profiles) in the following strategic fields: ▪ Information technology (10.2.22) ▪ Mathematics (10.2.24)
Chapter 11, Section 11.2	* Impact (citation) of top institutions compared to international impact standard in the following strategic field: ▪ Information technology

PHYSICAL SCIENCES	
Chapter 6, Section 6.4.6	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.6	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 8, Section 8.3.6	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.6	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
Chapter 10, Sections 10.2.14; 10.2.27; 10.2.28; & 10.2.29	* International benchmarking (citation profiles) in the following strategic fields: ▪ Astronomy & astrophysics (10.2.14) ▪ Nuclear physics and nuclear science & technology (10.2.27) ▪ Condensed matter physics (10.2.28) ▪ Physics (excl Condensed matter & nuclear) (10.2.29)
Chapter 11, Section 11.2	* Impact (citation) of top institutions compared to international impact standard in the following strategic fields: ▪ Astronomy & astrophysics ▪ Nuclear physics and nuclear science & technology ▪ Physics (excl Condensed matter & nuclear)

MULTIDISCIPLINARY SCIENCES	
Chapter 6, Section 6.4.7	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.7	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 9, Section 9.2.7	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field

ENGINEERING & APPLIED TECHNOLOGIES	
Chapter 6, Section 6.4.8	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.8	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 7, Section 7.4	* Book output by year, 1990-2004
Chapter 8, Section 8.3.7	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.8	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
Chapter 10, Sections 10.2.1; 10.2.2; 10.2.3; 10.2.4; & 10.2.5	* International benchmarking (citation profiles) in the following strategic fields: ▪ Chemical engineering (10.2.1) ▪ Electrical & electronic engineering (10.2.2) ▪ Materials science (10.2.3) ▪ Mechanical engineering & mechanics (10.2.4) ▪ Metallurgy & metallurgical engineering (10.2.5)
Chapter 11, Section 11.2	* Impact (citation) of top institutions compared to international impact standard in the following strategic fields: ▪ Chemical engineering ▪ Materials science

BASIC HEALTH	
Chapter 6, Section 6.4.9	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.9	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 8, Section 8.3.8	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.9	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
Chapter 10, Sections 10.2.7 & 10.2.15	* International benchmarking (citation profiles) in the following strategic fields: ▪ Genetics & heredity (10.2.7) ▪ Biochemistry, molecular & cell biology (10.2.15)
Chapter 11, Section 11.2	* Impact (citation) of top institutions compared to international impact standard in the following strategic fields: ▪ Genetics & heredity ▪ Biochemistry, molecular & cell biology

CLINICAL HEALTH	
Chapter 6, Section 6.4.10	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.10	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 8, Section 8.3.9 (Combined with public & community health)	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.10	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
Chapter 10, Sections 10.2.6; 10.2.8; 10.2.9; 10.2.10; 10.2.12; & 10.2.13	* International benchmarking (citation profiles) in the following strategic fields: ▪ General & internal medicine (10.2.6) ▪ Obstetrics, gynecology & pediatrics (10.2.8) ▪ Oncology (10.2.9) ▪ Pharmacology & pharmacy (10.2.10) ▪ Surgery (10.2.12) ▪ Virology, infectious diseases, immunology, parasitology & tropical medicine (10.2.13)
Chapter 11, Section 11.2	* Impact (citation) of top institutions compared to international impact standard in the following strategic fields: ▪ General & internal medicine ▪ Obstetrics, gynecology & pediatrics ▪ Pharmacology & pharmacy ▪ Virology, infectious diseases, immunology, parasitology & tropical medicine

PUBLIC & COMMUNITY HEALTH	
Chapter 6, Section 6.4.11	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.11	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 8, Section 8.3.9 (Combined with clinical health)	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.11	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
Chapter 10, Section 10.2.11	* International benchmarking (citation profiles) in the following strategic field: ▪ Public, environmental & occupational health (10.2.11)
Chapter 11, Section 11.2	* Impact (citation) of top institutions compared to international impact standard in the following strategic field: ▪ Public, environmental & occupational health

ECONOMICS & MANAGEMENT SCIENCES	
Chapter 6, Section 6.4.12	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.12	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 7, Section 7.4	* Book output by year, 1990-2004
Chapter 8, Section 8.3.10	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.12	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
Chapter 10, Section 10.2.34	* International benchmarking (citation profiles) in the following strategic field: ▪ Economics & management sciences (10.2.34)
Chapter 11, Section 11.2	* Impact (citation) of top institutions compared to international impact standard in the following strategic field: ▪ Economics & management sciences

EDUCATION	
Chapter 6, Section 6.4.13	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.13	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 7, Section 7.4	* Book output by year, 1990-2004
Chapter 8, Section 8.3.11	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.13	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
PSYCHOLOGY	
Chapter 6, Section 6.4.14	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.14	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 8, Section 8.3.12	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.14	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field

SOCIOLOGY & RELATED STUDIES	
Chapter 6, Section 6.4.15	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.15	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 8, Section 8.3.13	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.15	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
OTHER SOCIAL SCIENCES	
Chapter 6, Section 6.4.16	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.16	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 7, Section 7.4	* Book output by year, 1990-2004
Chapter 8, Section 8.3.14	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.16	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field

LANGUAGE & LINGUISTICS	
Chapter 6, Section 6.4.17	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.17	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 7, Section 7.4 (Part of 'humanities & arts')	* Book output by year, 1990-2004
Chapter 8, Section 8.3.15	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.17	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
LAW	
Chapter 6, Section 6.4.18	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.18	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 7, Section 7.4	* Book output by year, 1990-2004
Chapter 8, Section 8.3.16	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.18	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field

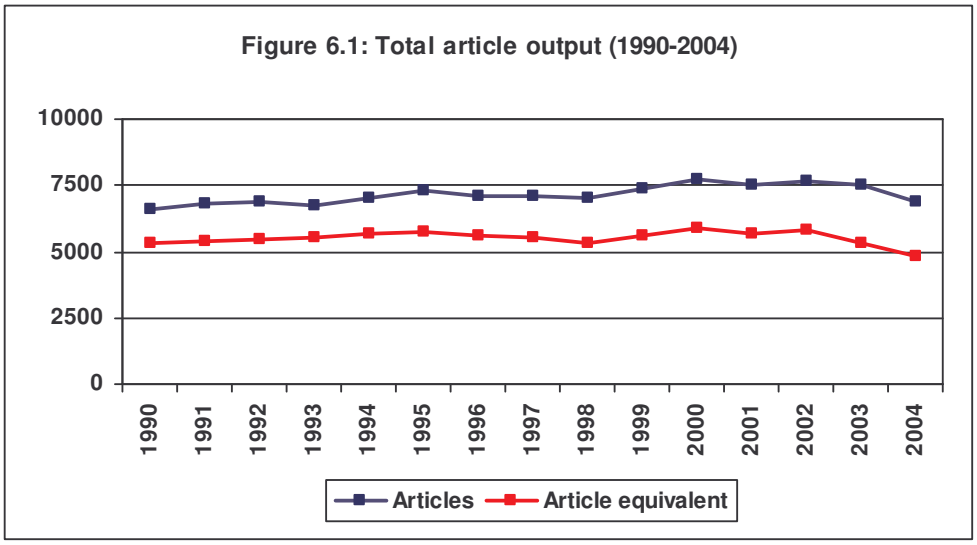
RELIGION	
Chapter 6, Section 6.4.19	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.19	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 7, Section 7.4 (Part of 'humanities & arts')	* Book output by year, 1990-2004
Chapter 8, Section 8.3.17	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.19	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field
OTHER HUMANITIES & ARTS	
Chapter 6, Section 6.4.20	* Articles and article equivalents by 3-year periods, 1990-2004
Chapter 6, Section 6.5.20	* Article equivalents by gender of authors (3-year periods, 1990-2004) * Article equivalents by race of authors (3-year periods, 1990-2004) * Article equivalents by age of authors (3-year periods, 1990-2004) * Article equivalents by age of authors for top 20% of authors (3-year periods, 1990-2004)
Chapter 7, Section 7.4	* Book output by year, 1990-2004
Chapter 8, Section 8.3.18	* Share of doctoral dissertations in field (3-year periods, 1990-2004) * Race-by-gender profile of those producing doctoral dissertations (3-year periods, 1990-2004) * Top 5 universities producing doctoral dissertations
Chapter 9, Section 9.2.20	* Share of foreign co-authorship (3-year periods, 1990-2004) * List of countries co-authoring in field

CHAPTER 6
PROFILE OF JOURNAL ARTICLE OUTPUT

6.1 TOTAL SCIENTIFIC ARTICLE OUTPUT

Figure 6.1 shows that South Africa's production of scientific articles has remained quite stable over the past 15 years with a small increase over the past five years. The seeming decline in output over the past two years (2003-2004) is probably due to data capture issues rather than an actual decline in output.

Figure 6.1: Total article output (1990-2004)



6.2 ARTICLE OUTPUT BY SECTOR

In Figure 6.2 we show the total article output (in terms of fractional counts or article equivalents) broken down by sector. Table 6.1 gives a breakdown of the South African article equivalents by year. Table 6.2 does the same but for articles.

Figure 6.2: Article output by sector (1990-2004)

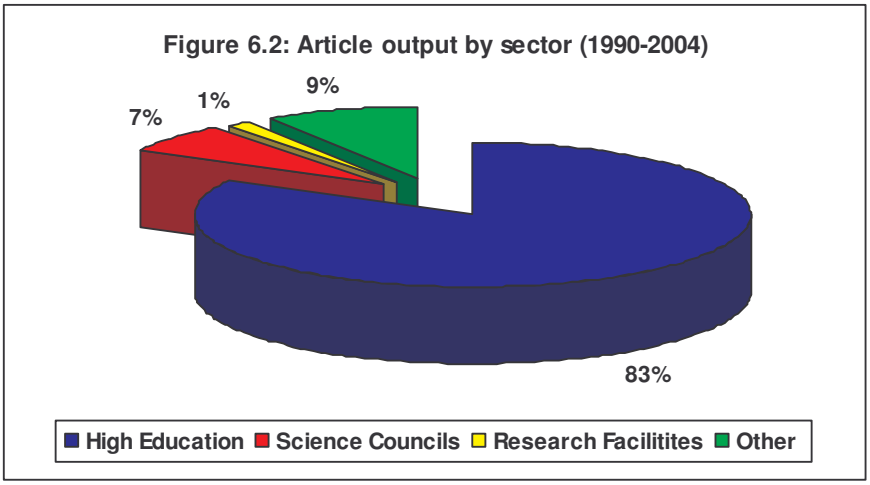


Table 6.1: Article equivalent output by sector and year, 1990-2004

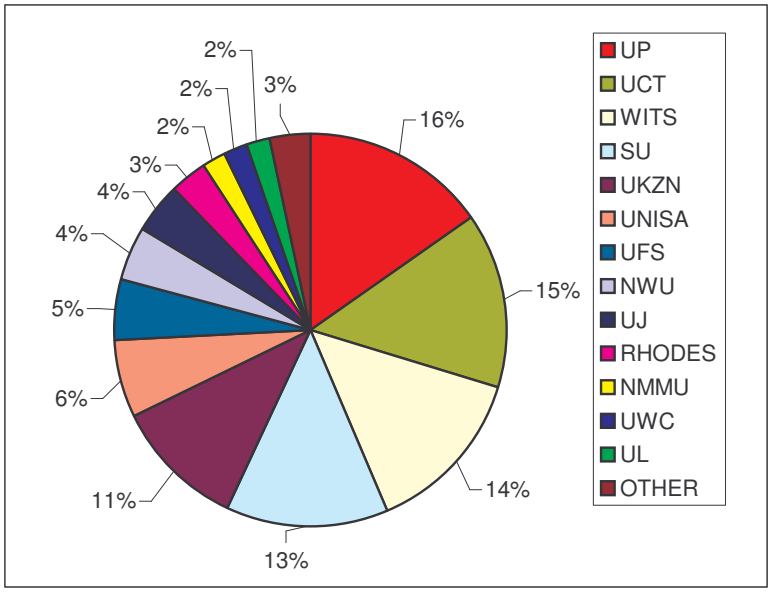
Year	Total SA	HE	SC	RF	Other SA
1990	5347.48	4498.15	408.88	48.26	392.19
1991	5356.01	4550.78	371.92	37.68	395.63
1992	5485.98	4665.76	352.38	50.67	417.18
1993	5496.47	4737.52	319.44	45.04	394.47
1994	5678.75	4940.78	266.31	57.99	413.67
1995	5731.07	4932.47	270.78	79.96	447.85
1996	5603.22	4939.70	263.88	55.32	344.32
1997	5556.35	4858.87	275.92	50.46	371.10
1998	5312.26	4628.59	263.36	36.62	383.69
1999	5623.41	4914.39	257.33	60.61	391.07
2000	5872.81	5209.98	235.76	45.36	381.71
2001	5649.06	5048.15	228.43	50.30	322.19
2002	5789.25	5152.88	242.12	42.74	351.51
2003	5344.13	4774.86	190.26	35.07	343.94
2004	4839.68	4313.40	174.51	27.00	324.76
Total	**82685.91**	**72166.29**	**4121.28**	**723.07**	**5675.28**

Table 6.2: Article output by sector and year, 1990-2004

Year	Total	HE	SC	RF	Other SA
1990	6623	5048	610	67	567
1991	6813	5079	558	60	545
1992	6846	5228	531	83	598
1993	6751	5300	503	73	567
1994	7055	5546	414	99	597
1995	7285	5593	440	122	641
1996	7119	5625	419	99	522
1997	7118	5604	453	104	569
1998	7021	5421	437	90	613
1999	7407	5819	431	121	626
2000	7764	6153	420	113	636
2001	7533	5999	402	104	562
2002	7648	6215	439	100	645
2003	7515	5834	390	78	647
2004	6902	5495	371	69	635
Total	**107400**	**83959**	**6818**	**1382**	**8970**

The higher education sector accounted for 78% of the total South African peer-reviewed article output during 1990-2004[19]. The top 5 universities produced, in combination, about 68% of the article output in this sector (Figure 6.3). Eight more universities each produced about 2%-6% of the total sector output. The combined output of the remaining universities comprised only 3% during that period.

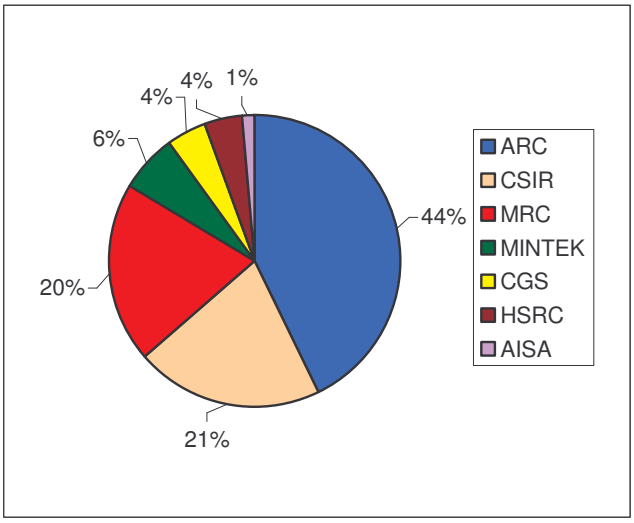
Figure 6.3: Institutional contribution to article output in the higher education sector, 1990-2004



The seven research performing science councils accounted for just over 6% of the total South African article output in peer-reviewed journals during 1990-2004, with three science councils dominating the sector. They are the Agricultural Research Council, the Council for Scientific and Industrial Research, and the Medical Research Council, which respectively produced 44%, 21% and 20% of the total sector output during this period (Figure 6.4).

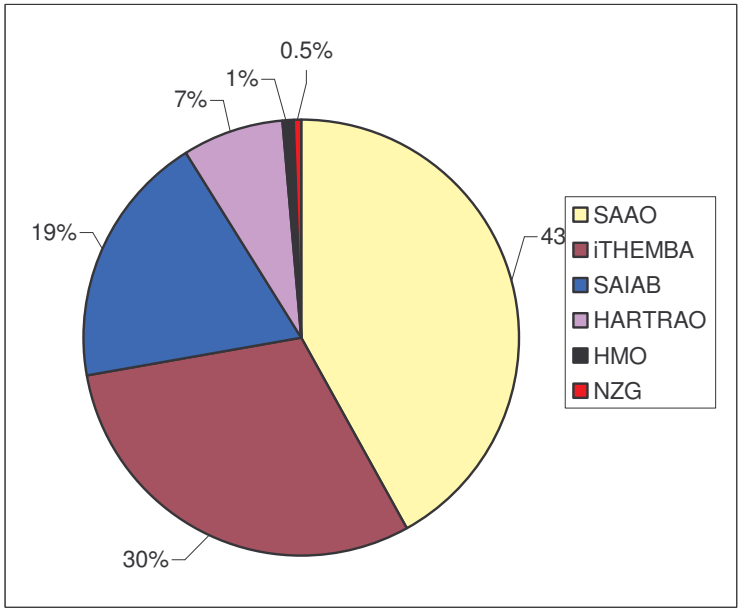
[19] This percentage is based on calculating total articles (rather than article equivalents) produced by authors affiliated to South African universities as proportion of total article output. One can also calculate this based on article equivalents.

Figure 6.4: Institutional contribution to article output in the science council sector, 1990-2004



The six national research facilities produced approximately 1.2% of the total South African article output in peer-reviewed journals during 1990-2004. The two most prominent facilities are the South African Astronomical Observatory and the iThemba Laboratory for Accelerator Based Sciences. They respectively accounted for 43% and 30% of the total article output of research facilities over the period of interest (Figure 6.5).

Figure 6.5: Institutional contribution to article output in the national research facility sector, 1990-2004



The remaining 8% of article output (8 970/107 400 – Table 6.2) is produced by government-based research units, research NGO's and the private and business sector.

6.3 ARTICLE OUTPUT BY BROAD FIELD

In this section we present the article output data (in 3-year output windows) for the five broad scientific fields (i.e. level-1 categories in Table 1.1):

- Engineering Sciences and Applied Technologies
- Health Sciences
- Natural and Agricultural Sciences
- Social Sciences
- Humanities and Arts

The breakdown by broad field for the total period is presented in Figure 6.6. Further breakdowns by year (Figure 6.7) and by journal index (ISI and non-ISI – Figures 6.8 & 6.9) are presented below. These figures reveal the following main trends:

- Overall output shows that the Natural and Agricultural Sciences produced 34% of total output, the Humanities and Social Sciences together constituted 40%, the Health Sciences 19% and Engineering Science and Applied Technologies 7% of all article output (Figure 6.6).
- Output over time has not shifted significantly as far as broad field is concerned (Figure 6.7).
- The breakdown by journal index shows that the majority of articles in the natural sciences, health sciences and engineering sciences are published in ISI-journals, whereas the majority of articles in the social sciences and humanities are published in non-ISI journals. There has been a small shift in the social sciences towards publishing in ISI-journals over this period. It should, of course, be kept in mind, that the majority of South African journals indexed in the ISI (17 out of 24) are in the natural and health sciences (Figures 6.8 & 6.9).

Figure 6.6: Total article output by broad field, 1990-2004

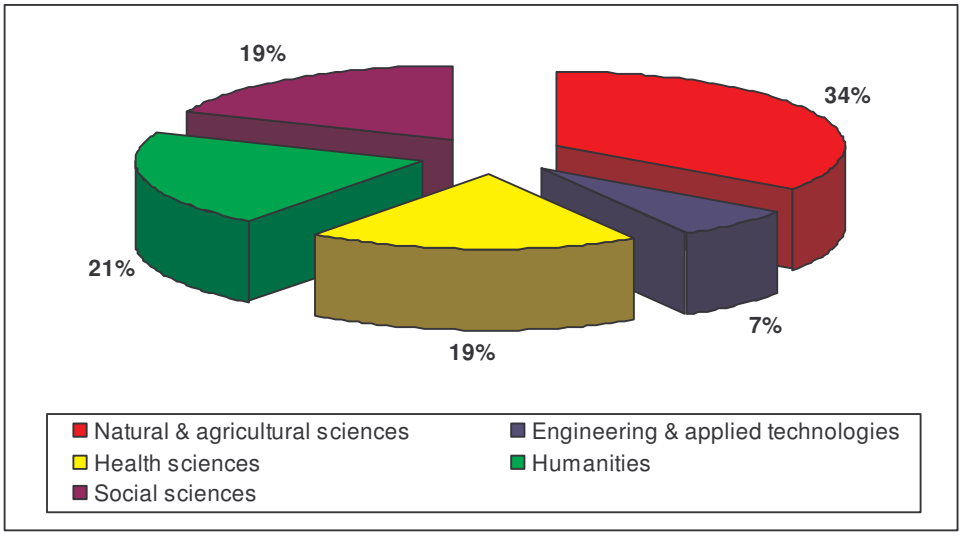


Figure 6.7: Broad scientific field distribution of South African article output (article output in all journals)

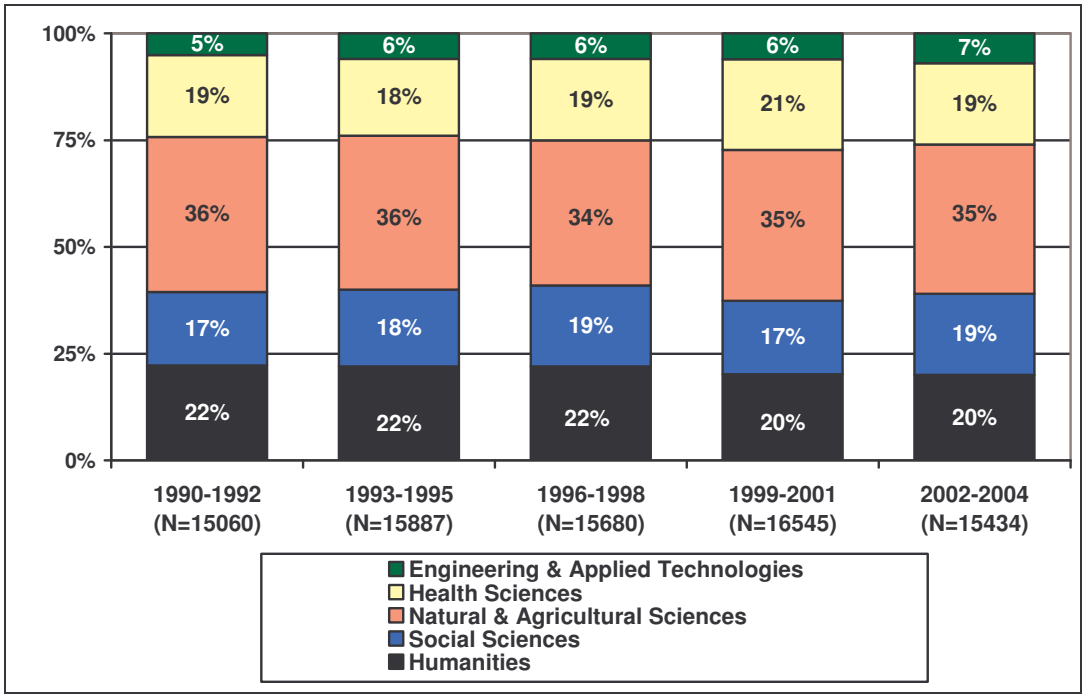


Figure 6.8: Broad scientific field distribution of South African article output in ISI journals

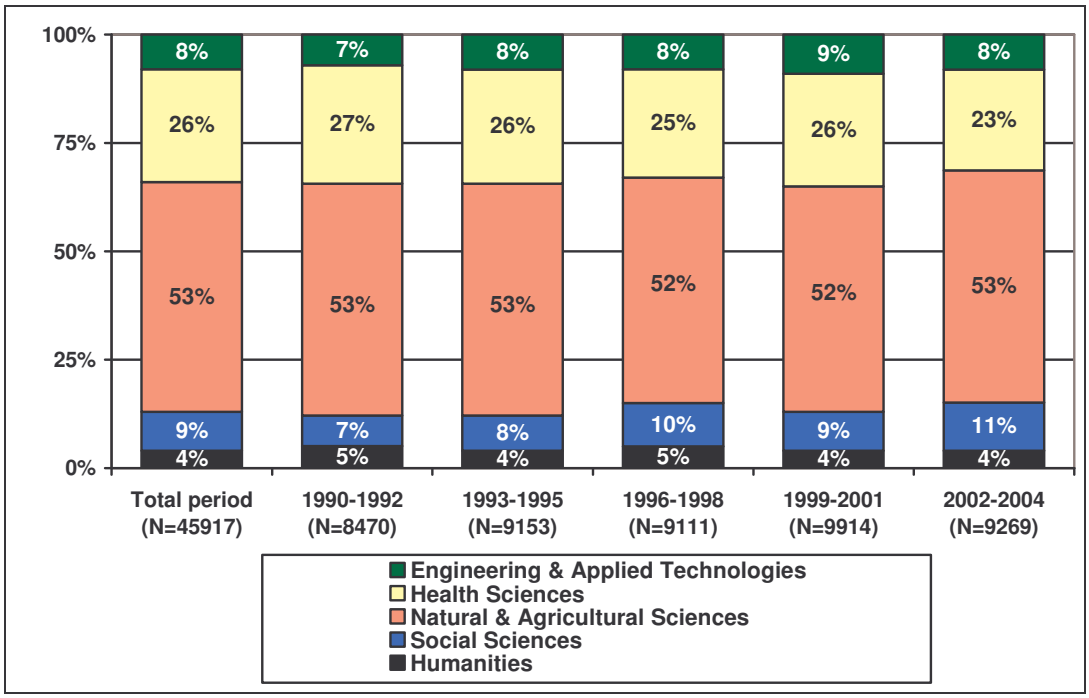
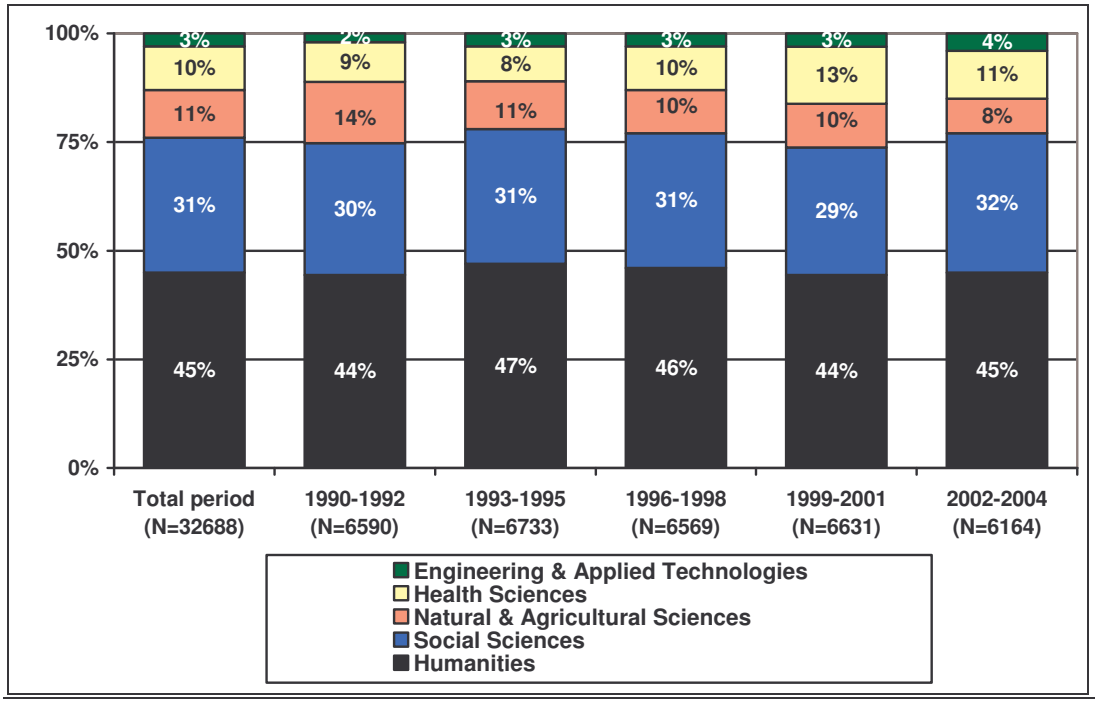


Figure 6.9: Broad scientific field distribution of South African article output in non-ISI journals



6.4 ARTICLE OUTPUT BY SCIENTIFIC FIELD

As indicated in Chapter 1, our classification of scientific field distinguishes between 20 categories. In this section of the report, we present the detailed output data for each of these 20 fields (distinguishing between output in terms of articles and article equivalents). Figure 6.10 presents the overall distribution for these 20 fields for the total period 1990-2004. A more detailed breakdown per three-year period for each field is presented in Table 6.3.

Figure 6.10: Distribution of article equivalents per scientific field, 1990-2004

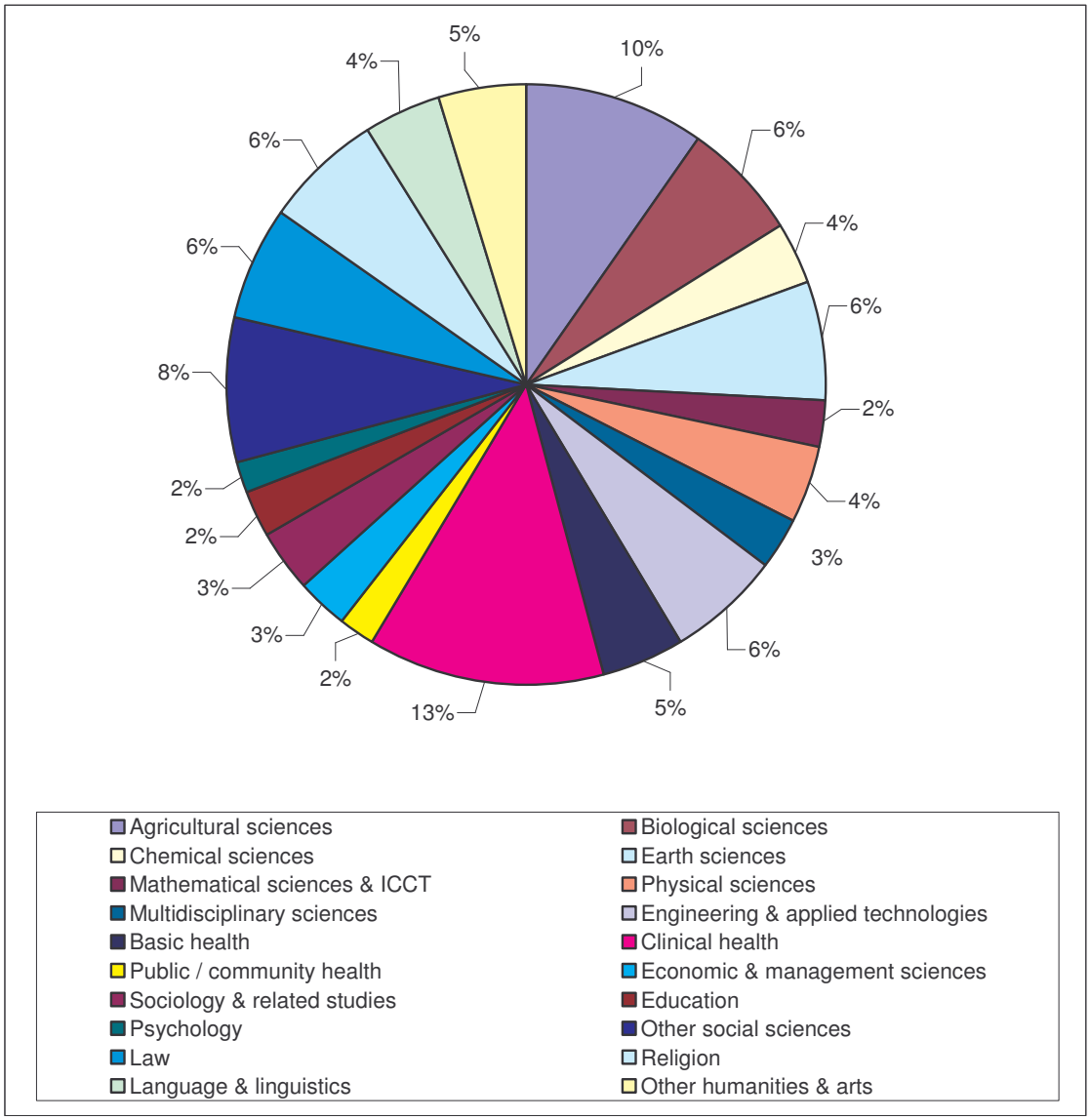


Table 6.3: Distribution of article equivalents per scientific field, broken down by 3-year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Scientific field	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Agricultural sciences	1651.18	11%	1548.22	10%	1517.01	10%	1537.31	9%	1396.00	9%
Biological sciences	890.97	6%	992.99	6%	913.19	6%	1101.64	7%	1012.74	7%
Chemical sciences	549.12	4%	572.32	4%	529.75	3%	568.09	3%	606.09	4%
Earth sciences	958.64	6%	983.11	6%	975.84	6%	1039.54	6%	1065.70	7%
Mathematical sciences & ICCT	334.36	2%	330.44	2%	347.77	2%	467.58	3%	436.66	3%
Physical sciences	581.53	4%	746.65	5%	586.63	4%	628.98	4%	583.20	4%
Multidisciplinary sciences	499.70	3%	486.91	3%	475.41	3%	485.89	3%	320.47	2%
Engineering & applied technologies	777.62	5%	951.01	6%	974.45	6%	1060.97	6%	1037.42	7%
Basic health	677.71	5%	684.91	4%	728.44	5%	791.18	5%	656.31	4%
Clinical health	1938.04	13%	1953.37	12%	1949.82	12%	2223.07	13%	1869.18	12%
Public / community health	301.81	2%	244.12	2%	310.46	2%	490.46	3%	333.19	2%
Economic & management sciences	320.17	2%	431.20	3%	425.26	3%	421.69	3%	465.53	3%
Education	341.58	2%	313.74	2%	324.17	2%	453.44	3%	503.00	3%
Psychology	286.24	2%	243.84	2%	366.01	2%	239.52	1%	234.40	2%
Sociology & related studies	491.10	3%	585.74	4%	537.34	3%	482.37	3%	534.67	3%
Other social sciences	1140.09	8%	1266.33	8%	1267.16	8%	1214.18	7%	1264.47	8%
Language & linguistics	636.25	4%	664.92	4%	716.92	5%	640.67	4%	632.25	4%
Law	993.08	7%	1115.58	7%	1010.67	6%	1009.78	6%	735.49	5%
Religion	849.30	6%	1006.67	6%	957.04	6%	958.33	6%	1068.58	7%
Other humanities & arts	841.42	6%	764.43	5%	766.87	5%	730.28	4%	678.16	4%
Total	**15060**	**100%**	**15887**	**100%**	**15680**	**100%**	**16545**	**100%**	**15434**	**100%**

Some of the more significant shifts (increases and decreases) in field-specific output as evidenced by Table 6.3 are:

- Agricultural sciences losing its “market” share (from 11% to 9%) which is a 15% decline in output
- Engineering and applied technologies increasing its share from 5% to 7% (25% increase in share of national output)

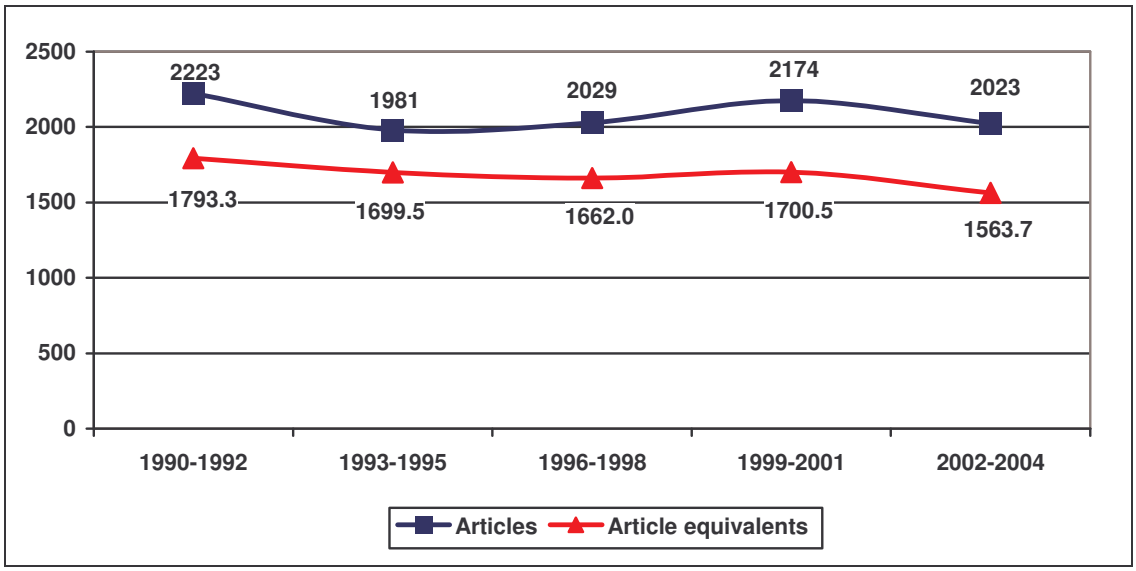
- Basic and clinical health both declining slightly
- Law with a decrease in its share from 7% to 5% (20% loss)
- Other humanities and arts also with a decrease in its share of South Africa's output (from 6% to 4%)

In Table 6.3 each article equivalent received only a fraction of the journal in which it is published. For instance, if author X published an article equivalent of 0.5 in a particular journal, and that journal has two scientific field categories, namely Chemical Sciences and Earth Sciences, the article equivalent has been fractioned in terms of the number of scientific field categories. In other words, an article equivalent of 0.25 was assigned to the field of Chemical Sciences and another equivalent of 0.25 to the field of Earth Sciences. The reason was because the focus of Table 6.3 is on the relative contribution of each scientific field to the total scientific field.

In the next series of figures (Figures 6.11 to 6.30), however, the scientific fields are treated independently from each other. This means that, using our previous illustration, and article equivalent of 0.5 will be reported for each of the fields of Chemical Sciences and Earth Sciences. Hence, the values reported in these graphs are higher than those reported in Table 6.3.

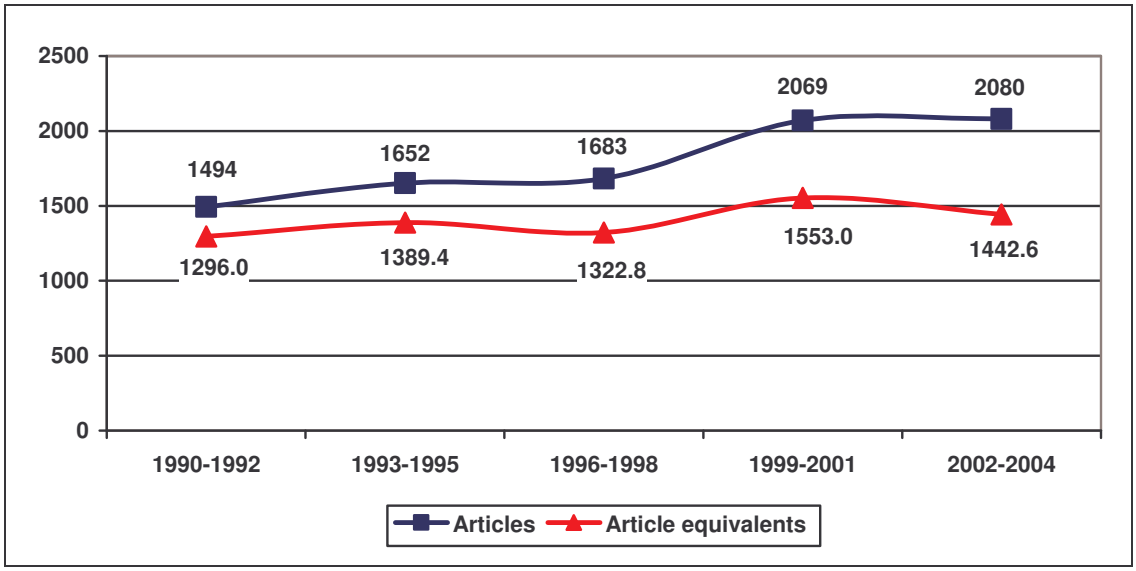
6.4.1 Agricultural sciences

Figure 6.11: Distribution of articles and article equivalents in Agricultural Sciences



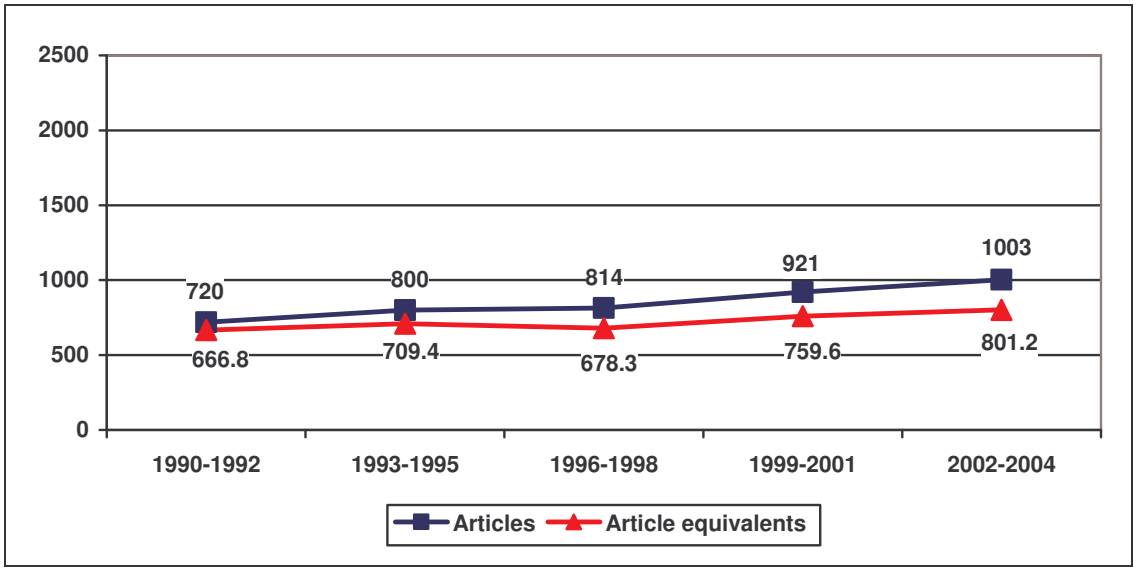
6.4.2 Biological sciences

Figure 6.12: Distribution of articles and article equivalents in Biological Sciences



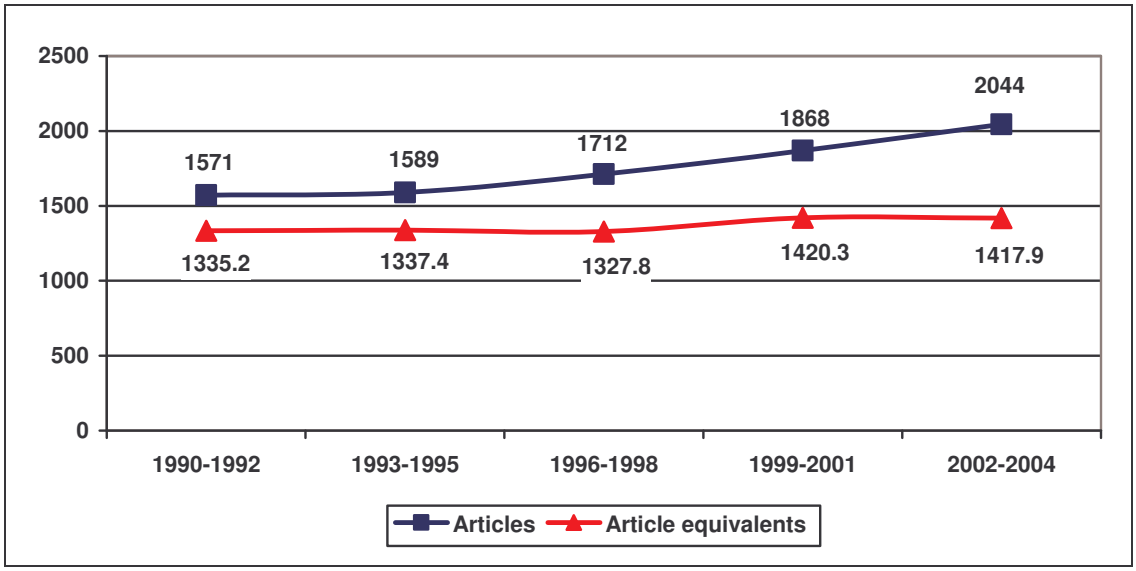
6.4.3 Chemical sciences

Figure 6.13: Distribution of articles and article equivalents in Chemical Sciences



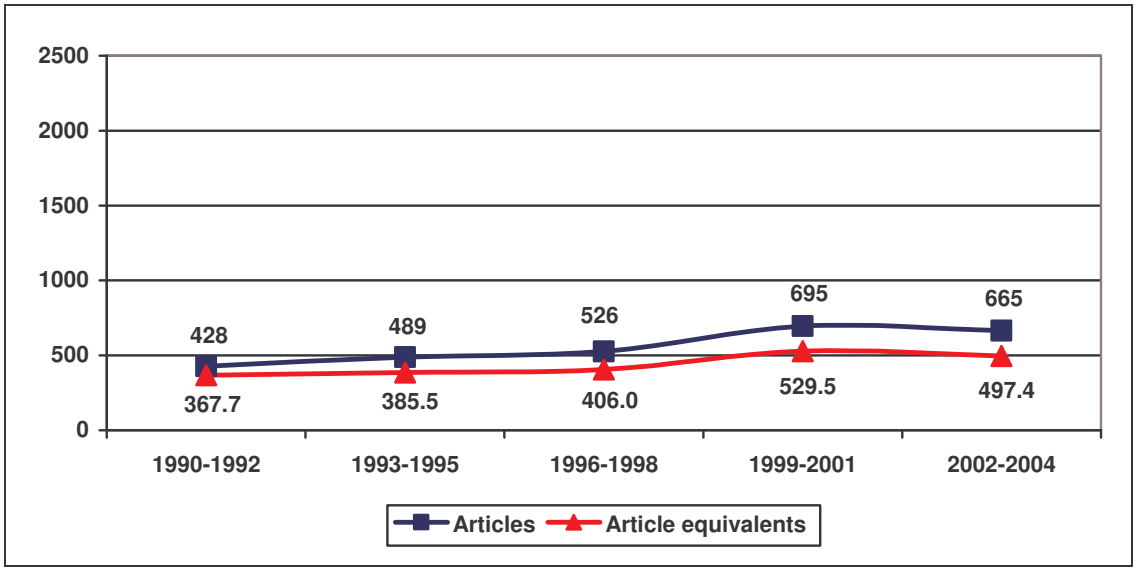
6.4.4 Earth sciences

Figure 6.14: Distribution of articles and article equivalents in Earth Sciences



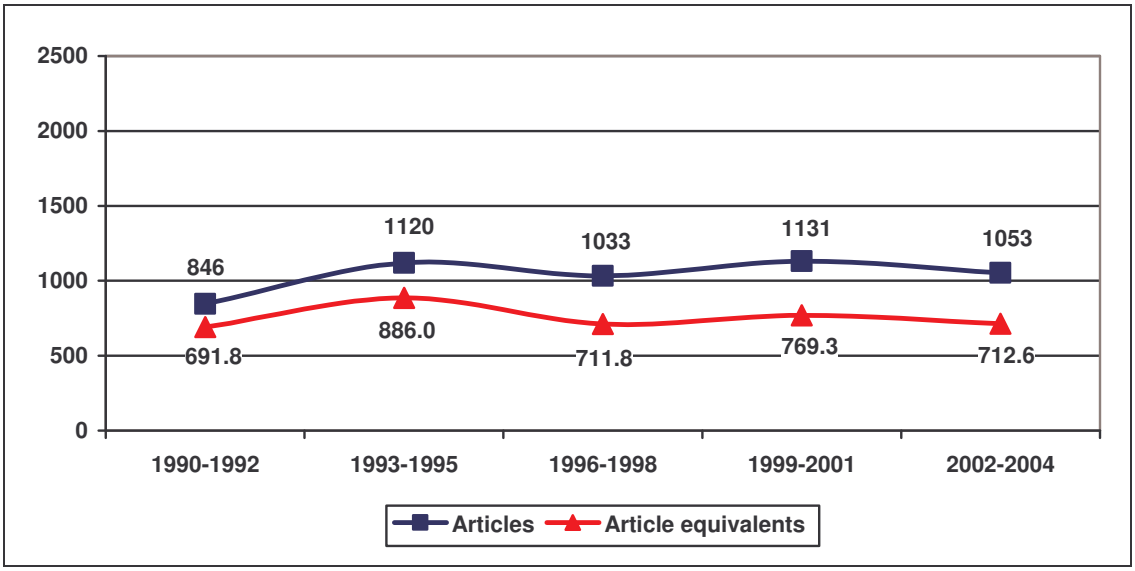
6.4.5 Mathematical sciences & ICCT

Figure 6.15: Distribution of articles and article equivalents in Mathematical Sciences & ICCT



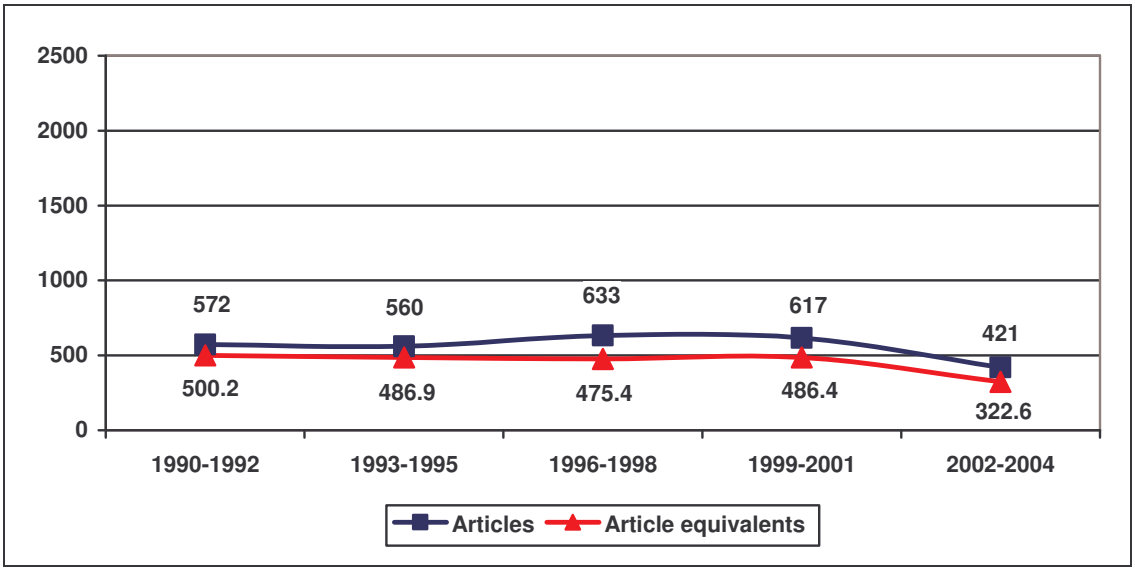
6.4.6 Physical sciences

Figure 6.16: Distribution of articles and article equivalents in Physical Sciences



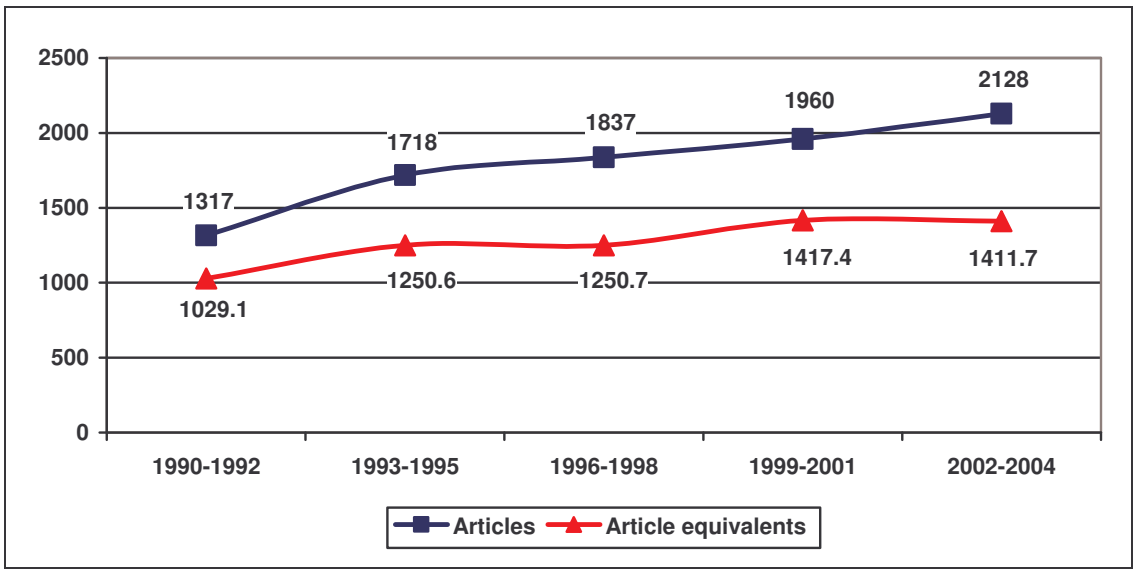
6.4.7 Multidisciplinary sciences

Figure 6.17: Distribution of articles and article equivalents in Multidisciplinary Sciences



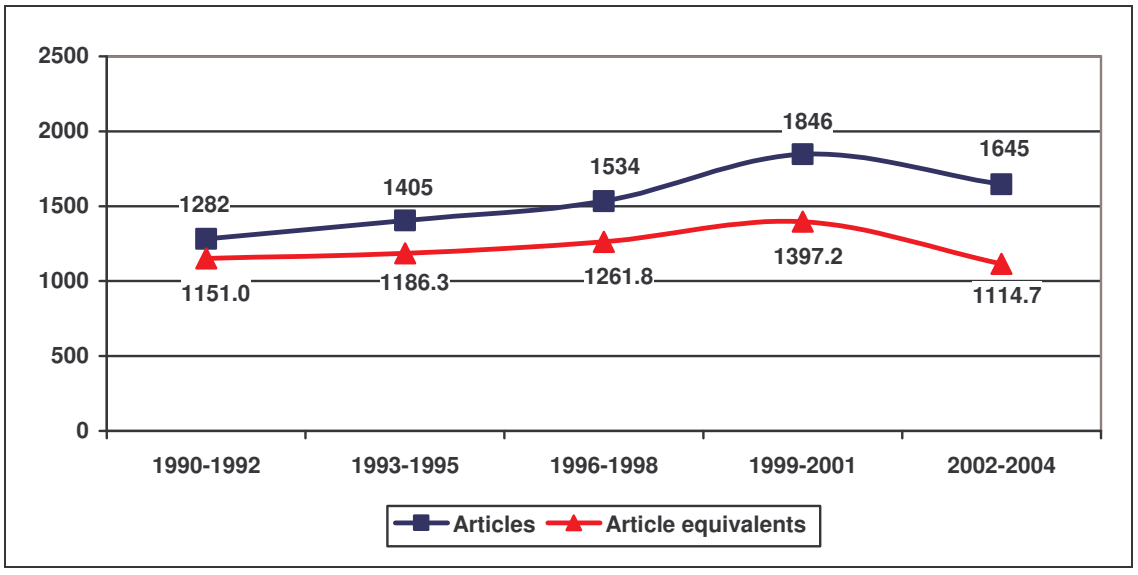
6.4.8 Engineering & applied technologies

Figure 6.18: Distribution of articles and article equivalents in Engineering & Applied Technologies



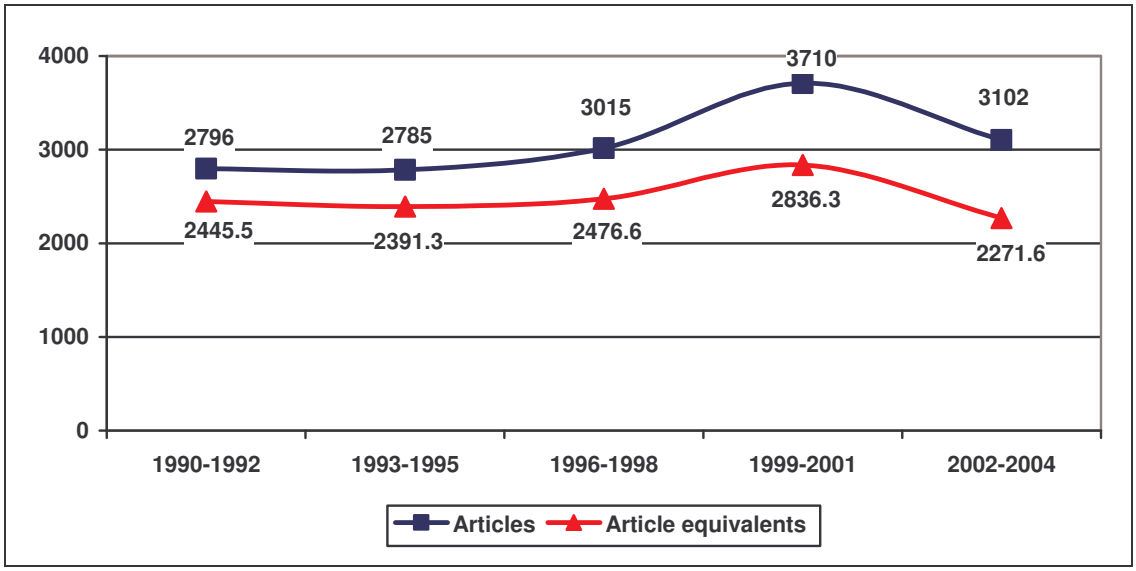
6.4.9 Basic health

Figure 6.19: Distribution of articles and article equivalents in Basic Health



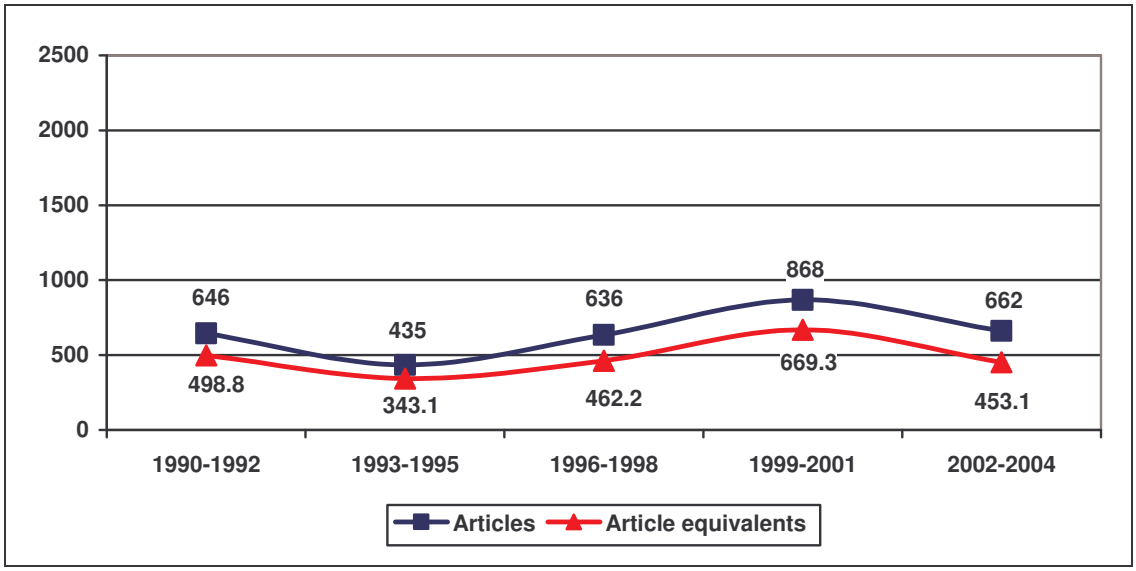
6.4.10 Clinical health

Figure 6.20: Distribution of articles and article equivalents in Clinical Health



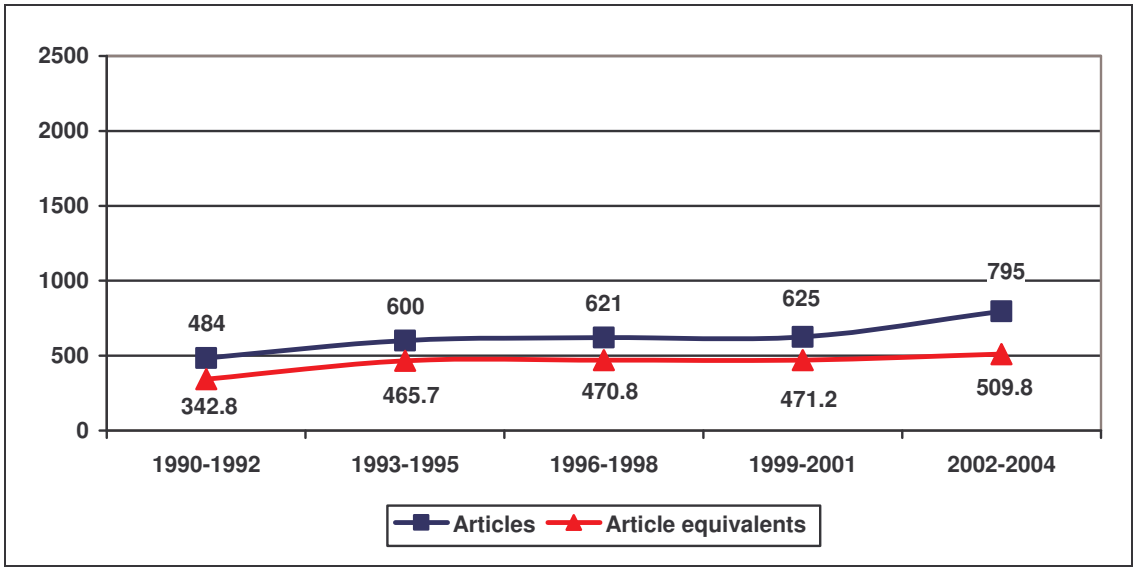
6.4.11 Public & community health

Figure 6.21: Distribution of articles and article equivalents in Public& Community Health



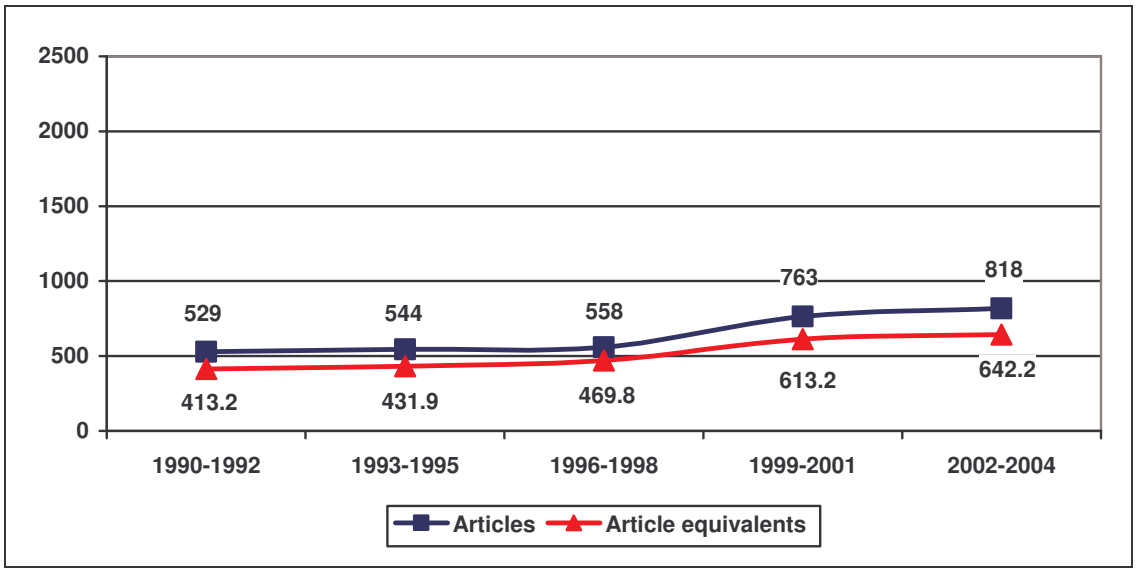
6.4.12 Economics & management sciences

Figure 6.22: Distribution of articles and article equivalents in Economics & Management Sciences



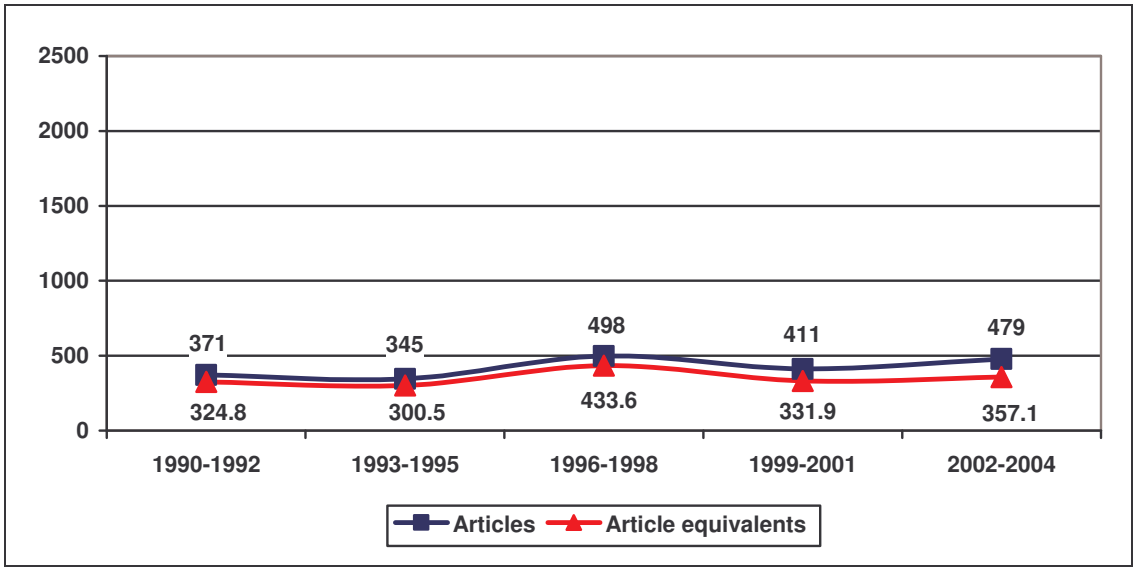
6.4.13 Education

Figure 6.23: Distribution of articles and article equivalents in Education



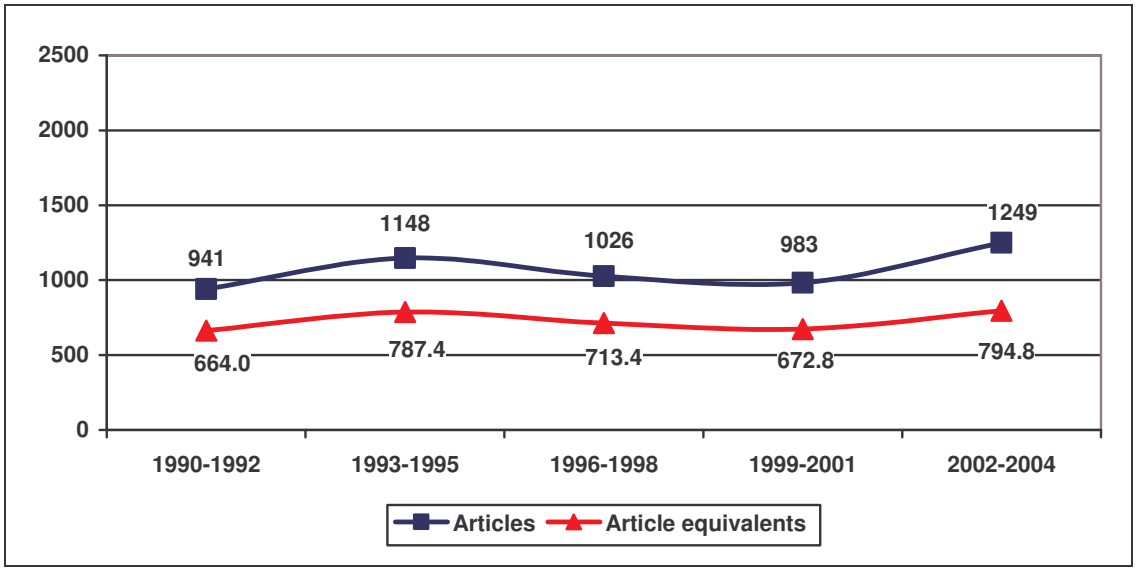
6.4.14 Psychology

Figure 6.24: Distribution of articles and article equivalents in Psychology



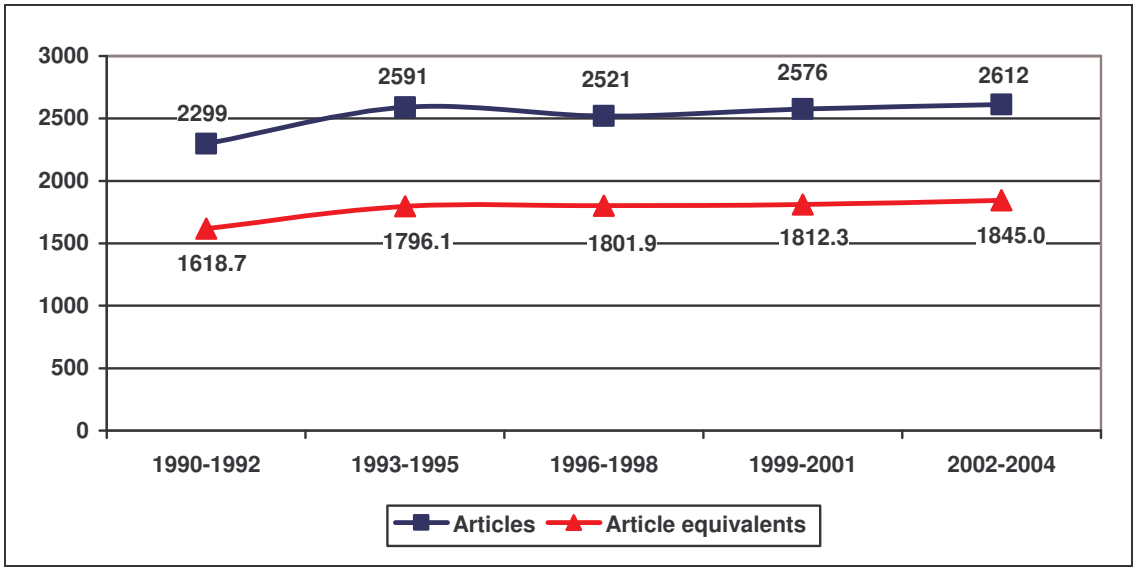
6.4.15 Sociology & related studies

Figure 6.25: Distribution of articles and article equivalents in Sociology & Related Studies



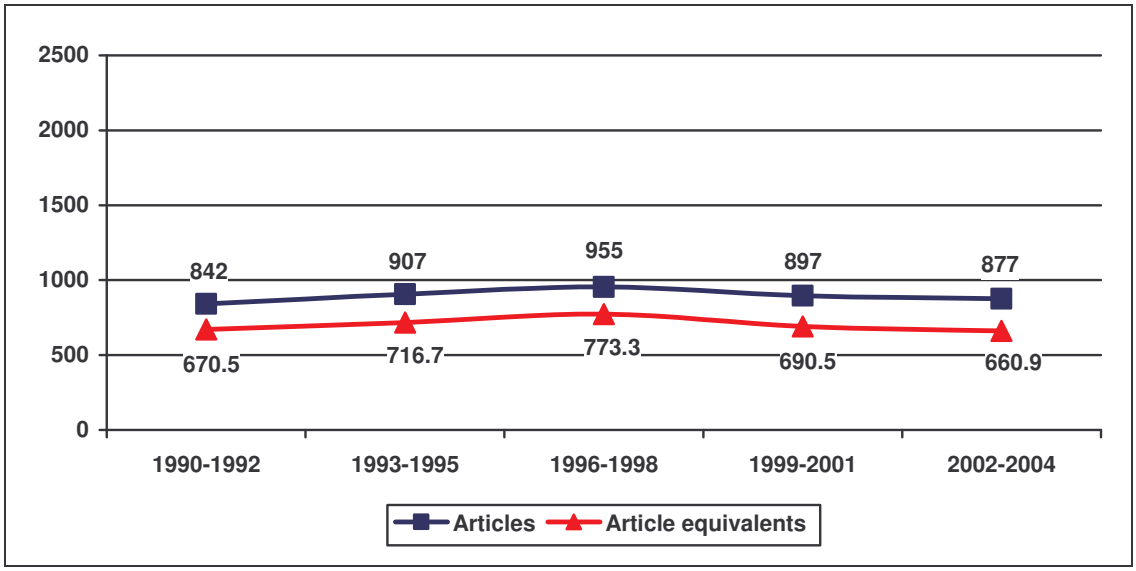
6.4.16 Other social sciences

Figure 6.26: Distribution of articles and article equivalents in Other Social Sciences



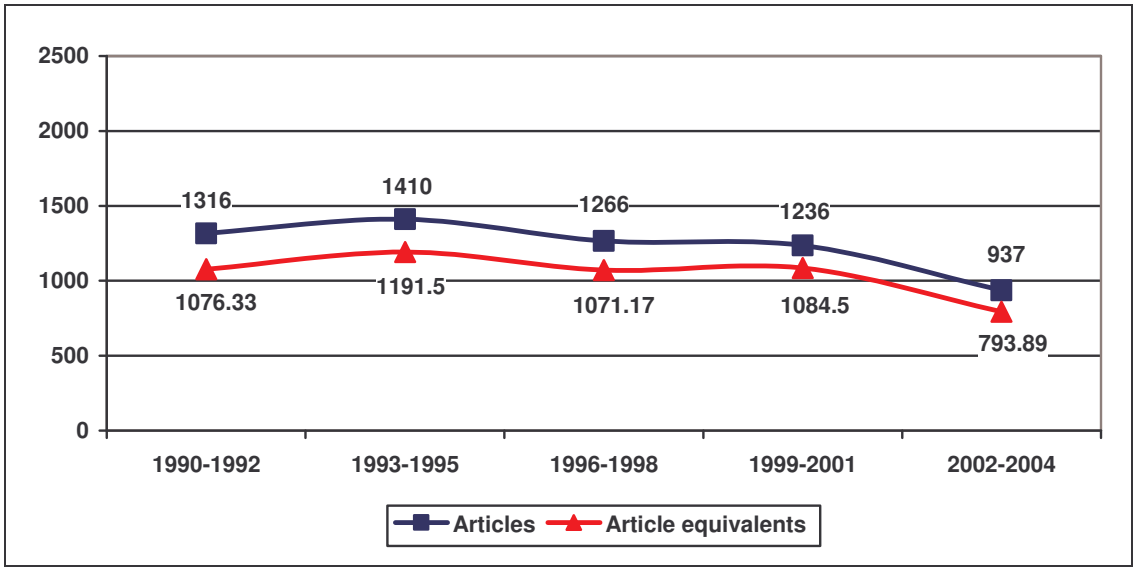
6.4.17 Language & linguistics

Figure 6.27: Distribution of articles and article equivalents in Language & Linguistics



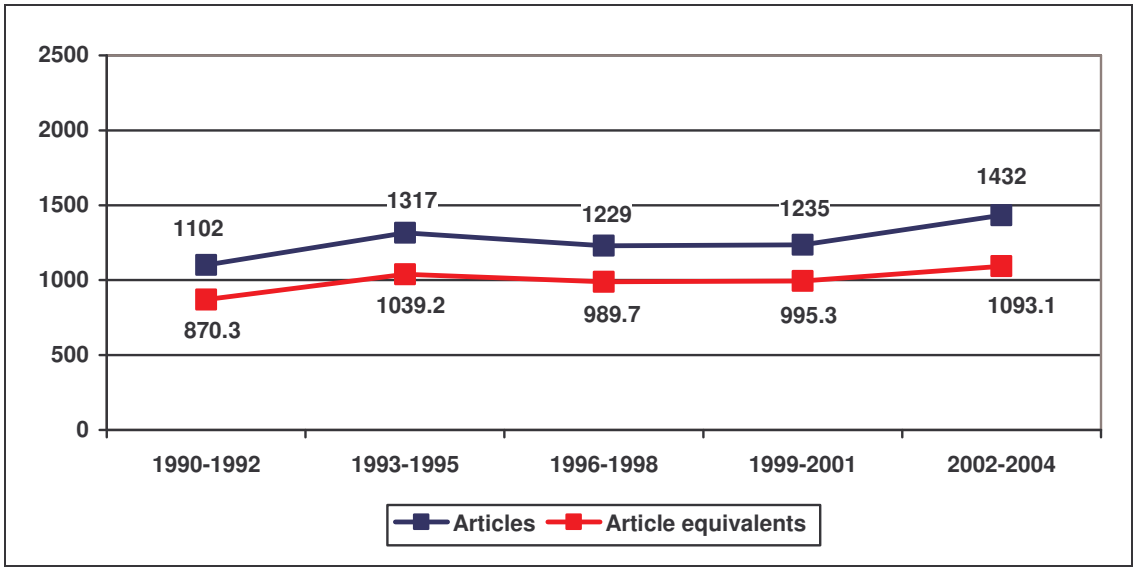
6.4.18 Law

Figure 6.28: Distribution of articles and article equivalents in Law



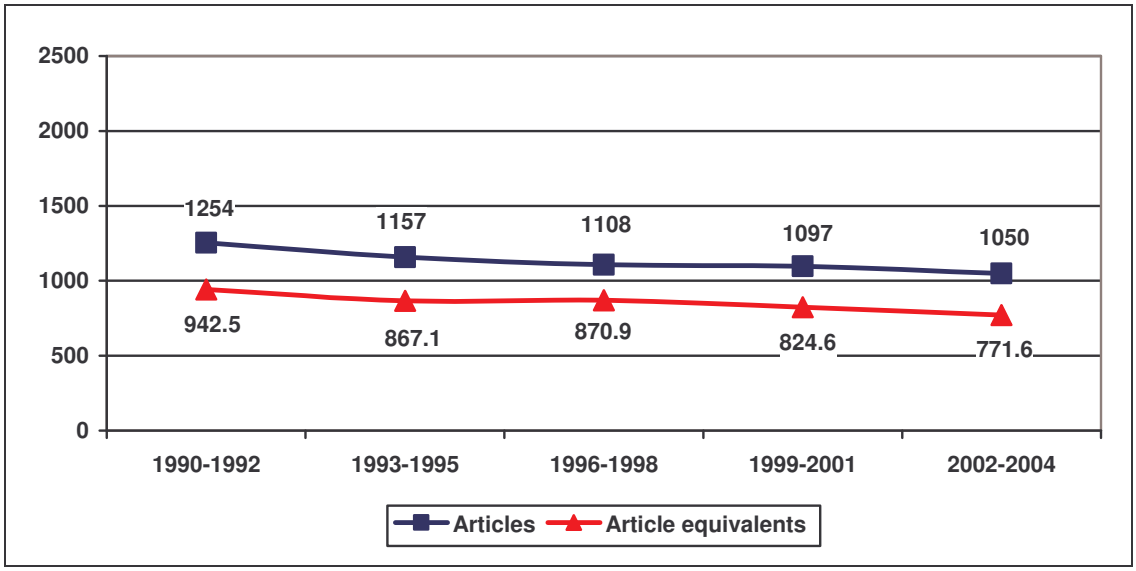
6.4.19 Religion

Figure 6.29: Distribution of articles and article equivalents in Religion



6.4.20 Other humanities & arts

Figure 6.30: Distribution of articles and article equivalents in Other Humanities & Arts



6.5 ARTICLE OUTPUT BY AUTHOR DEMOGRAPHICS

SA Knowledgebase captures basic demographic information (race, gender and birth year of the authors of articles). This enables us to calculate author demographic profiles in a very systematic and detailed manner. In this section we report on the gender, race and age profiles per scientific field.

6.5.1 Agricultural sciences

Figure 6.31: Percentage distribution of article equivalents in Agricultural Sciences, by gender of authors

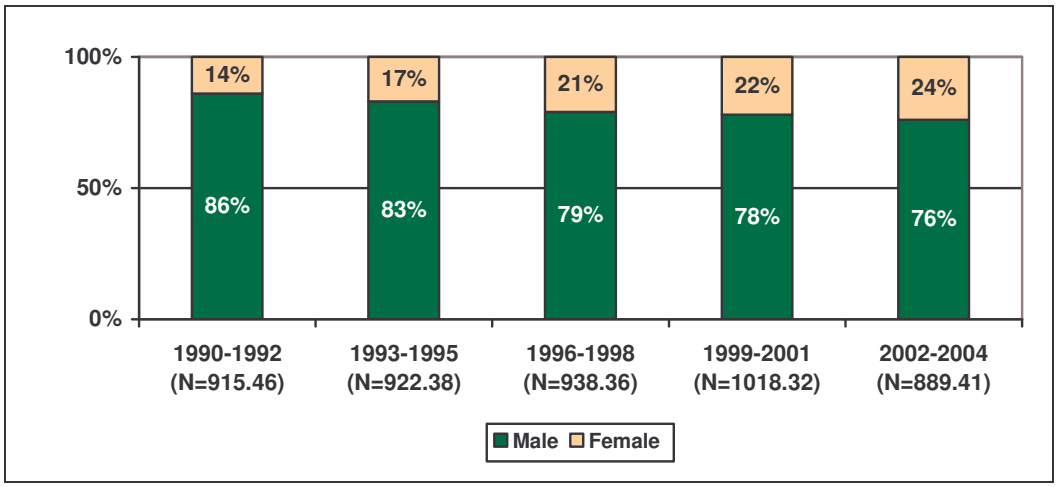
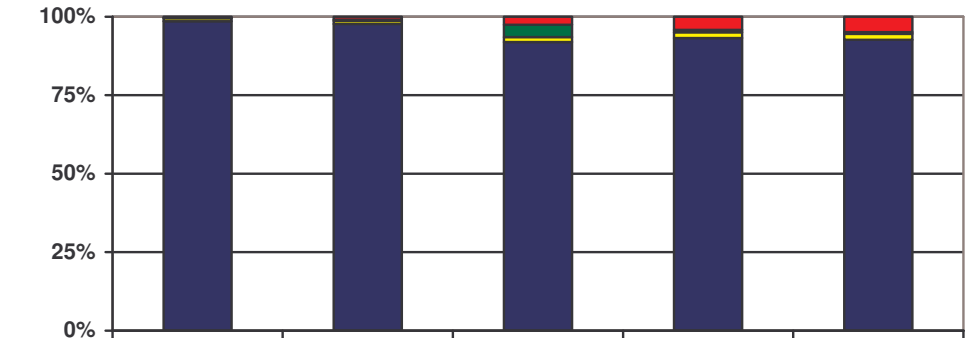
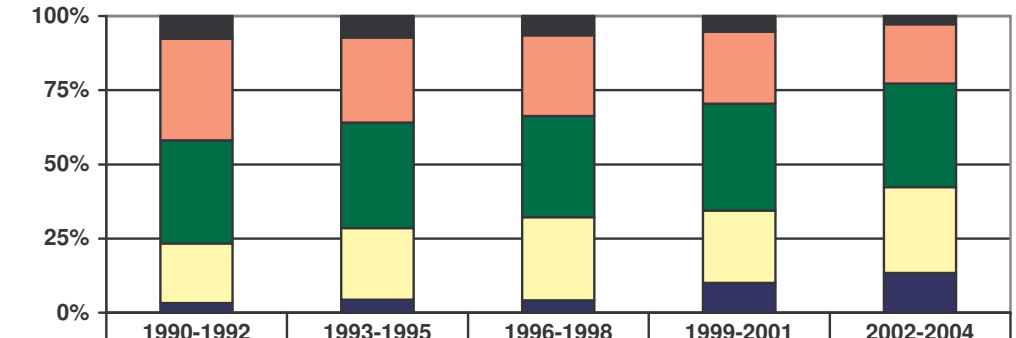


Figure 6.32: Percentage distribution of article equivalents in Agricultural Sciences, by race of authors



	1990-1992 (N=838.23)	1993-1995 (N=861.26)	1996-1998 (N=881.89)	1999-2001 (N=968.58)	2002-2004 (N=852.43)
African	0.3%	1.0%	2.7%	4.2%	4.9%
Coloured	0.2%	0.3%	4.0%	0.8%	0.6%
Indian/Asian	0.9%	1.0%	1.6%	1.8%	1.9%
White	98.6%	97.7%	95.3%	93.2%	92.5%

Figure 6.33: Percentage distribution of article equivalents in Agricultural Sciences, by age of authors

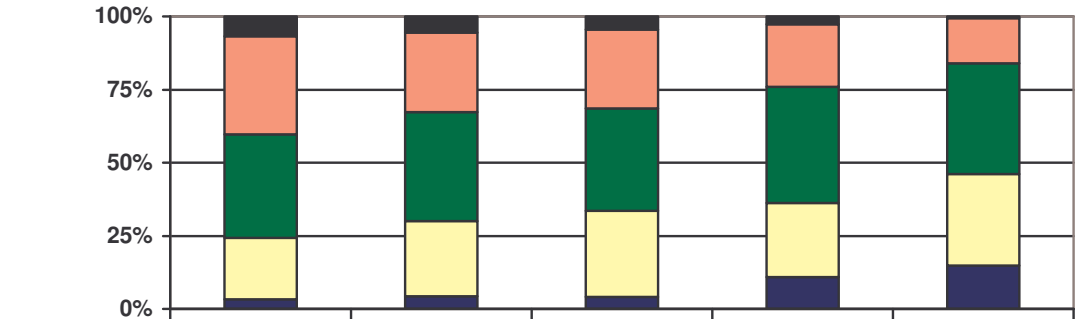


	1990-1992 (N=847.47)	1993-1995 (N=845.05)	1996-1998 (N=835.33)	1999-2001 (N=917.02)	2002-2004 (N=815.49)
<30 years	7.6%	7.2%	6.5%	5.3%	2.7%
30-39 years	34.3%	28.8%	27.2%	24.3%	20.0%
40-49 years	34.8%	35.5%	34.1%	36.1%	35.0%
50-59 years	20.1%	24.2%	28.0%	24.3%	28.9%
60+ years	3.2%	4.4%	4.2%	10.1%	13.4%

Table 6.4: Summary statistics of article equivalents by top 20% of authors in Agricultural Sciences

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Agricultural sciences	5383	8418.95	1077	5878.55	69.8%

Figure 6.34: Percentage distribution of article equivalents in Agricultural Sciences, by age of top 20% of authors



	1990-1992 (N=708.86)	1993-1995 (N=719.77)	1996-1998 (N=697.70)	1999-2001 (N=743.53)	2002-2004 (N=645.41)
<30 years	6.8%	5.5%	4.6%	2.6%	0.6%
30-39 years	33.5%	27.2%	26.8%	21.6%	15.4%
40-49 years	35.4%	37.4%	34.9%	39.6%	38.0%
50-59 years	21.0%	25.7%	29.4%	25.3%	31.2%
60+ years	3.3%	4.3%	4.2%	11.0%	14.8%

6.5.2 Biological sciences

Figure 6.35: Percentage distribution of article equivalents in Biological Sciences, by gender of authors

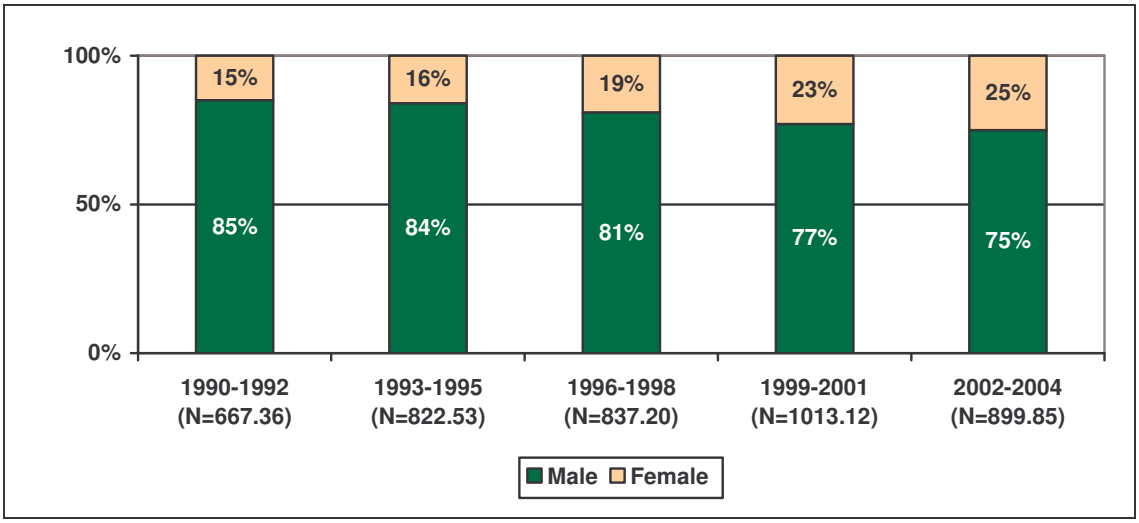
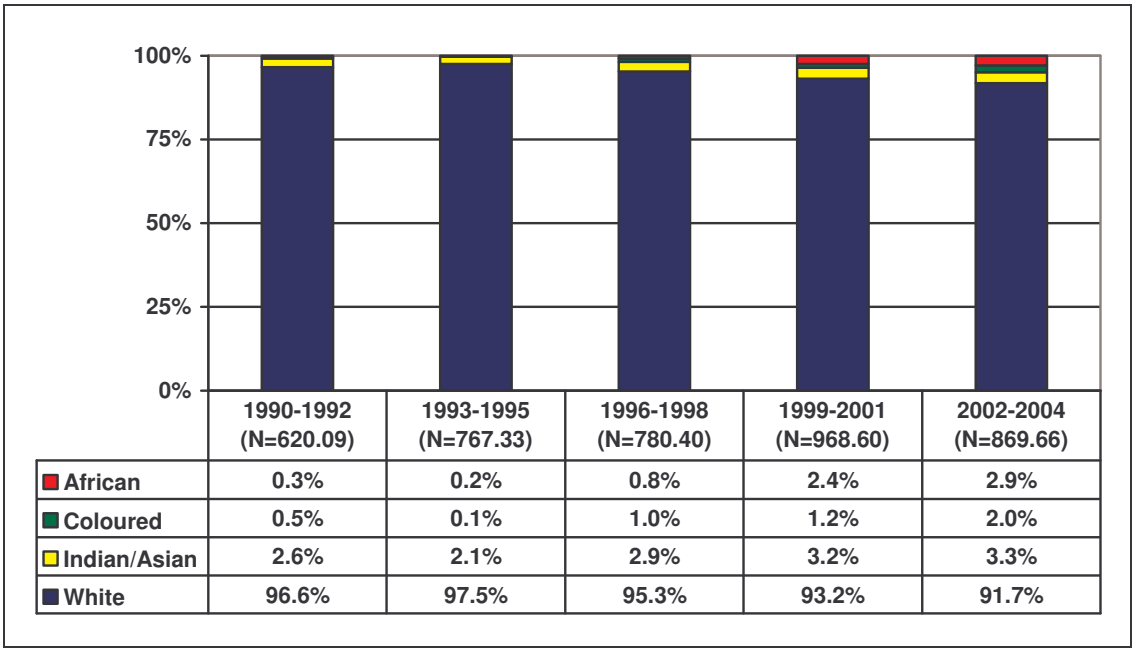
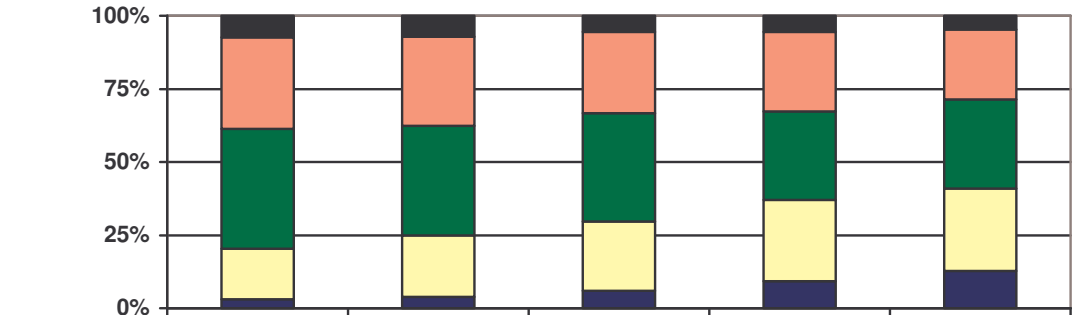


Figure 6.36: Percentage distribution of article equivalents in Biological Sciences, by race of authors



	1990-1992 (N=620.09)	1993-1995 (N=767.33)	1996-1998 (N=780.40)	1999-2001 (N=968.60)	2002-2004 (N=869.66)
African	0.3%	0.2%	0.8%	2.4%	2.9%
Coloured	0.5%	0.1%	1.0%	1.2%	2.0%
Indian/Asian	2.6%	2.1%	2.9%	3.2%	3.3%
White	96.6%	97.5%	95.3%	93.2%	91.7%

Figure 6.37: Percentage distribution of article equivalents in Biological Sciences, by age of authors

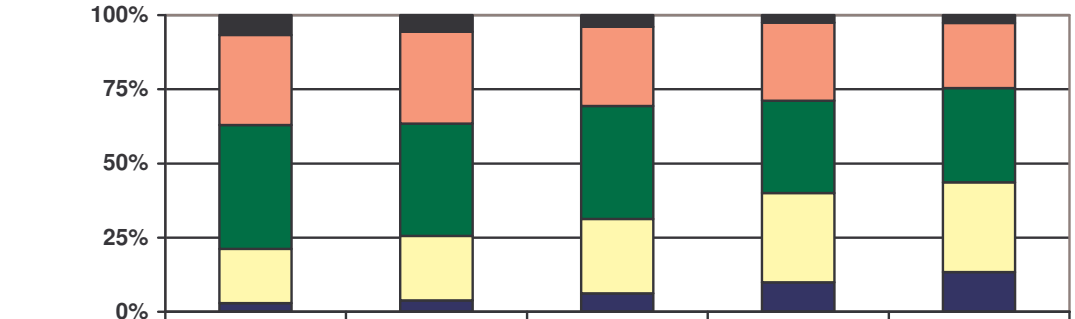


	1990-1992 (N=637.60)	1993-1995 (N=778.10)	1996-1998 (N=763.59)	1999-2001 (N=932.59)	2002-2004 (N=831.20)
<30 years	7.5%	7.1%	5.5%	5.5%	4.7%
30-39 years	31.2%	30.6%	27.9%	27.2%	23.8%
40-49 years	40.9%	37.4%	36.8%	30.4%	30.5%
50-59 years	17.4%	20.9%	23.7%	27.7%	28.3%
60+ years	3.0%	4.0%	6.0%	9.3%	12.7%

Table 6.5: Summary statistics of article equivalents by top 20% of authors in Biological Sciences

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Biological sciences	5697	7003.81	1139	4914.18	70.2%

Figure 6.38: Percentage distribution of article equivalents in Biological Sciences, by age of top 20% of authors



	1990-1992 (N=536.61)	1993-1995 (N=662.98)	1996-1998 (N=628.90)	1999-2001 (N=760.62)	2002-2004 (N=660.08)
<30 years	6.7%	5.6%	4.0%	2.5%	2.6%
30-39 years	30.4%	31.0%	26.6%	26.3%	22.0%
40-49 years	41.7%	37.9%	38.1%	31.2%	31.7%
50-59 years	18.3%	21.7%	25.0%	30.0%	30.3%
60+ years	2.9%	3.9%	6.2%	10.0%	13.4%

6.5.3 Chemical sciences

Figure 6.39: Percentage distribution of article equivalents in Chemical Sciences, by gender of authors

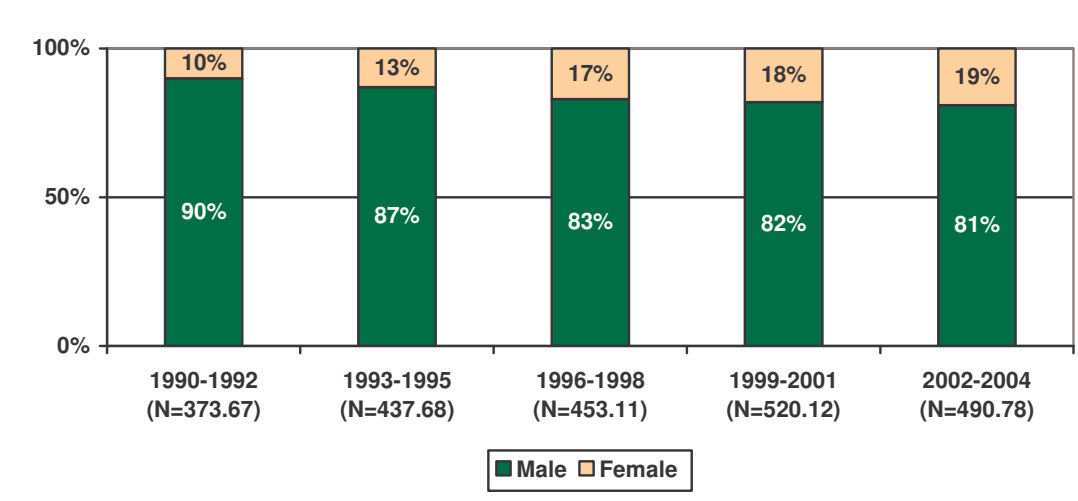
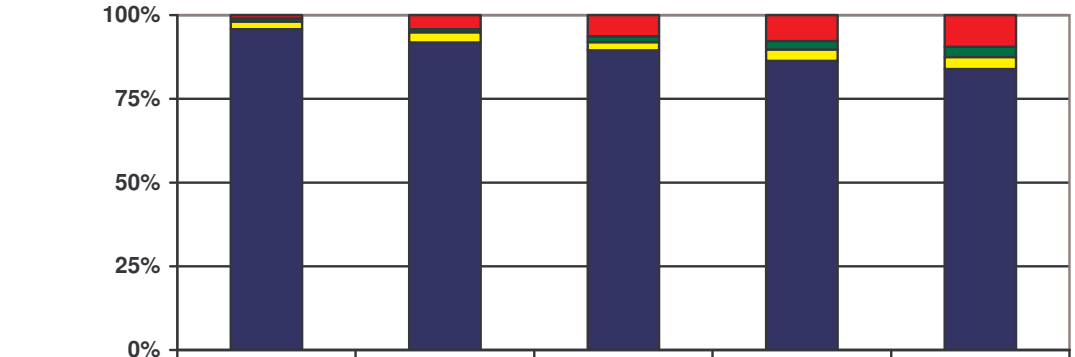
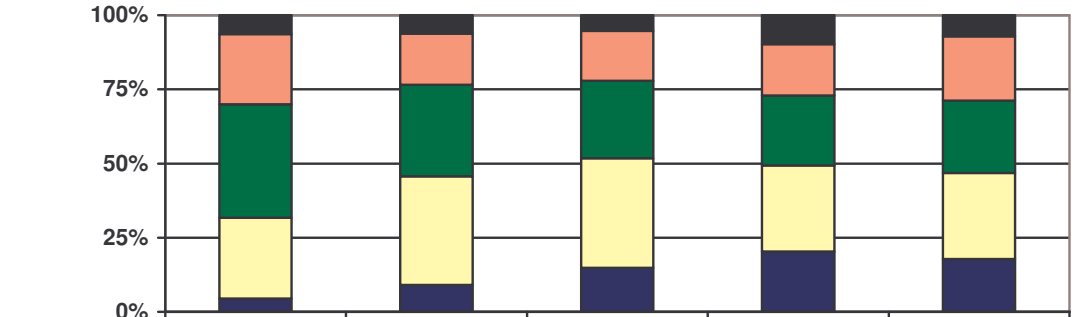


Figure 6.40: Percentage distribution of article equivalents in Chemical Sciences, by race of authors



	1990-1992 (N=356.57)	1993-1995 (N=413.83)	1996-1998 (N=426.20)	1999-2001 (N=505.20)	2002-2004 (N=476.88)
African	1.0%	4.2%	6.3%	7.7%	9.4%
Coloured	0.9%	0.9%	1.8%	2.6%	3.1%
Indian/Asian	2.3%	3.1%	2.4%	3.4%	3.6%
White	95.8%	91.8%	89.5%	86.4%	83.9%

Figure 6.41: Percentage distribution of article equivalents in Chemical Sciences, by age of authors

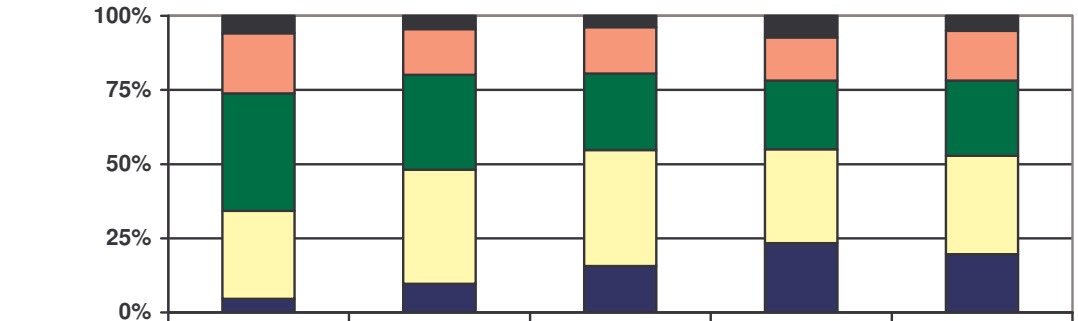


	1990-1992 (N=354.34)	1993-1995 (N=393.22)	1996-1998 (N=397.76)	1999-2001 (N=454.96)	2002-2004 (N=448.47)
<30 years	6.4%	6.2%	5.3%	9.8%	7.1%
30-39 years	23.6%	17.3%	16.9%	17.3%	21.7%
40-49 years	38.2%	30.8%	26.1%	23.6%	24.4%
50-59 years	27.1%	36.7%	37.0%	29.1%	29.0%
60+ years	4.5%	9.0%	14.8%	20.3%	17.8%

Table 6.6: Summary statistics of article equivalents by top 20% of authors in Chemical Sciences

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Chemical sciences	2819	3615.26	564	2520.77	69.7%

Figure 6.42: Percentage distribution of article equivalents in Chemical Sciences, by age of top 20% of authors



	1990-1992 (N=302.60)	1993-1995 (N=342.09)	1996-1998 (N=345.46)	1999-2001 (N=379.00)	2002-2004 (N=358.92)
<30 years	5.9%	4.5%	3.9%	7.3%	5.1%
30-39 years	20.3%	15.4%	15.6%	14.5%	16.7%
40-49 years	39.6%	32.0%	25.8%	23.2%	25.4%
50-59 years	29.6%	38.5%	39.1%	31.7%	33.2%
60+ years	4.6%	9.6%	15.6%	23.3%	19.6%

6.5.4 Earth sciences

Figure 6.43: Percentage distribution of article equivalents in Earth Sciences, by gender of authors

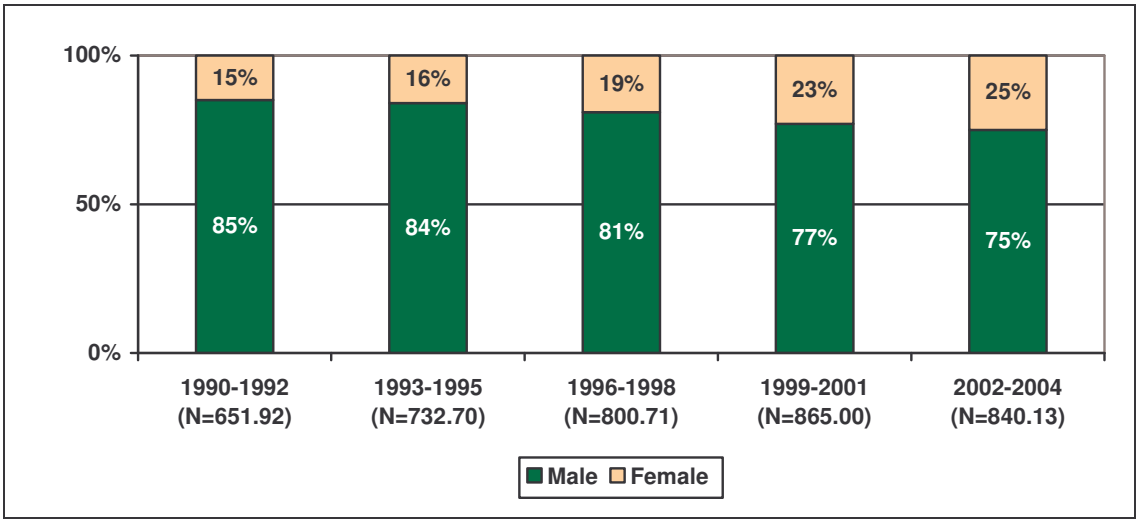
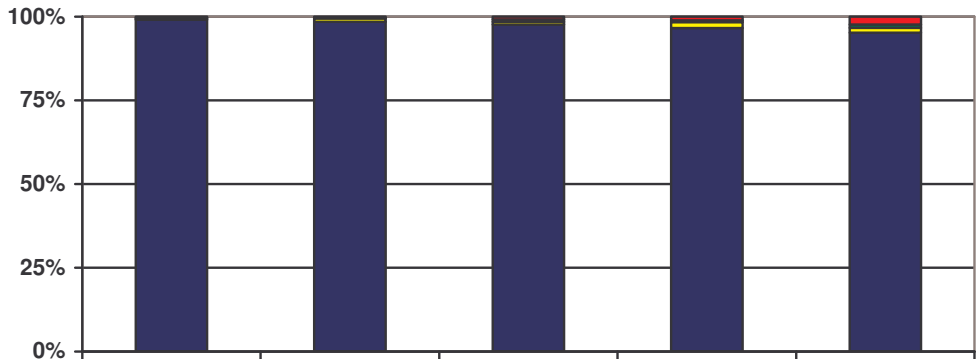
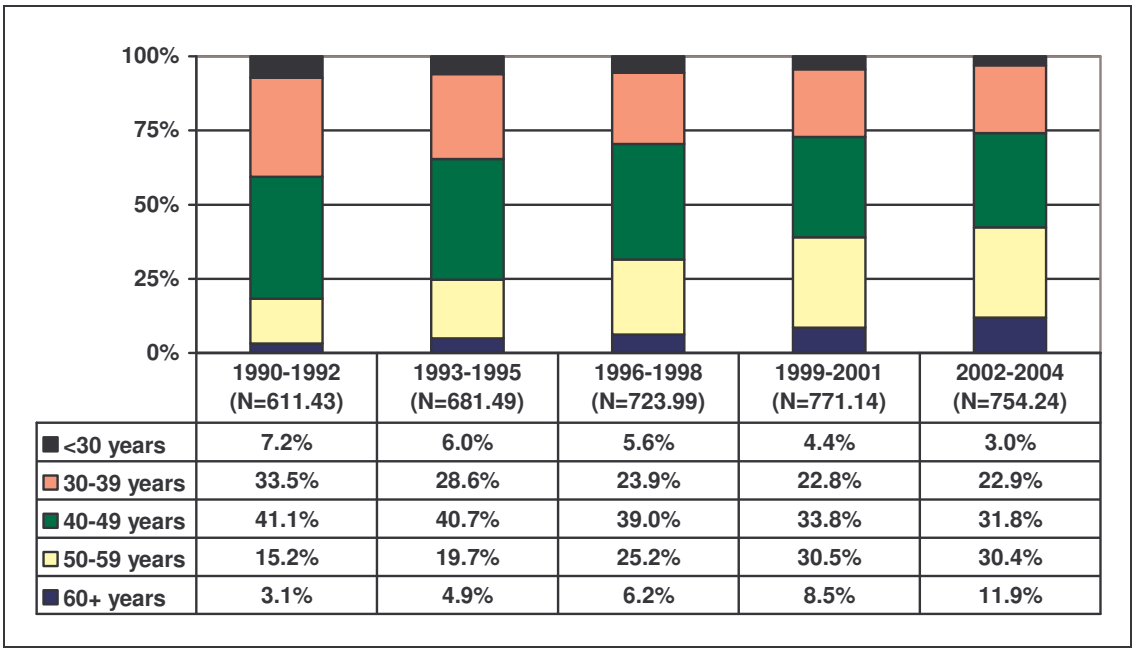


Figure 6.44: Percentage distribution of article equivalents in Earth Sciences, by race of authors



	1990-1992 (N=617.03)	1993-1995 (N=690.39)	1996-1998 (N=763.11)	1999-2001 (N=822.99)	2002-2004 (N=794.86)
African	0.3%	0.4%	0.8%	1.1%	2.3%
Coloured	0.3%	0.1%	0.7%	0.5%	1.0%
Indian/Asian	0.3%	1.0%	0.8%	1.8%	1.5%
White	99.0%	98.5%	97.6%	96.6%	95.2%

Figure 6.45: Percentage distribution of article equivalents in Earth Sciences, by age of authors

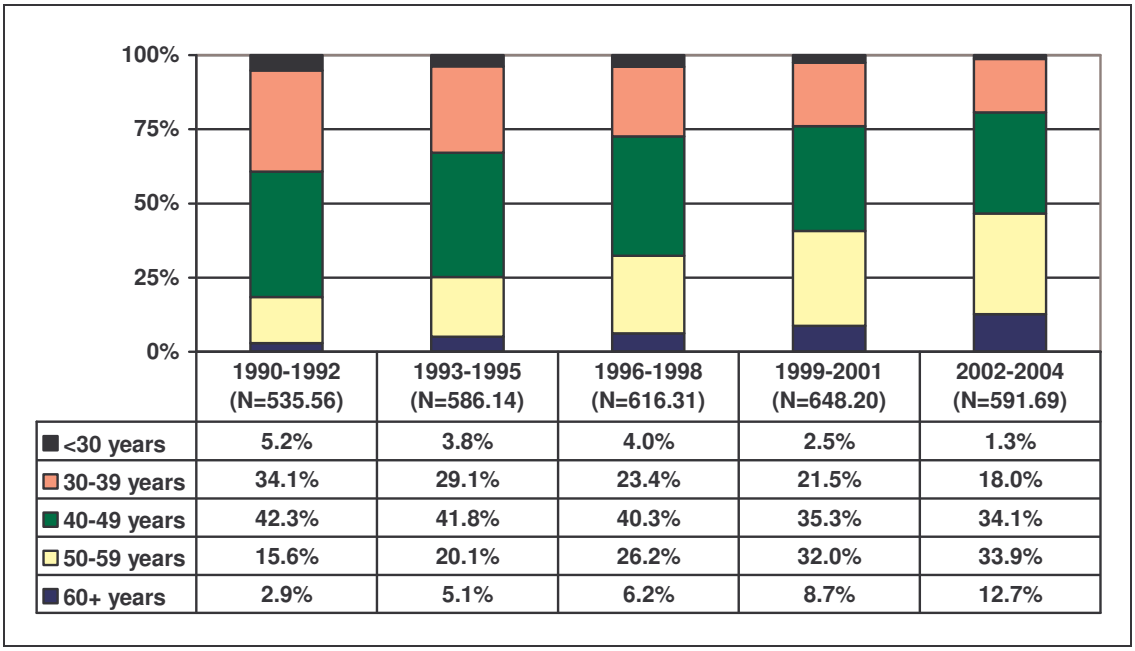


	1990-1992 (N=611.43)	1993-1995 (N=681.49)	1996-1998 (N=723.99)	1999-2001 (N=771.14)	2002-2004 (N=754.24)
<30 years	7.2%	6.0%	5.6%	4.4%	3.0%
30-39 years	33.5%	28.6%	23.9%	22.8%	22.9%
40-49 years	41.1%	40.7%	39.0%	33.8%	31.8%
50-59 years	15.2%	19.7%	25.2%	30.5%	30.4%
60+ years	3.1%	4.9%	6.2%	8.5%	11.9%

Table 6.7: Summary statistics of article equivalents by top 20% of authors in Earth Sciences

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Earth sciences	4933	6838.54	987	4682.89	68.5%

Figure 6.46: Percentage distribution of article equivalents in Earth Sciences, by age of top 20% of authors



	1990-1992 (N=535.56)	1993-1995 (N=586.14)	1996-1998 (N=616.31)	1999-2001 (N=648.20)	2002-2004 (N=591.69)
<30 years	5.2%	3.8%	4.0%	2.5%	1.3%
30-39 years	34.1%	29.1%	23.4%	21.5%	18.0%
40-49 years	42.3%	41.8%	40.3%	35.3%	34.1%
50-59 years	15.6%	20.1%	26.2%	32.0%	33.9%
60+ years	2.9%	5.1%	6.2%	8.7%	12.7%

6.5.5 Mathematical sciences & ICCT

Figure 6.47: Percentage distribution of article equivalents in Mathematical Sciences & ICCT, by gender of authors

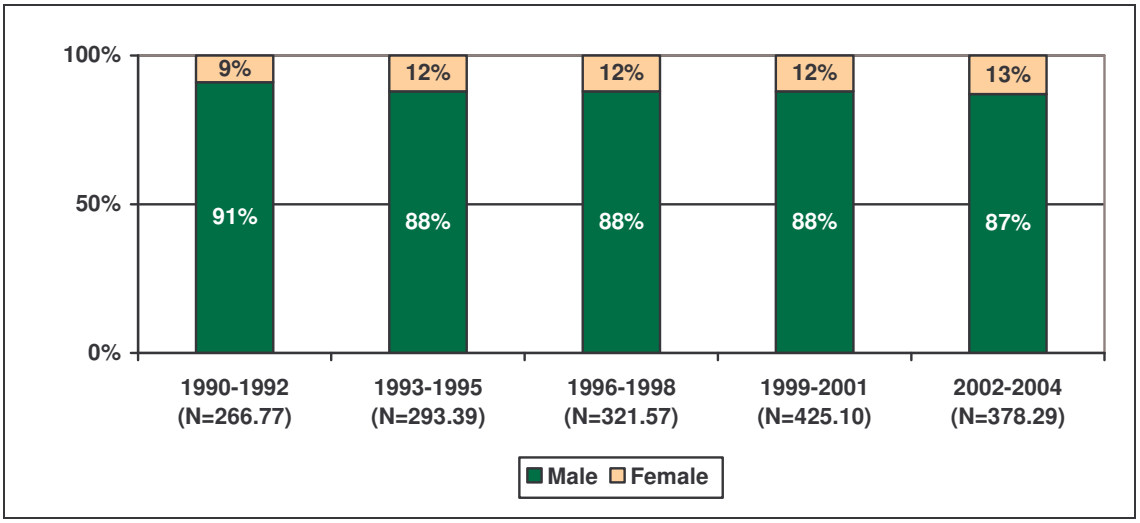
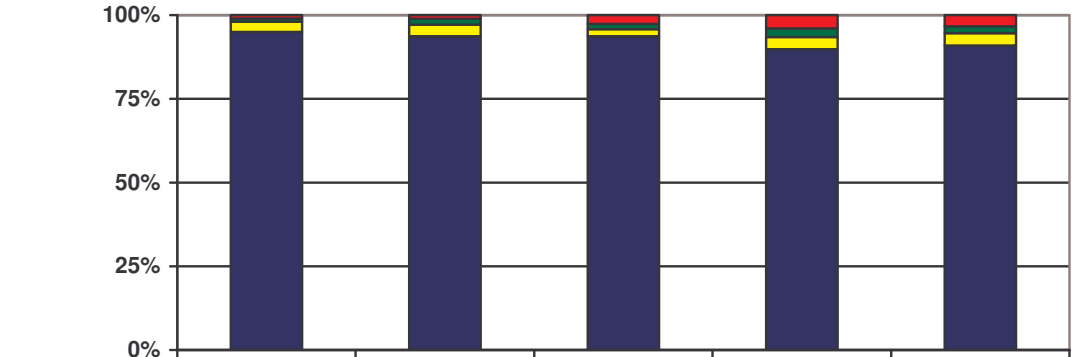
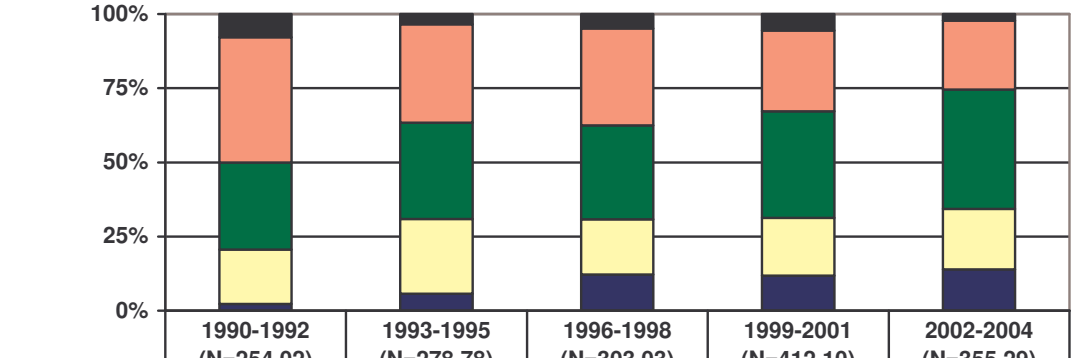


Figure 6.48: Percentage distribution of article equivalents in Mathematical Sciences & ICCT, by race of authors



	1990-1992 (N=259.77)	1993-1995 (N=285.63)	1996-1998 (N=314.53)	1999-2001 (N=418.93)	2002-2004 (N=367.39)
African	1.0%	1.1%	2.6%	4.0%	3.3%
Coloured	1.0%	1.8%	1.6%	2.6%	2.1%
Indian/Asian	3.0%	3.4%	2.1%	3.6%	3.7%
White	95.1%	93.8%	93.7%	89.8%	90.9%

Figure 6.49: Percentage distribution of article equivalents in Mathematical Sciences & ICCT, by age of authors

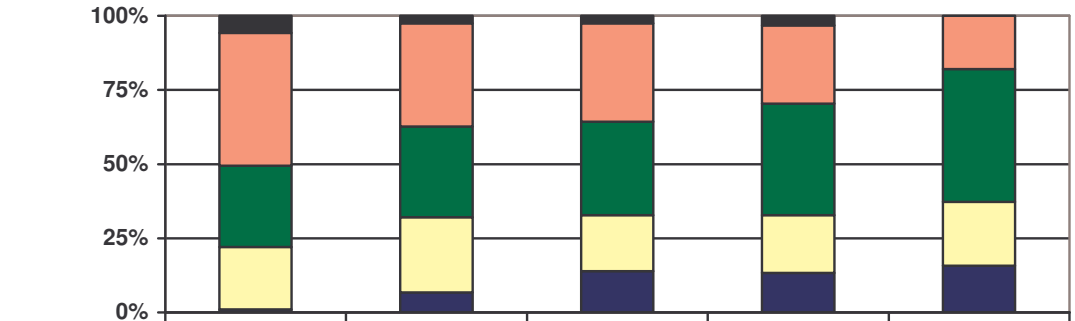


	1990-1992 (N=254.02)	1993-1995 (N=278.78)	1996-1998 (N=303.03)	1999-2001 (N=412.10)	2002-2004 (N=355.29)
<30 years	7.8%	3.5%	4.9%	5.6%	2.2%
30-39 years	42.3%	33.2%	32.7%	27.2%	23.3%
40-49 years	29.3%	32.4%	31.6%	36.0%	40.1%
50-59 years	18.4%	25.2%	18.6%	19.5%	20.4%
60+ years	2.2%	5.7%	12.2%	11.8%	13.9%

Table 6.8: Summary statistics of article equivalents by top 20% of authors in Mathematical Sciences & ICCT

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Mathematical sciences & ICCT	1256	2186.05	251	1447.58	66.2%

Figure 6.50: Percentage distribution of article equivalents in Mathematical Sciences & ICCT, by age of top 20% of authors



	1990-1992 (N=200.25)	1993-1995 (N=213.82)	1996-1998 (N=223.08)	1999-2001 (N=319.40)	2002-2004 (N=262.00)
<30 years	5.8%	2.5%	2.5%	3.2%	0.0%
30-39 years	44.8%	34.9%	33.2%	26.4%	18.0%
40-49 years	27.4%	30.5%	31.5%	37.5%	44.7%
50-59 years	21.0%	25.4%	18.9%	19.5%	21.5%
60+ years	1.0%	6.7%	13.9%	13.3%	15.7%

6.5.6 Physical sciences

Figure 6.51: Percentage distribution of article equivalents in Physical Sciences, by gender of authors

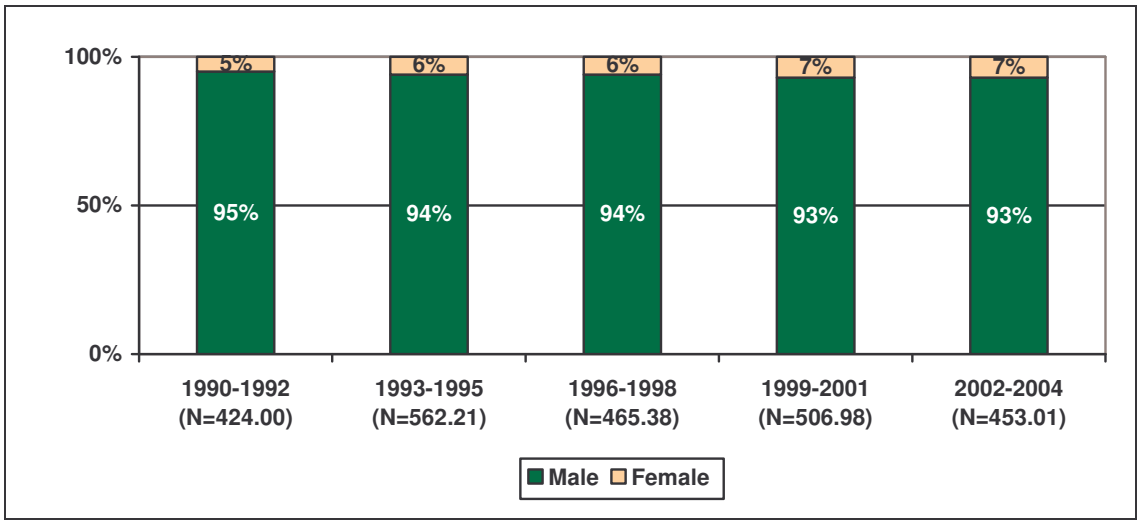
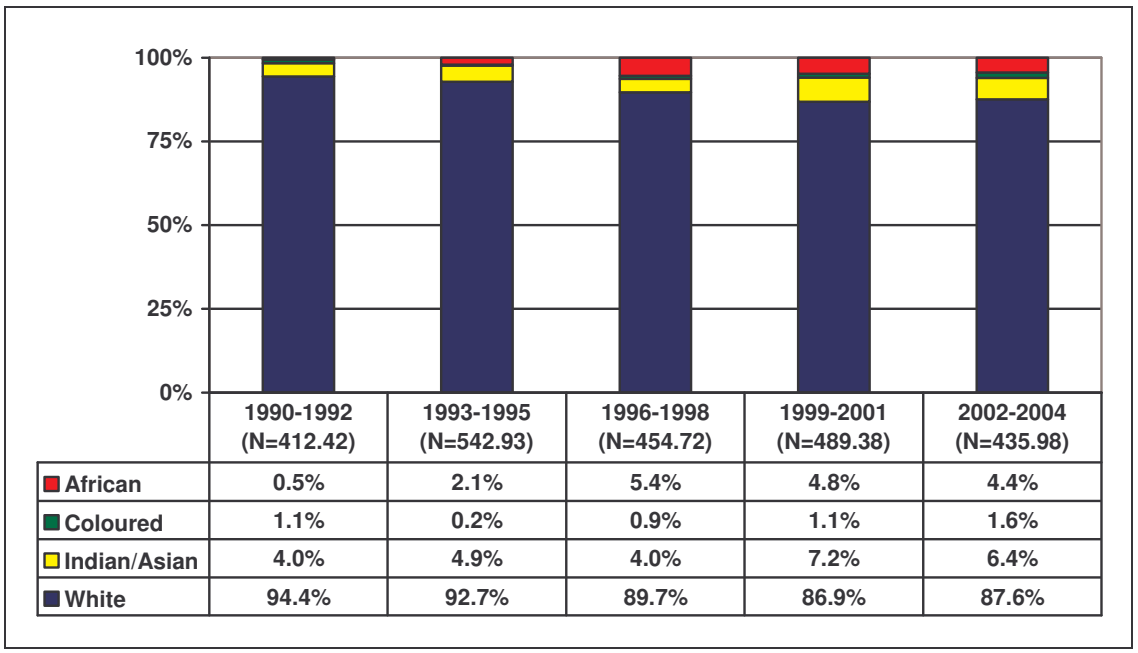
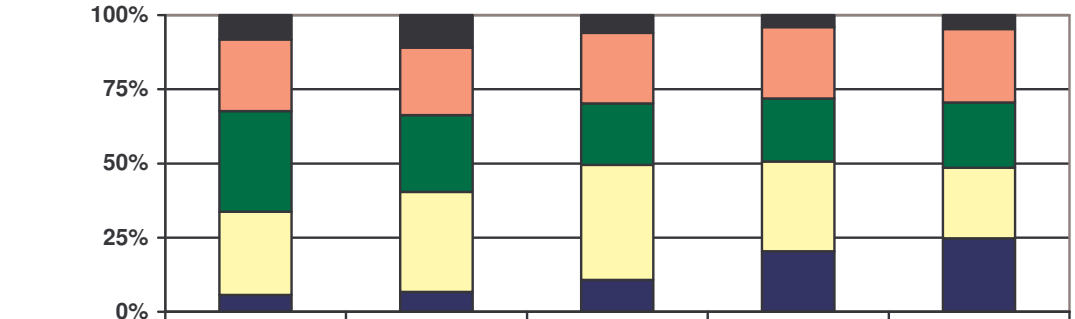


Figure 6.52: Percentage distribution of article equivalents in Physical Sciences, by race of authors



	1990-1992 (N=412.42)	1993-1995 (N=542.93)	1996-1998 (N=454.72)	1999-2001 (N=489.38)	2002-2004 (N=435.98)
African	0.5%	2.1%	5.4%	4.8%	4.4%
Coloured	1.1%	0.2%	0.9%	1.1%	1.6%
Indian/Asian	4.0%	4.9%	4.0%	7.2%	6.4%
White	94.4%	92.7%	89.7%	86.9%	87.6%

Figure 6.53: Percentage distribution of article equivalents in Physical Sciences, by age of authors

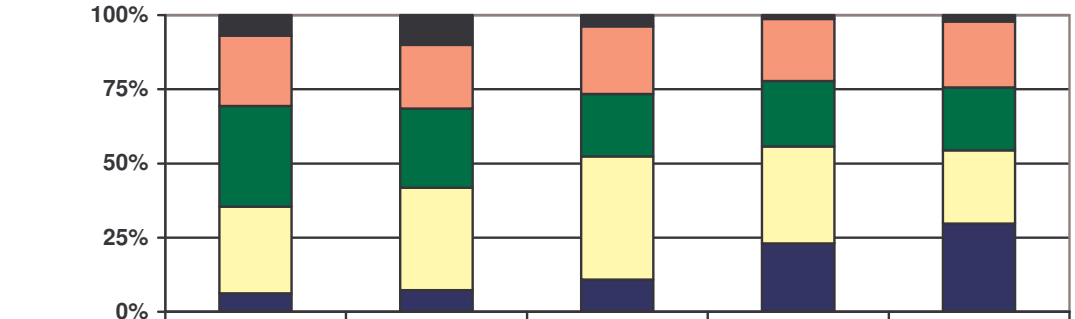


	1990-1992 (N=411.96)	1993-1995 (N=519.30)	1996-1998 (N=426.75)	1999-2001 (N=448.36)	2002-2004 (N=424.55)
<30 years	8.2%	11.0%	6.0%	4.1%	4.7%
30-39 years	24.2%	22.7%	23.7%	24.0%	24.8%
40-49 years	33.8%	25.9%	20.8%	21.2%	22.0%
50-59 years	28.0%	33.7%	38.7%	30.3%	23.8%
60+ years	5.7%	6.7%	10.8%	20.4%	24.8%

Table 6.9: Summary statistics of article equivalents by top 20% of authors in Physical Sciences

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Physical sciences	2264	3771.48	453	2780.65	73.7%

Figure 6.54: Percentage distribution of article equivalents in Physical Sciences, by age of top 20% of authors



	1990-1992 (N=361.04)	1993-1995 (N=448.69)	1996-1998 (N=370.68)	1999-2001 (N=382.99)	2002-2004 (N=344.50)
<30 years	6.9%	10.1%	3.8%	1.3%	2.1%
30-39 years	23.8%	21.4%	22.8%	20.9%	22.3%
40-49 years	33.9%	26.7%	21.0%	22.1%	21.2%
50-59 years	29.2%	34.6%	41.5%	32.7%	24.7%
60+ years	6.2%	7.3%	10.9%	23.0%	29.7%

6.5.7 Multidisciplinary sciences

Figure 6.55: Percentage distribution of article equivalents in Multidisciplinary Sciences, by gender of authors

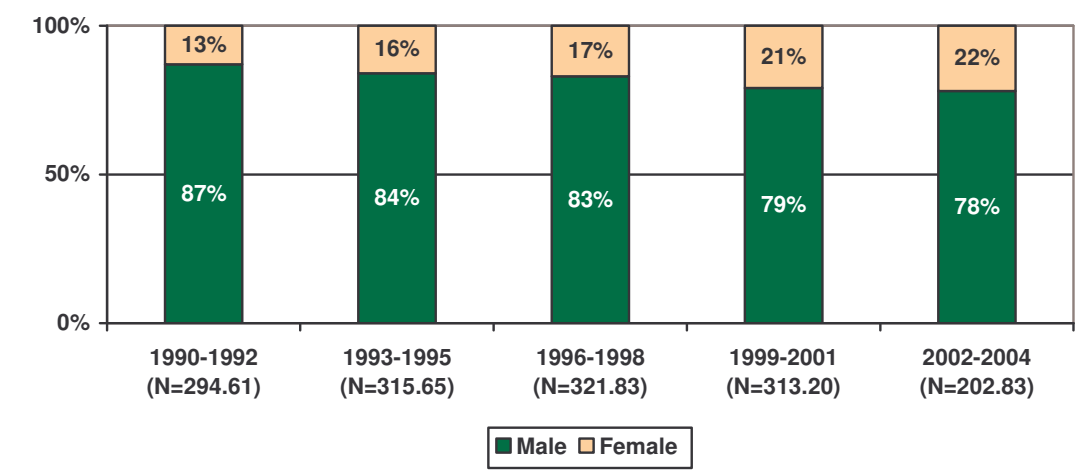
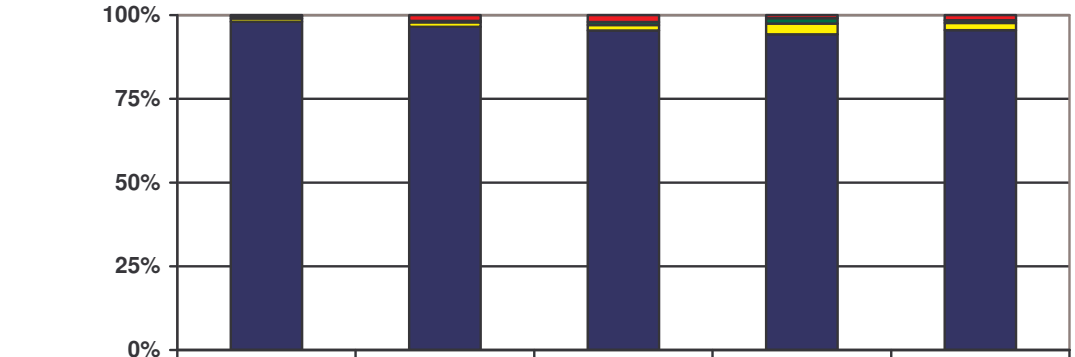
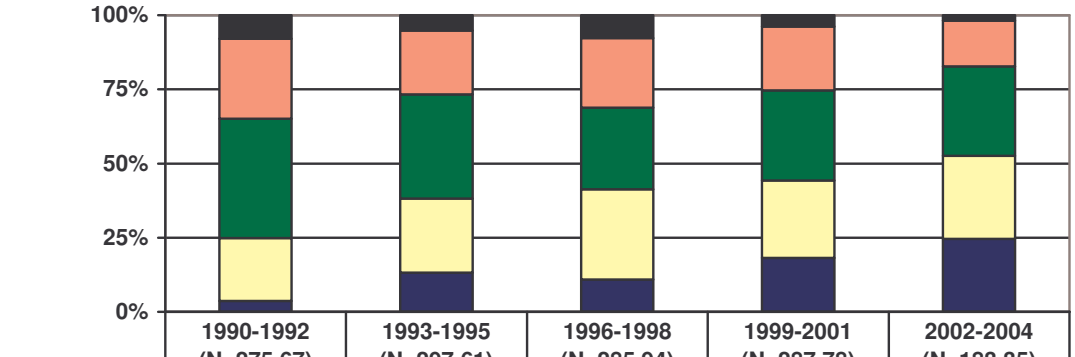


Figure 6.56: Percentage distribution of article equivalents in Multidisciplinary Sciences, by race of authors



	1990-1992 (N=273.07)	1993-1995 (N=299.43)	1996-1998 (N=301.38)	1999-2001 (N=297.25)	2002-2004 (N=194.94)
African	0.3%	1.7%	2.1%	0.9%	1.5%
Coloured	0.7%	0.5%	0.9%	1.6%	0.8%
Indian/Asian	1.0%	1.3%	1.6%	3.3%	2.2%
White	98.0%	96.5%	95.4%	94.2%	95.5%

Figure 6.57: Percentage distribution of article equivalents in Multidisciplinary Sciences, by age of authors

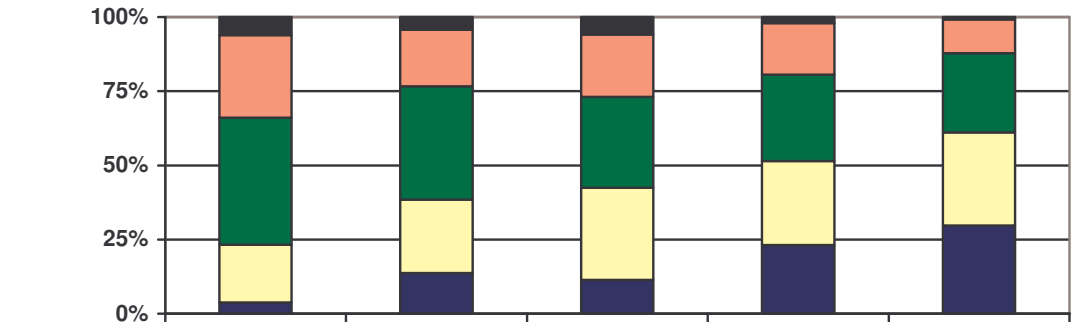


	1990-1992 (N=275.67)	1993-1995 (N=297.61)	1996-1998 (N=285.94)	1999-2001 (N=287.78)	2002-2004 (N=183.35)
<30 years	7.9%	5.2%	7.7%	3.9%	1.8%
30-39 years	27.0%	21.5%	23.5%	21.5%	15.5%
40-49 years	40.2%	35.1%	27.5%	30.4%	30.1%
50-59 years	21.2%	25.0%	30.4%	26.1%	28.0%
60+ years	3.7%	13.2%	10.9%	18.2%	24.6%

Table 6.10: Summary statistics of article equivalents by top 20% of authors in Multidisciplinary Sciences

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Multidisciplinary sciences	2885	2271.54	577	1302.05	57.3%

Figure 6.58: Percentage distribution of article equivalents in Multidisciplinary Sciences, by age of top 20% of authors



	1990-1992 (N=182.25)	1993-1995 (N=206.26)	1996-1998 (N=199.41)	1999-2001 (N=180.50)	2002-2004 (N=109.83)
<30 years	6.1%	4.3%	5.9%	2.0%	0.8%
30-39 years	27.8%	19.1%	21.0%	17.4%	11.4%
40-49 years	42.9%	38.1%	30.7%	29.1%	26.7%
50-59 years	19.4%	24.8%	31.0%	28.4%	31.4%
60+ years	3.8%	13.7%	11.4%	23.1%	29.7%

6.5.8 Engineering & applied technologies

Figure 6.59: Percentage distribution of article equivalents Engineering & Applied Technologies, by gender of authors

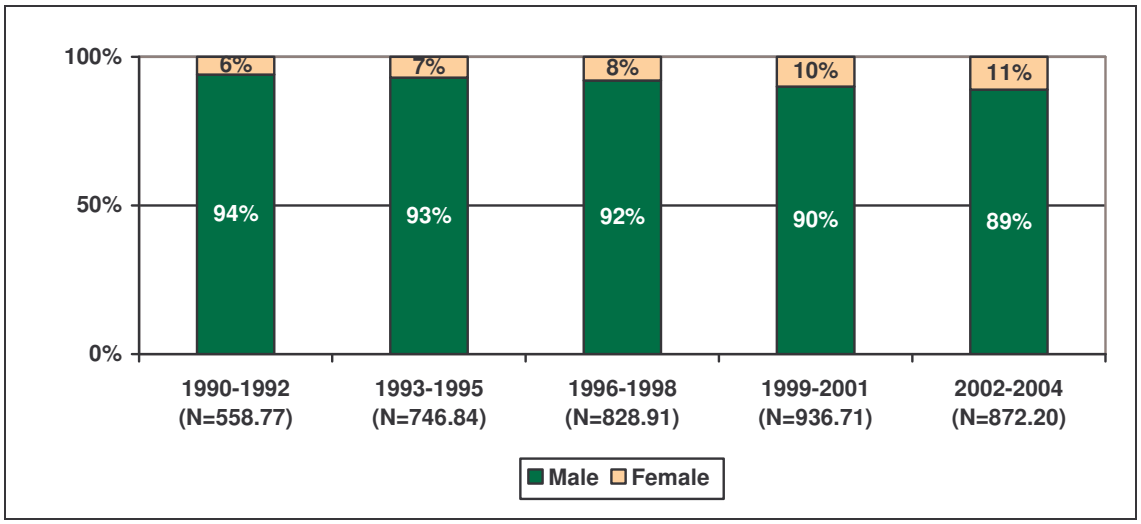
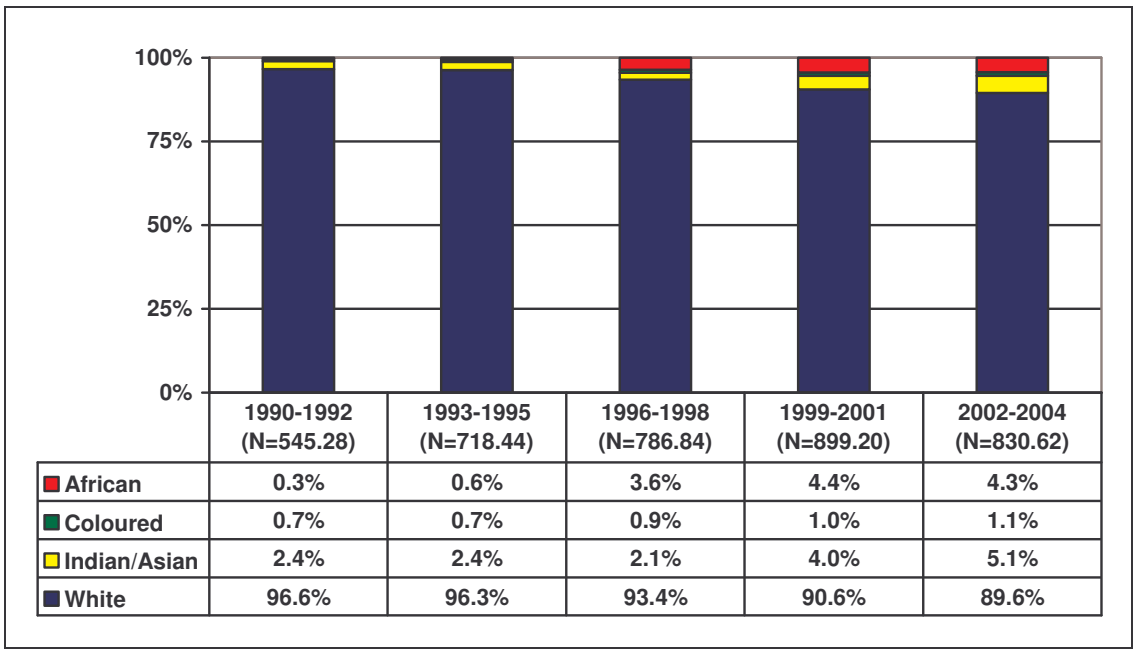
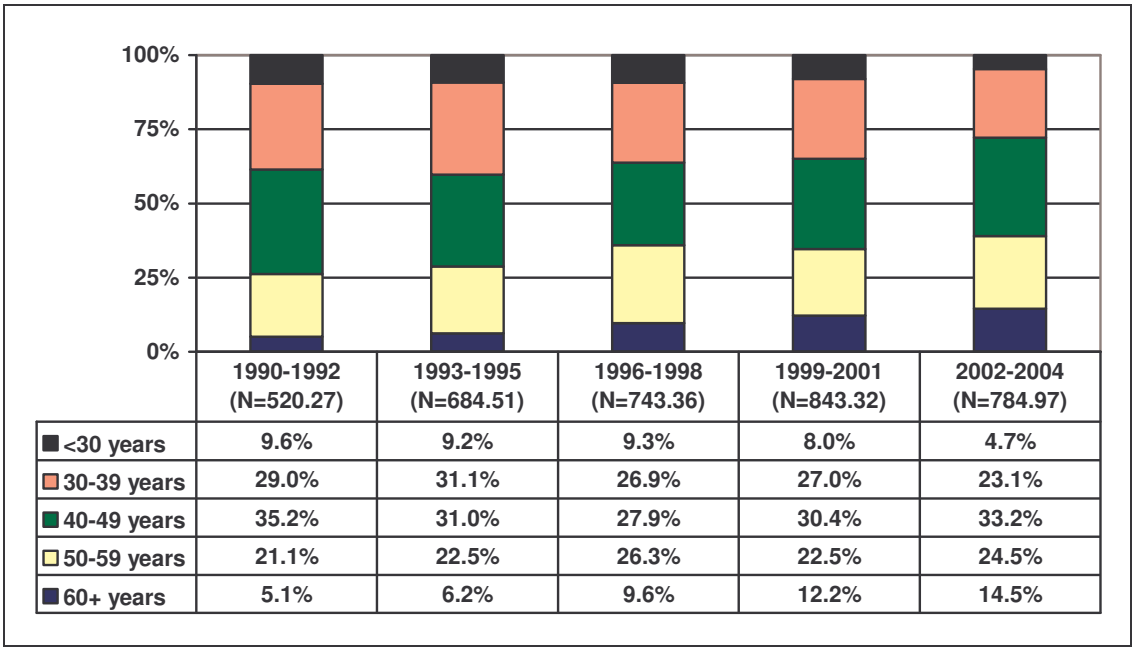


Figure 6.60: Percentage distribution of article equivalents in Engineering & Applied Technologies, by race of authors



	1990-1992 (N=545.28)	1993-1995 (N=718.44)	1996-1998 (N=786.84)	1999-2001 (N=899.20)	2002-2004 (N=830.62)
African	0.3%	0.6%	3.6%	4.4%	4.3%
Coloured	0.7%	0.7%	0.9%	1.0%	1.1%
Indian/Asian	2.4%	2.4%	2.1%	4.0%	5.1%
White	96.6%	96.3%	93.4%	90.6%	89.6%

Figure 6.61: Percentage distribution of article equivalents in Engineering & Applied Technologies, by age of authors

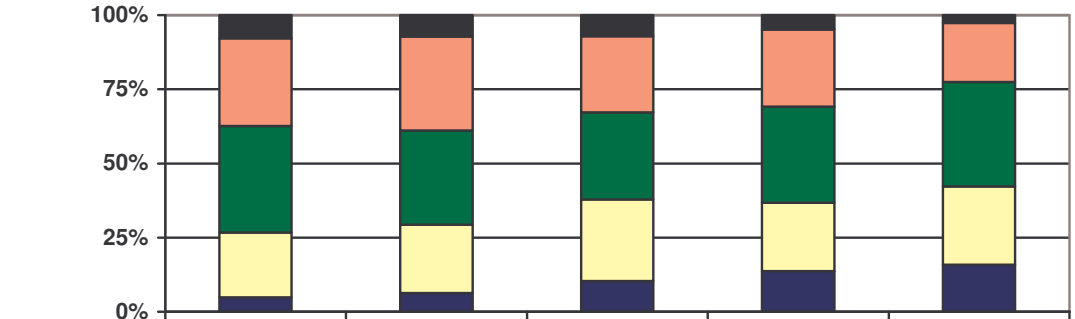


	1990-1992 (N=520.27)	1993-1995 (N=684.51)	1996-1998 (N=743.36)	1999-2001 (N=843.32)	2002-2004 (N=784.97)
<30 years	9.6%	9.2%	9.3%	8.0%	4.7%
30-39 years	29.0%	31.1%	26.9%	27.0%	23.1%
40-49 years	35.2%	31.0%	27.9%	30.4%	33.2%
50-59 years	21.1%	22.5%	26.3%	22.5%	24.5%
60+ years	5.1%	6.2%	9.6%	12.2%	14.5%

Table 6.11: Summary statistics of article equivalents by top 20% of authors in Engineering & Applied Technologies

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Engineering & applied technologies	5130	6359.45	1026	4175.24	65.7%

Figure 6.62: Percentage distribution of article equivalents in Engineering & Applied Technologies, by age of top 20% of authors



	1990-1992 (N=420.23)	1993-1995 (N=562.76)	1996-1998 (N=602.90)	1999-2001 (N=684.90)	2002-2004 (N=604.22)
<30 years	7.8%	7.2%	7.1%	4.9%	2.6%
30-39 years	29.5%	31.7%	25.7%	25.9%	19.9%
40-49 years	35.9%	31.8%	29.3%	32.4%	35.3%
50-59 years	21.8%	23.1%	27.5%	23.0%	26.4%
60+ years	4.9%	6.3%	10.4%	13.7%	15.8%

6.5.9 Basic health

Figure 6.63: Percentage distribution of article equivalents in Basic Health, by gender of authors

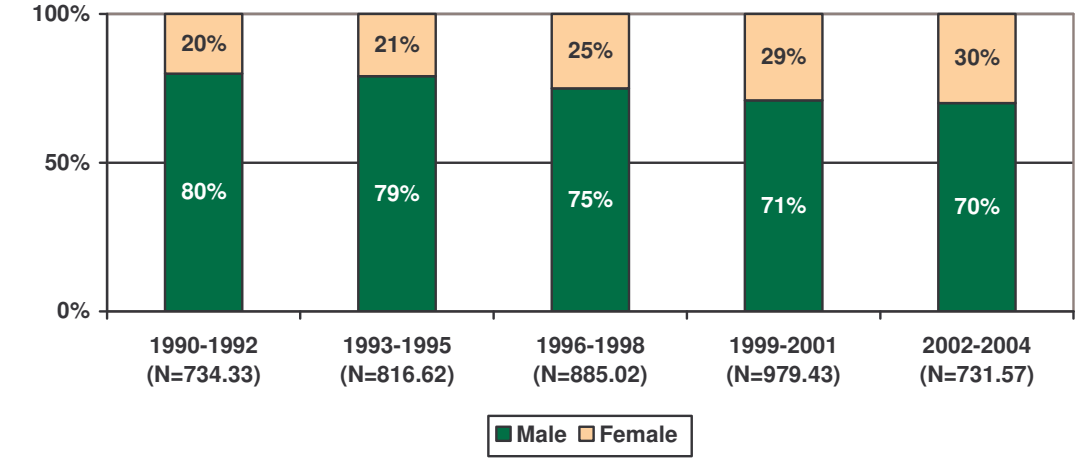
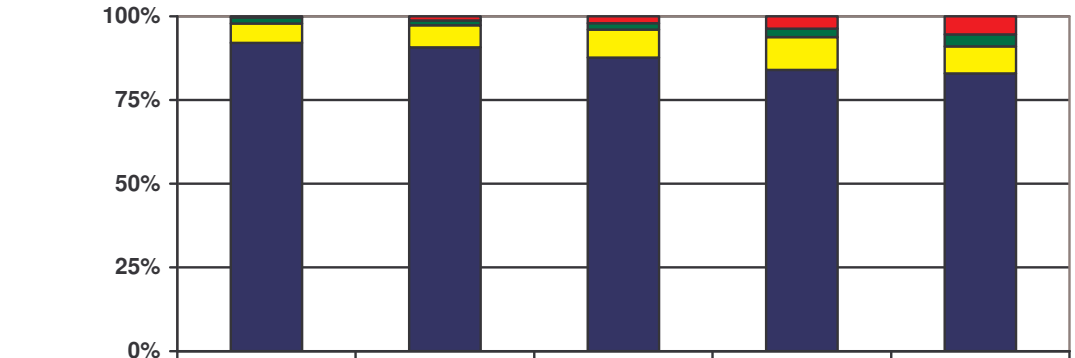
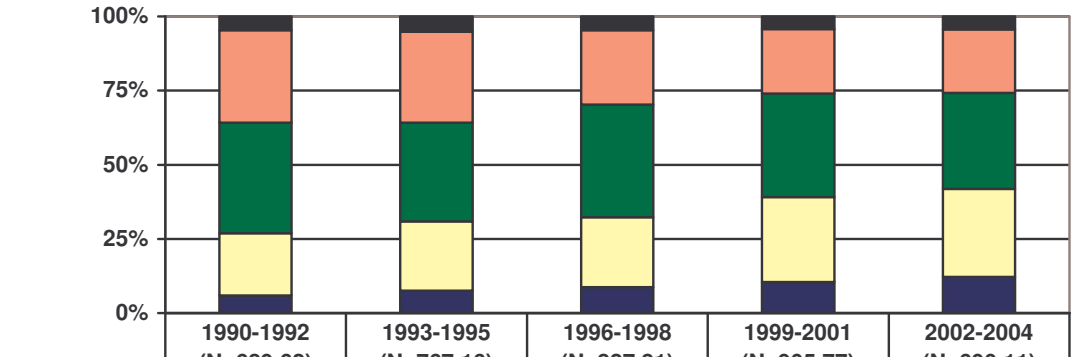


Figure 6.64: Percentage distribution of article equivalents in Basic Health, by race of authors



	1990-1992 (N=603.18)	1993-1995 (N=693.38)	1996-1998 (N=784.77)	1999-2001 (N=896.86)	2002-2004 (N=698.18)
African	0.4%	1.3%	2.1%	3.7%	5.4%
Coloured	1.8%	1.4%	1.9%	2.5%	3.6%
Indian/Asian	5.7%	6.6%	8.3%	9.8%	8.1%
White	92.1%	90.8%	87.8%	84.0%	82.9%

Figure 6.65: Percentage distribution of article equivalents in Basic Health, by age of authors

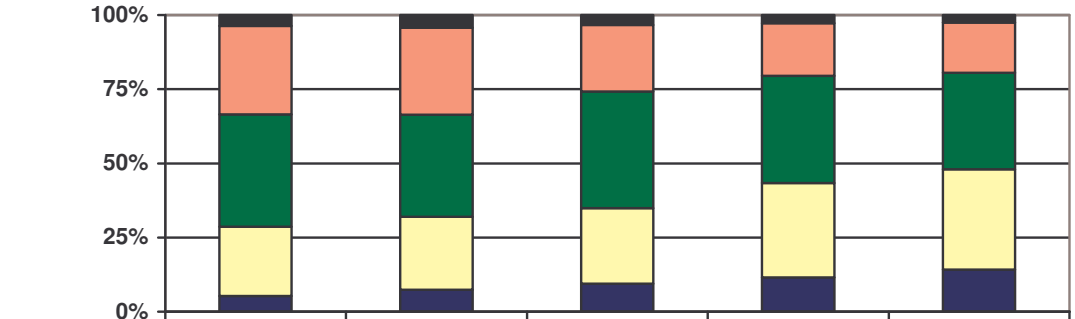


	1990-1992 (N=689.62)	1993-1995 (N=767.16)	1996-1998 (N=827.81)	1999-2001 (N=905.77)	2002-2004 (N=690.11)
<30 years	4.7%	5.2%	4.7%	4.3%	4.4%
30-39 years	31.2%	30.6%	25.0%	21.7%	21.4%
40-49 years	37.3%	33.3%	37.9%	34.9%	32.4%
50-59 years	21.0%	23.4%	23.6%	28.6%	29.6%
60+ years	5.9%	7.5%	8.7%	10.5%	12.2%

Table 6.12: Summary statistics of article equivalents by top 20% of authors in Basic Health

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Basic health	6963	6111.02	1393	3975.83	65.1%

Figure 6.66: Percentage distribution of article equivalents in Basic Health, by age of top 20% of authors



	1990-1992 (N=542.08)	1993-1995 (N=622.97)	1996-1998 (N=663.70)	1999-2001 (N=719.68)	2002-2004 (N=516.98)
<30 years	3.7%	4.3%	3.4%	2.7%	2.5%
30-39 years	29.8%	29.3%	22.4%	17.8%	17.0%
40-49 years	37.9%	34.4%	39.3%	36.2%	32.5%
50-59 years	23.3%	24.6%	25.5%	31.7%	33.8%
60+ years	5.3%	7.4%	9.4%	11.6%	14.2%

6.5.10 Clinical health

Figure 6.67: Percentage distribution of article equivalents in Clinical Health, by gender of authors

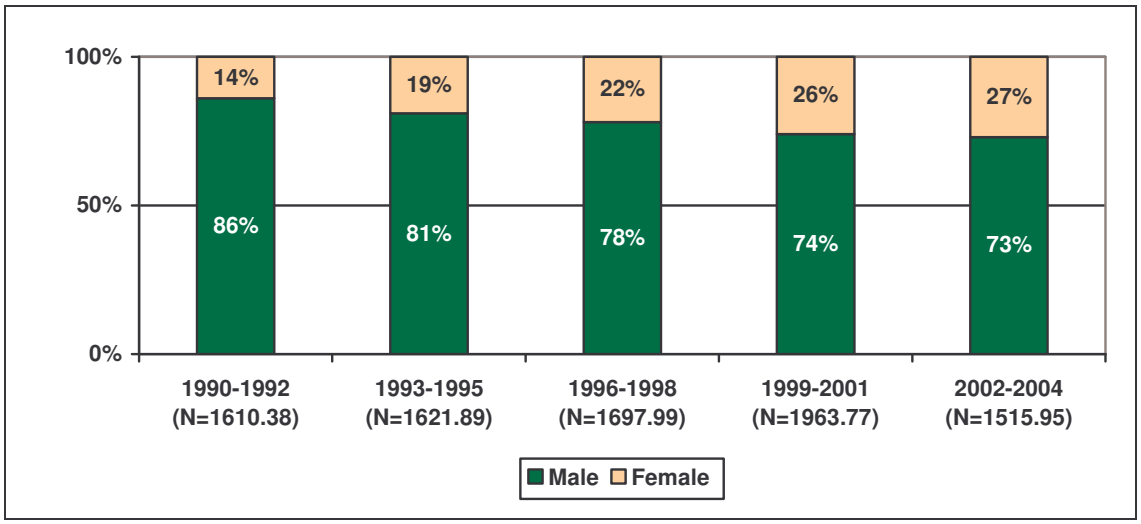
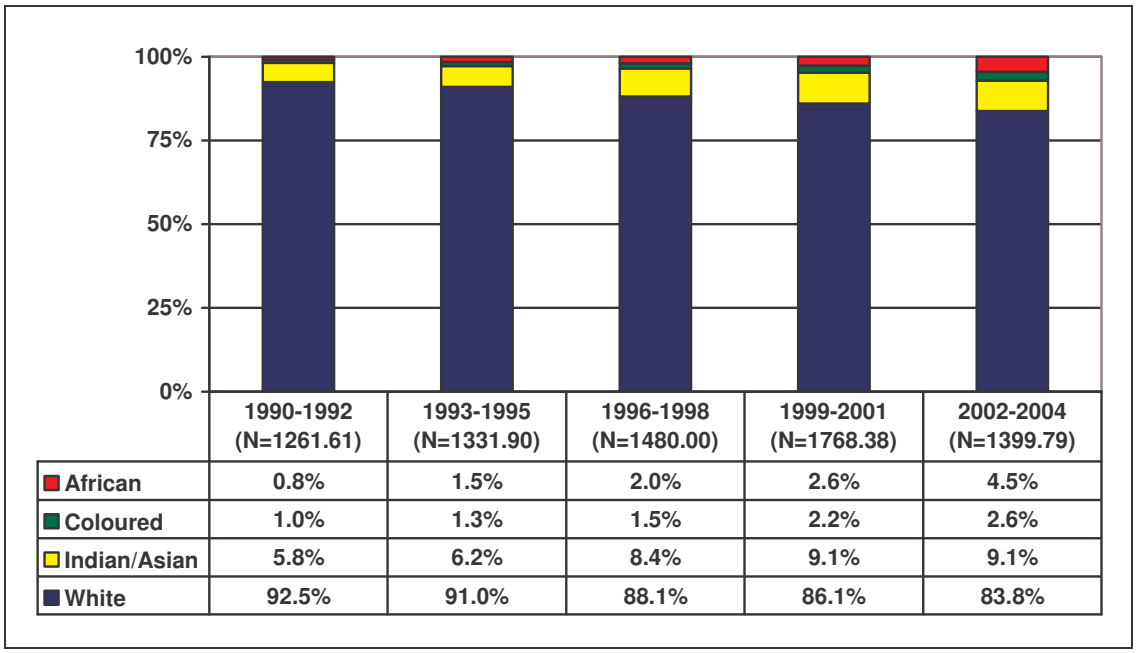
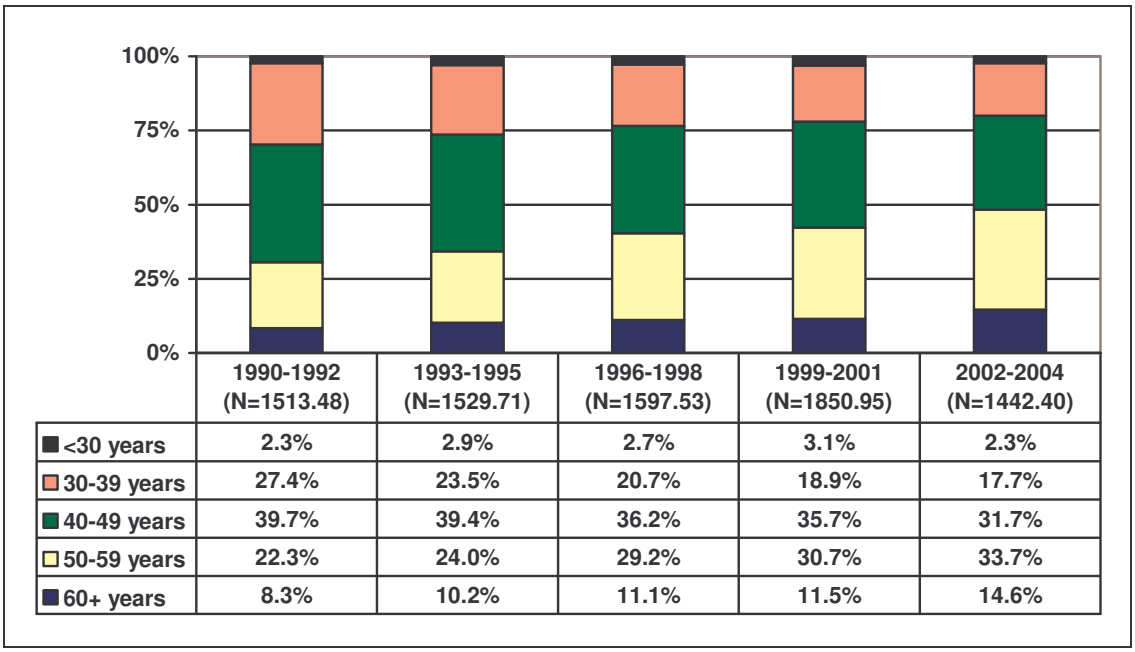


Figure 6.68: Percentage distribution of article equivalents in Clinical Health, by race of authors



	1990-1992 (N=1261.61)	1993-1995 (N=1331.90)	1996-1998 (N=1480.00)	1999-2001 (N=1768.38)	2002-2004 (N=1399.79)
African	0.8%	1.5%	2.0%	2.6%	4.5%
Coloured	1.0%	1.3%	1.5%	2.2%	2.6%
Indian/Asian	5.8%	6.2%	8.4%	9.1%	9.1%
White	92.5%	91.0%	88.1%	86.1%	83.8%

Figure 6.69: Percentage distribution of article equivalents in Clinical Health, by age of authors

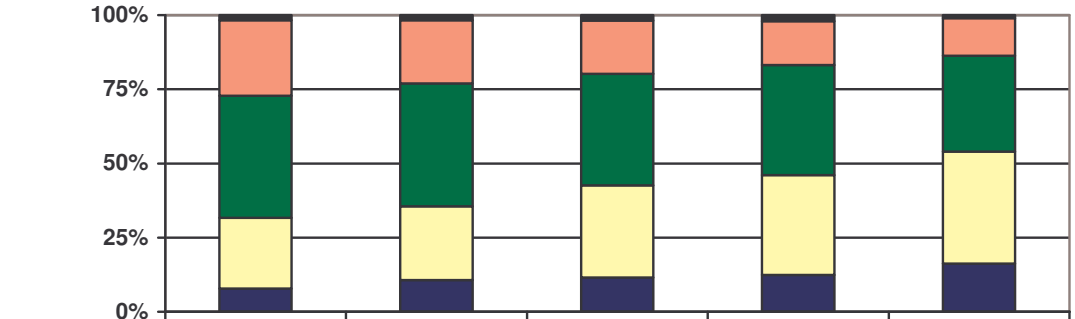


	1990-1992 (N=1513.48)	1993-1995 (N=1529.71)	1996-1998 (N=1597.53)	1999-2001 (N=1850.95)	2002-2004 (N=1442.40)
<30 years	2.3%	2.9%	2.7%	3.1%	2.3%
30-39 years	27.4%	23.5%	20.7%	18.9%	17.7%
40-49 years	39.7%	39.4%	36.2%	35.7%	31.7%
50-59 years	22.3%	24.0%	29.2%	30.7%	33.7%
60+ years	8.3%	10.2%	11.1%	11.5%	14.6%

Table 6.13: Summary statistics of article equivalents by top 20% of authors in Clinical Health

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Clinical health	9860	12421.33	1972	8882.76	71.5%

Figure 6.70: Percentage distribution of article equivalents in Clinical Health, by age of top 20% of authors



	1990-1992 (N=1293.88)	1993-1995 (N=1311.71)	1996-1998 (N=1353.33)	1999-2001 (N=1559.77)	2002-2004 (N=1158.33)
<30 years	1.7%	1.7%	1.8%	2.0%	1.0%
30-39 years	25.5%	21.4%	18.0%	14.9%	12.7%
40-49 years	41.1%	41.4%	37.6%	37.1%	32.3%
50-59 years	23.8%	24.9%	31.0%	33.7%	37.8%
60+ years	7.8%	10.7%	11.6%	12.4%	16.3%

6.5.11 Public & community health

Figure 6.71: Percentage distribution of article equivalents in Public / Community Health, by gender of authors

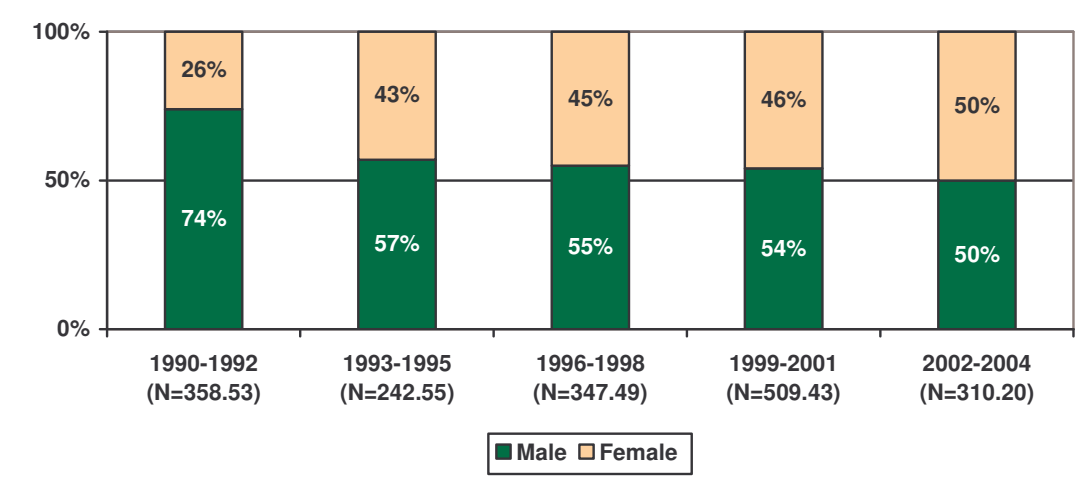
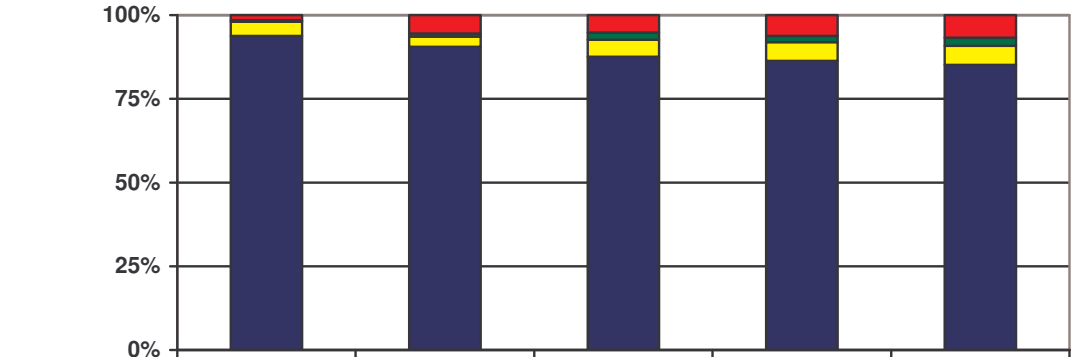
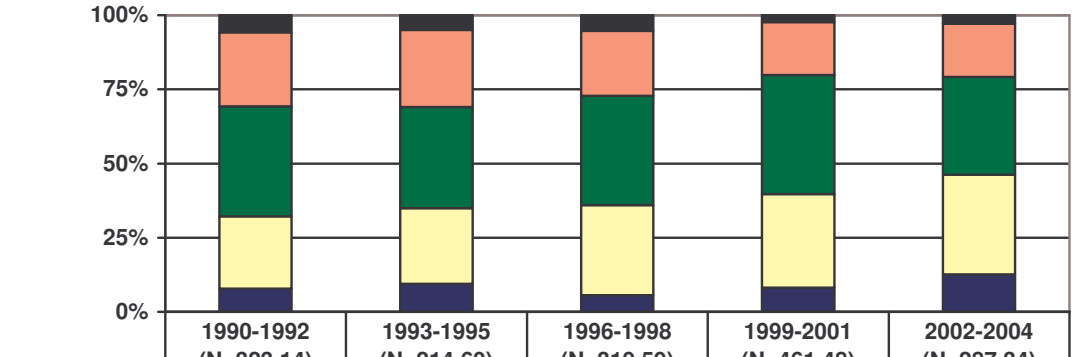


Figure 6.72: Percentage distribution of article equivalents in Public / Community Health, by race of authors



	1990-1992 (N=288.64)	1993-1995 (N=216.43)	1996-1998 (N=310.01)	1999-2001 (N=473.67)	2002-2004 (N=291.53)
African	1.5%	5.5%	5.2%	6.2%	6.7%
Coloured	0.5%	0.9%	2.2%	1.9%	2.5%
Indian/Asian	4.2%	3.0%	5.0%	5.6%	5.6%
White	93.8%	90.6%	87.6%	86.2%	85.2%

Figure 6.73: Percentage distribution of article equivalents in Public / Community Health, by age of authors

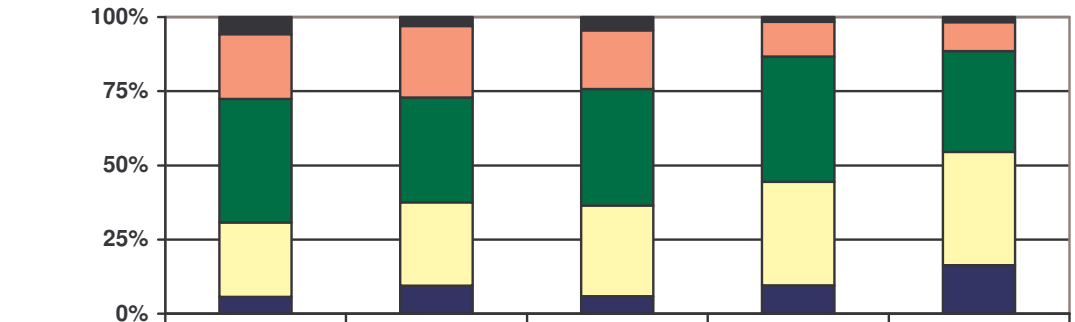


	1990-1992 (N=323.14)	1993-1995 (N=214.60)	1996-1998 (N=319.59)	1999-2001 (N=461.48)	2002-2004 (N=287.34)
<30 years	5.8%	5.0%	5.3%	2.3%	2.8%
30-39 years	24.9%	25.9%	21.9%	17.9%	18.0%
40-49 years	37.1%	34.1%	36.9%	40.1%	33.0%
50-59 years	24.3%	25.5%	30.3%	31.6%	33.6%
60+ years	7.8%	9.4%	5.6%	8.1%	12.6%

Table 6.14: Summary statistics of article equivalents by top 20% of authors in Public / Community Health

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Public / community health	2645	2426.37	529	1411.88	58.2%

Figure 6.74: Percentage distribution of article equivalents in Public / Community Health, by age of top 20% of authors



	1990-1992 (N=205.23)	1993-1995 (N=157.00)	1996-1998 (N=212.09)	1999-2001 (N=313.19)	2002-2004 (N=187.88)
<30 years	5.8%	3.0%	4.5%	1.6%	1.7%
30-39 years	21.8%	24.1%	19.7%	11.7%	9.8%
40-49 years	41.6%	35.3%	39.3%	42.2%	34.0%
50-59 years	25.1%	28.2%	30.5%	35.0%	38.2%
60+ years	5.7%	9.4%	5.9%	9.5%	16.3%

6.5.12 Economics & management sciences

Figure 6.75: Percentage distribution of article equivalents in Economics & Management Sciences, by gender of authors

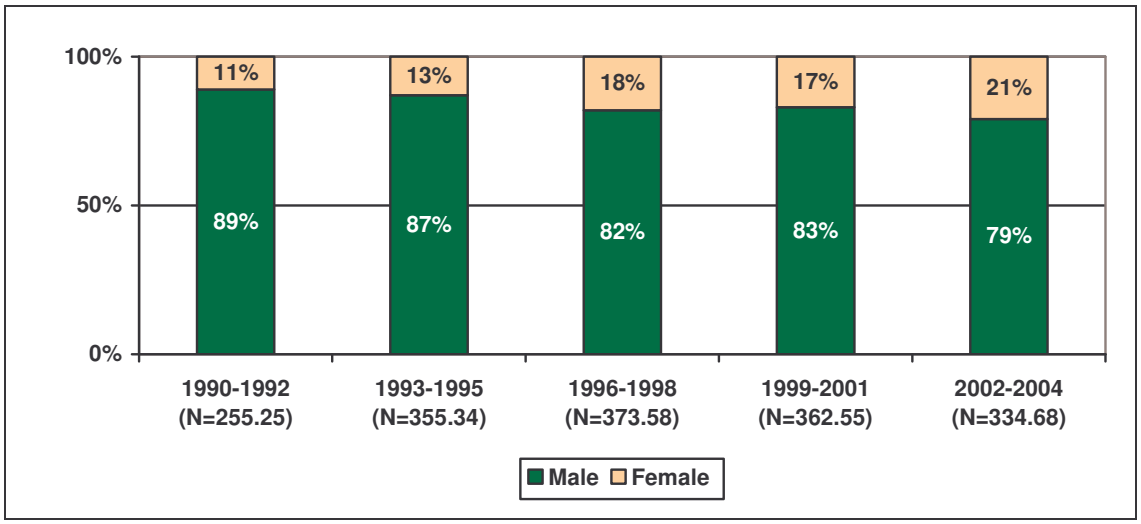
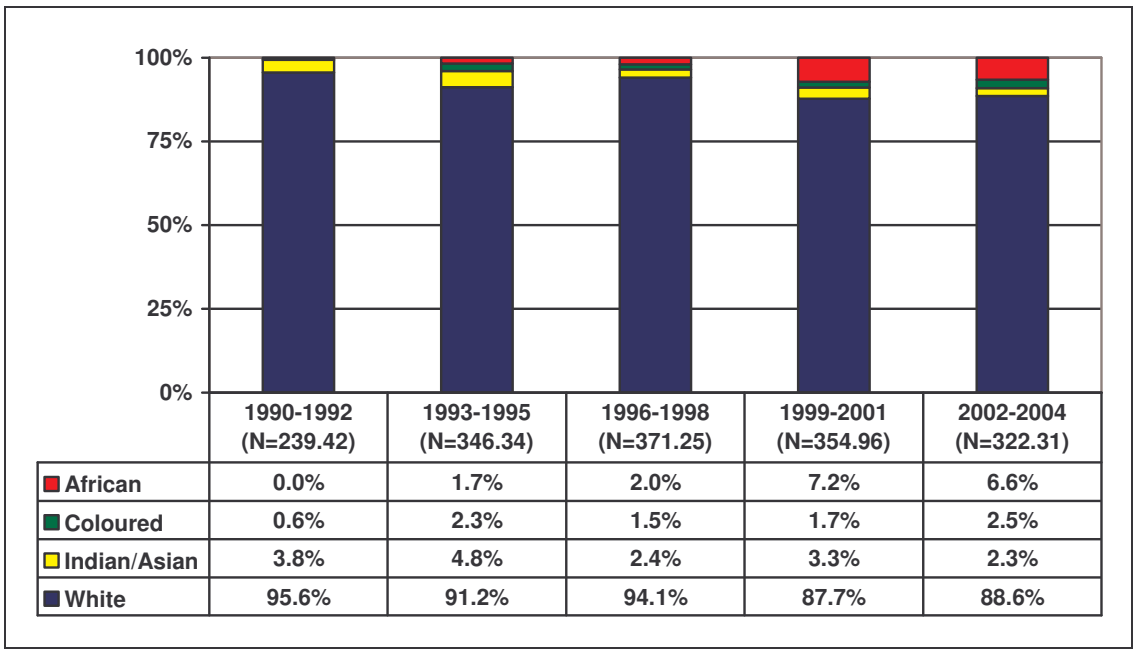
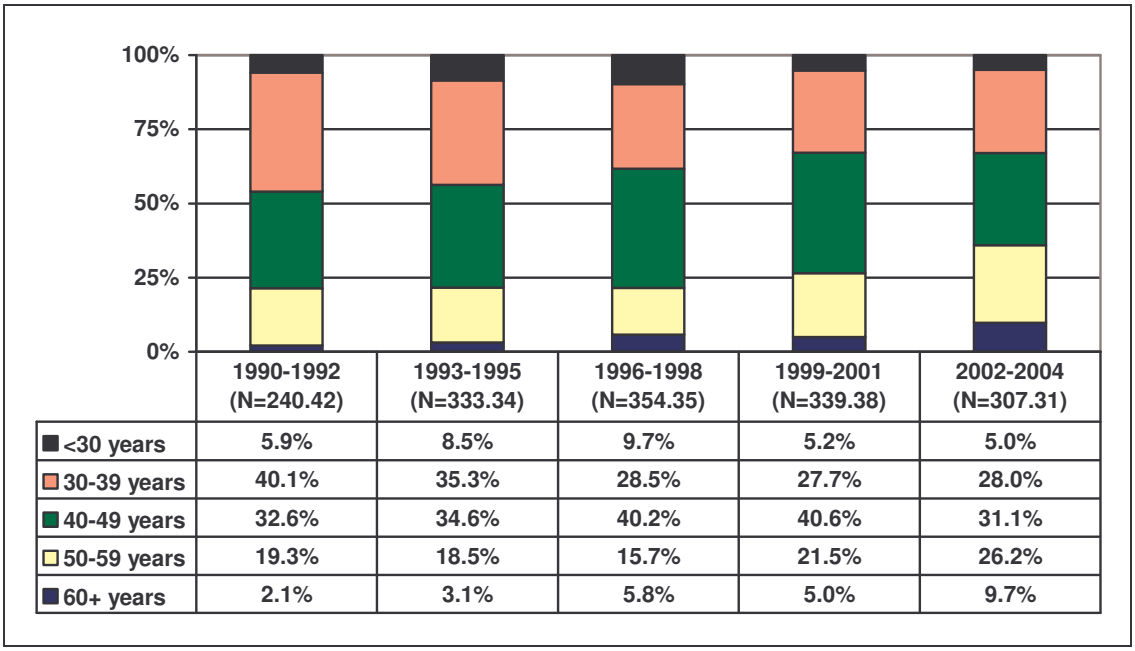


Figure 6.76: Percentage distribution of article equivalents in Economic & Management Sciences, by race of authors



	1990-1992 (N=239.42)	1993-1995 (N=346.34)	1996-1998 (N=371.25)	1999-2001 (N=354.96)	2002-2004 (N=322.31)
African	0.0%	1.7%	2.0%	7.2%	6.6%
Coloured	0.6%	2.3%	1.5%	1.7%	2.5%
Indian/Asian	3.8%	4.8%	2.4%	3.3%	2.3%
White	95.6%	91.2%	94.1%	87.7%	88.6%

Figure 6.77: Percentage distribution of article equivalents in Economic & Management Sciences, by age of authors

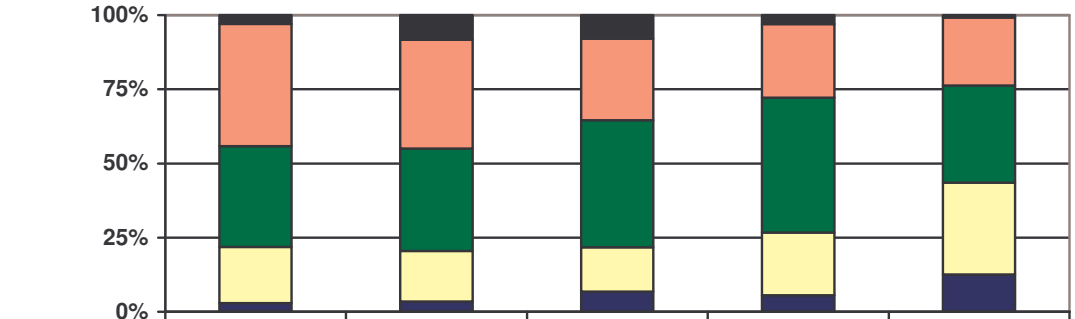


	1990-1992 (N=240.42)	1993-1995 (N=333.34)	1996-1998 (N=354.35)	1999-2001 (N=339.38)	2002-2004 (N=307.31)
<30 years	5.9%	8.5%	9.7%	5.2%	5.0%
30-39 years	40.1%	35.3%	28.5%	27.7%	28.0%
40-49 years	32.6%	34.6%	40.2%	40.6%	31.1%
50-59 years	19.3%	18.5%	15.7%	21.5%	26.2%
60+ years	2.1%	3.1%	5.8%	5.0%	9.7%

Table 6.15: Summary statistics of article equivalents by top 20% of authors in Economic & Management Sciences

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Economic & management sciences	1428	2260.27	286	1367.72	60.5%

Figure 6.78: Percentage distribution of article equivalents in Economic & Management Sciences, by age of top 20% of authors



	1990-1992 (N=169.50)	1993-1995 (N=244.00)	1996-1998 (N=255.42)	1999-2001 (N=236.06)	2002-2004 (N=192.03)
<30 years	2.9%	8.3%	7.9%	3.0%	0.8%
30-39 years	41.2%	36.7%	27.5%	24.8%	22.9%
40-49 years	34.0%	34.5%	42.9%	45.5%	32.7%
50-59 years	18.9%	17.0%	14.9%	21.1%	30.9%
60+ years	2.9%	3.5%	6.8%	5.6%	12.6%

6.5.13 Education

Figure 6.79: Percentage distribution of article equivalents in Education, by gender of authors

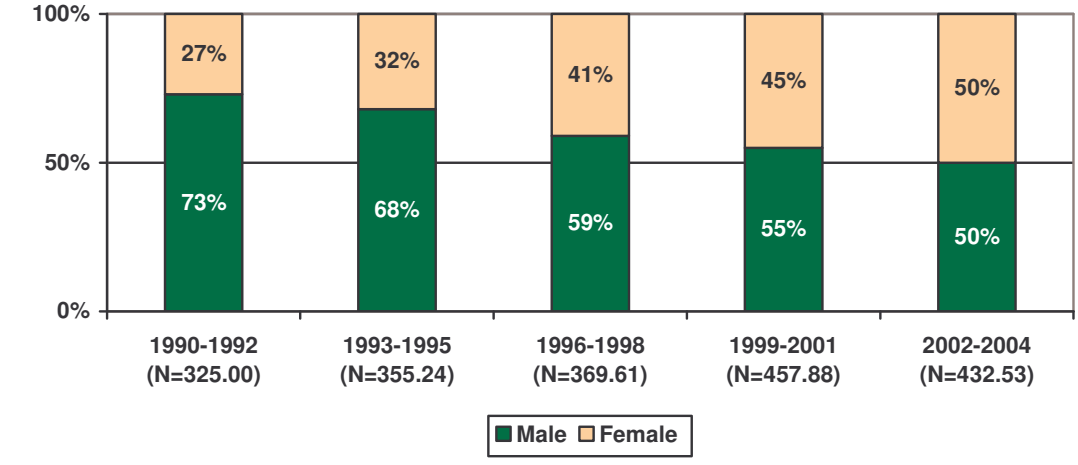
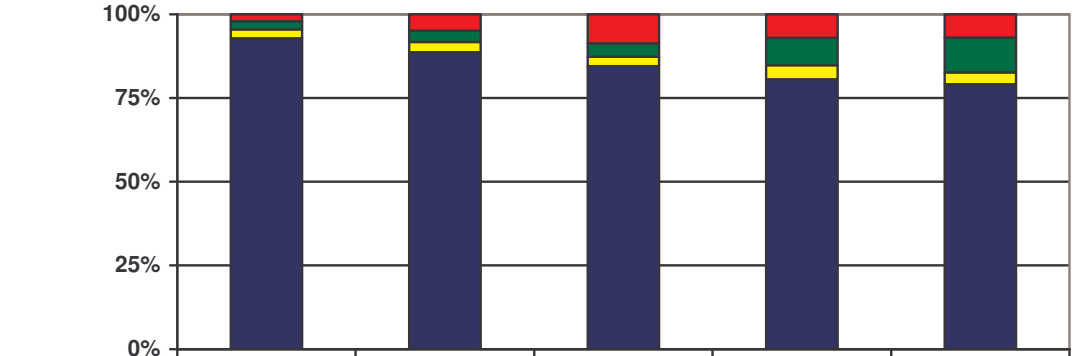
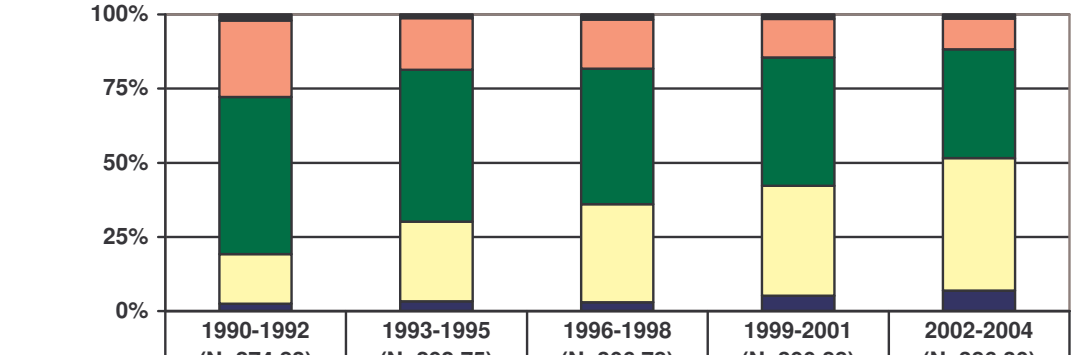


Figure 6.80: Percentage distribution of article equivalents in Education, by race of authors



	1990-1992 (N=354.50)	1993-1995 (N=370.15)	1996-1998 (N=391.71)	1999-2001 (N=457.53)	2002-2004 (N=419.66)
African	2.1%	4.9%	8.6%	7.0%	6.9%
Coloured	2.4%	3.4%	4.1%	8.2%	10.5%
Indian/Asian	2.7%	3.0%	2.8%	4.2%	3.5%
White	92.8%	88.7%	84.5%	80.7%	79.1%

Figure 6.81: Percentage distribution of article equivalents in Education, by age of authors

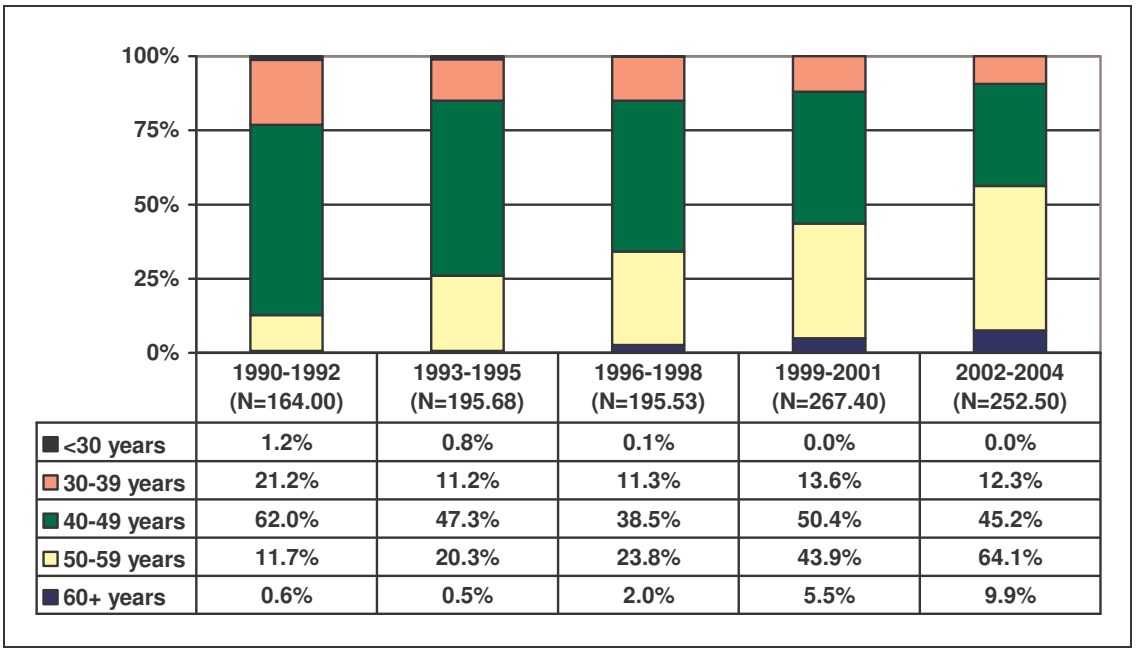


	1990-1992 (N=274.83)	1993-1995 (N=292.75)	1996-1998 (N=306.78)	1999-2001 (N=390.88)	2002-2004 (N=386.30)
<30 years	2.0%	1.2%	1.7%	1.5%	1.4%
30-39 years	25.8%	17.8%	16.6%	13.0%	10.4%
40-49 years	53.0%	52.0%	45.6%	43.3%	36.7%
50-59 years	16.8%	27.4%	33.1%	37.0%	44.7%
60+ years	2.4%	3.3%	2.9%	5.2%	6.9%

Table 6.16: Summary statistics of article equivalents by top 20% of authors in Education

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Education	1726	2570.29	345	1485.82	57.8%

Figure 6.82: Percentage distribution of article equivalents in Education, by age of top 20% of authors



	1990-1992 (N=164.00)	1993-1995 (N=195.68)	1996-1998 (N=195.53)	1999-2001 (N=267.40)	2002-2004 (N=252.50)
<30 years	1.2%	0.8%	0.1%	0.0%	0.0%
30-39 years	21.2%	11.2%	11.3%	13.6%	12.3%
40-49 years	62.0%	47.3%	38.5%	50.4%	45.2%
50-59 years	11.7%	20.3%	23.8%	43.9%	64.1%
60+ years	0.6%	0.5%	2.0%	5.5%	9.9%

6.5.14 Psychology

Figure 6.83: Percentage distribution of article equivalents in Psychology, by gender of authors

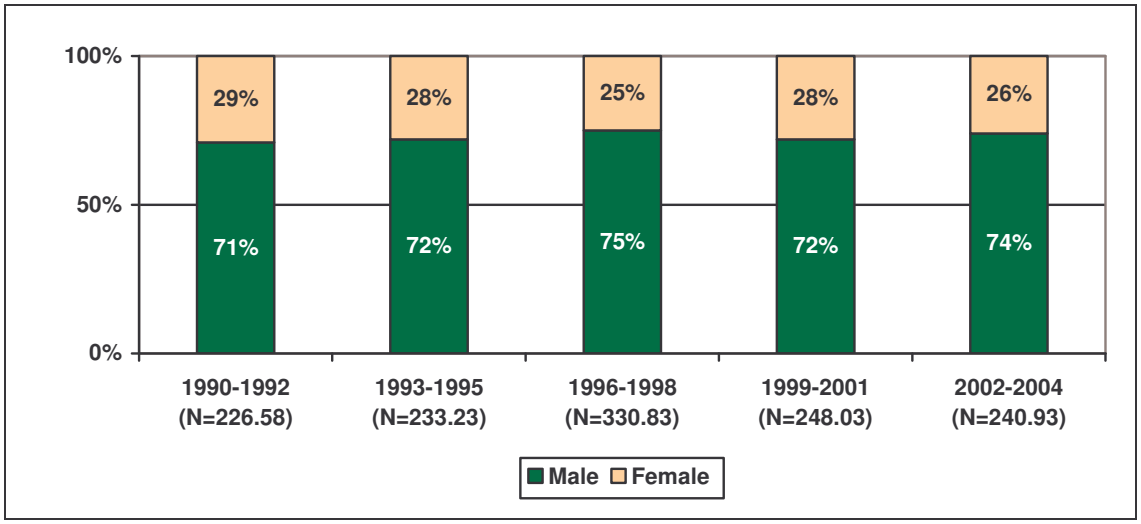
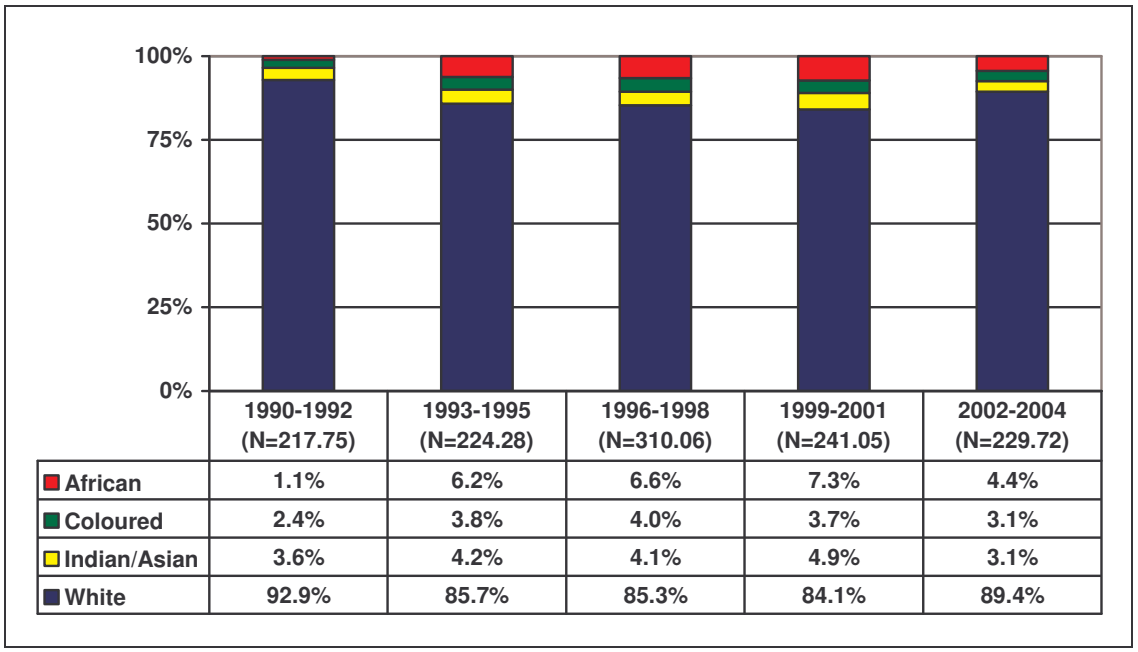
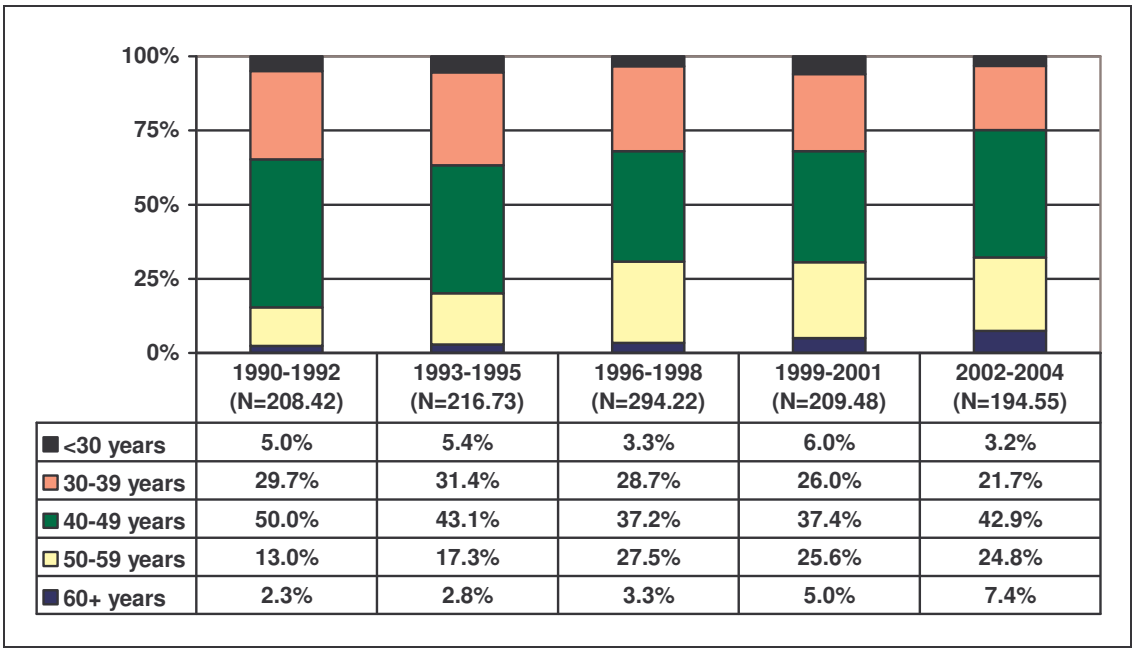


Figure 6.84: Percentage distribution of article equivalents in Psychology, by race of authors



	1990-1992 (N=217.75)	1993-1995 (N=224.28)	1996-1998 (N=310.06)	1999-2001 (N=241.05)	2002-2004 (N=229.72)
African	1.1%	6.2%	6.6%	7.3%	4.4%
Coloured	2.4%	3.8%	4.0%	3.7%	3.1%
Indian/Asian	3.6%	4.2%	4.1%	4.9%	3.1%
White	92.9%	85.7%	85.3%	84.1%	89.4%

Figure 6.85: Percentage distribution of article equivalents in Psychology, by age of authors

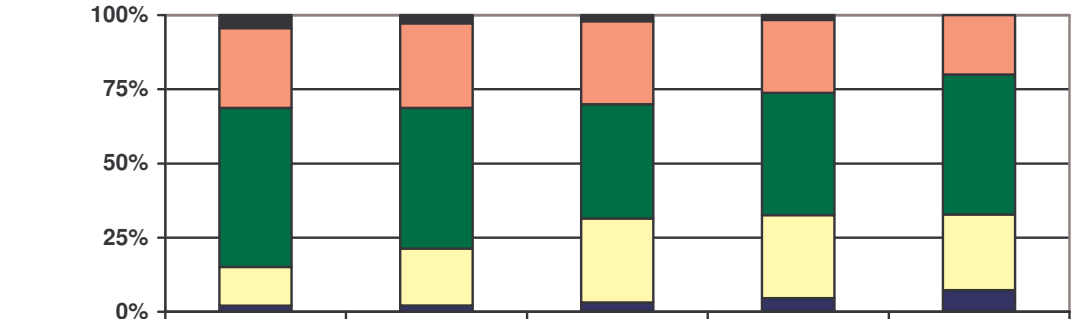


	1990-1992 (N=208.42)	1993-1995 (N=216.73)	1996-1998 (N=294.22)	1999-2001 (N=209.48)	2002-2004 (N=194.55)
<30 years	5.0%	5.4%	3.3%	6.0%	3.2%
30-39 years	29.7%	31.4%	28.7%	26.0%	21.7%
40-49 years	50.0%	43.1%	37.2%	37.4%	42.9%
50-59 years	13.0%	17.3%	27.5%	25.6%	24.8%
60+ years	2.3%	2.8%	3.3%	5.0%	7.4%

Table 6.17: Summary statistics of article equivalents by top 20% of authors in Psychology

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Psychology	1420	1747.82	284	1172.71	67.1%

Figure 6.86: Percentage distribution of article equivalents in Psychology, by age of top 20% of authors



	1990-1992 (N=170.25)	1993-1995 (N=167.19)	1996-1998 (N=237.54)	1999-2001 (N=155.25)	2002-2004 (N=144.30)
<30 years	4.4%	2.7%	2.0%	1.6%	0.0%
30-39 years	26.9%	28.6%	28.1%	24.6%	20.0%
40-49 years	53.6%	47.4%	38.4%	41.2%	47.2%
50-59 years	13.1%	19.2%	28.4%	28.0%	25.5%
60+ years	2.0%	2.1%	3.1%	4.6%	7.3%

6.5.15 Sociology & related studies

Figure 6.87: Percentage distribution of article equivalents in Sociology & Related Studies, by gender of authors

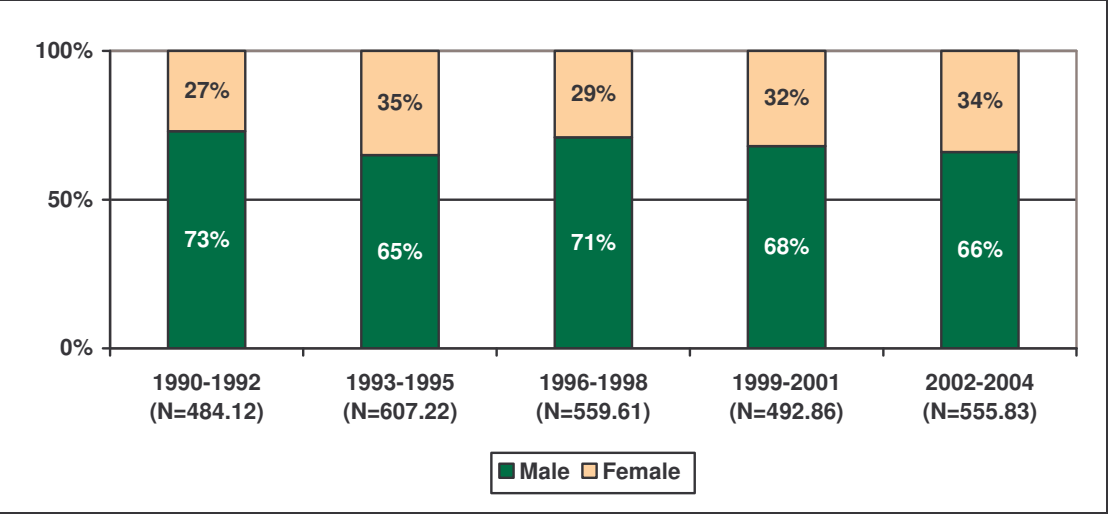
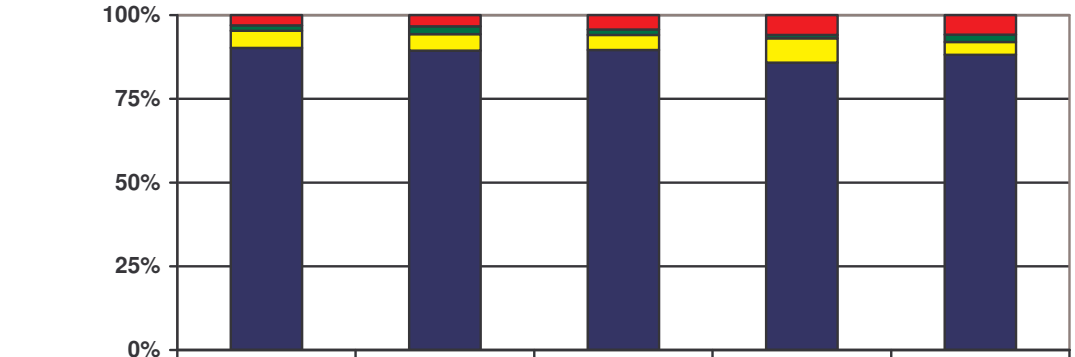
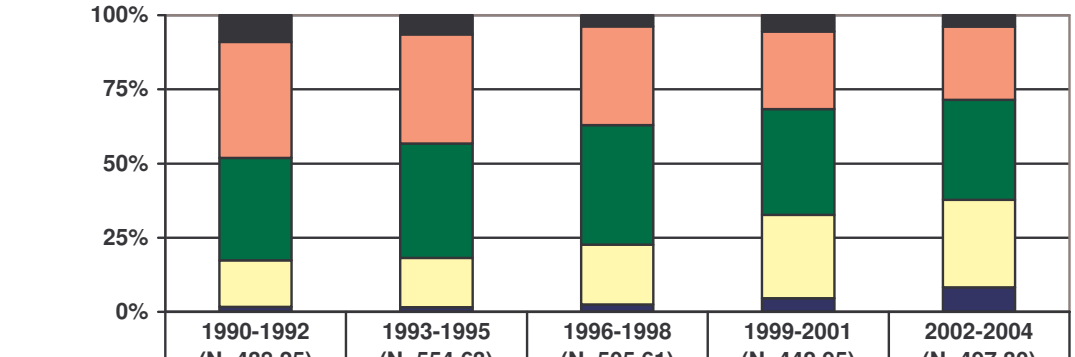


Figure 6.88: Percentage distribution of article equivalents in Sociology & Related Studies, by race of authors



	1990-1992 (N=464.37)	1993-1995 (N=576.63)	1996-1998 (N=540.90)	1999-2001 (N=482.23)	2002-2004 (N=533.43)
African	3.1%	3.3%	4.3%	5.9%	5.8%
Coloured	1.6%	2.4%	1.6%	1.0%	2.2%
Indian/Asian	5.1%	4.9%	4.5%	7.3%	3.9%
White	90.2%	89.4%	89.7%	85.8%	88.0%

Figure 6.89: Percentage distribution of article equivalents in Sociology & Related Studies, by age of authors

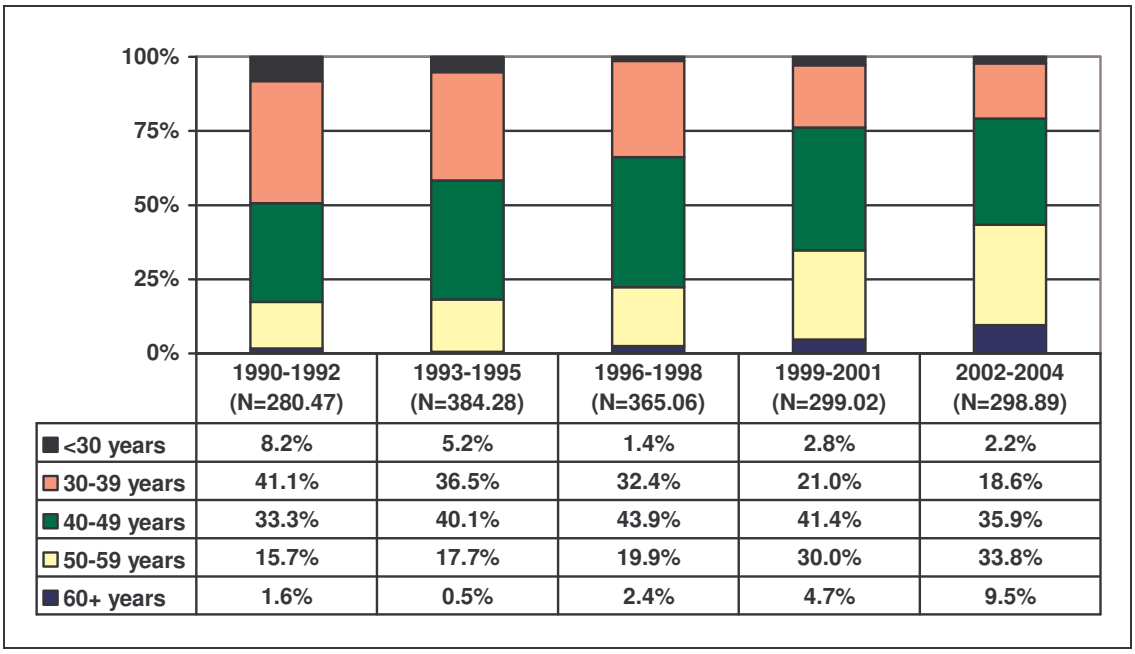


	1990-1992 (N=438.25)	1993-1995 (N=554.63)	1996-1998 (N=505.61)	1999-2001 (N=442.95)	2002-2004 (N=497.30)
<30 years	9.0%	6.5%	3.8%	5.5%	3.9%
30-39 years	39.1%	36.7%	33.3%	26.2%	24.7%
40-49 years	34.5%	38.6%	40.3%	35.6%	33.7%
50-59 years	15.8%	16.7%	20.2%	28.1%	29.6%
60+ years	1.6%	1.5%	2.4%	4.6%	8.2%

Table 6.18: Summary statistics of article equivalents by top 20% of authors in Sociology & Related Studies

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Sociology & related studies	1954	3632.52	391	2219.38	61.1%

Figure 6.90: Percentage distribution of article equivalents in Sociology & Related Studies, by age of top 20% of authors



	1990-1992 (N=280.47)	1993-1995 (N=384.28)	1996-1998 (N=365.06)	1999-2001 (N=299.02)	2002-2004 (N=298.89)
<30 years	8.2%	5.2%	1.4%	2.8%	2.2%
30-39 years	41.1%	36.5%	32.4%	21.0%	18.6%
40-49 years	33.3%	40.1%	43.9%	41.4%	35.9%
50-59 years	15.7%	17.7%	19.9%	30.0%	33.8%
60+ years	1.6%	0.5%	2.4%	4.7%	9.5%

6.5.16 Other social sciences

Figure 6.91: Percentage distribution of article equivalents in Other Social Sciences, by gender of authors

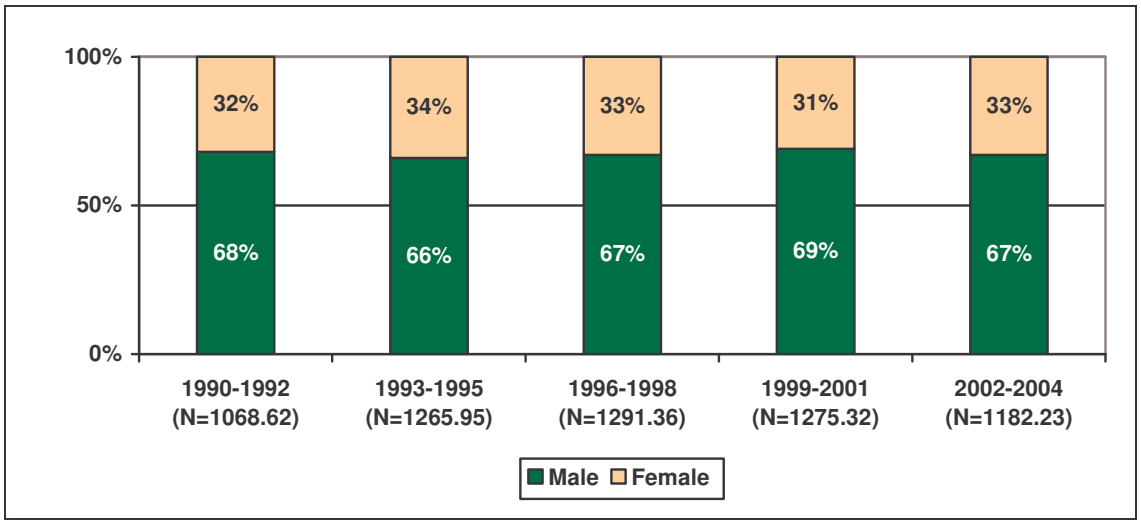
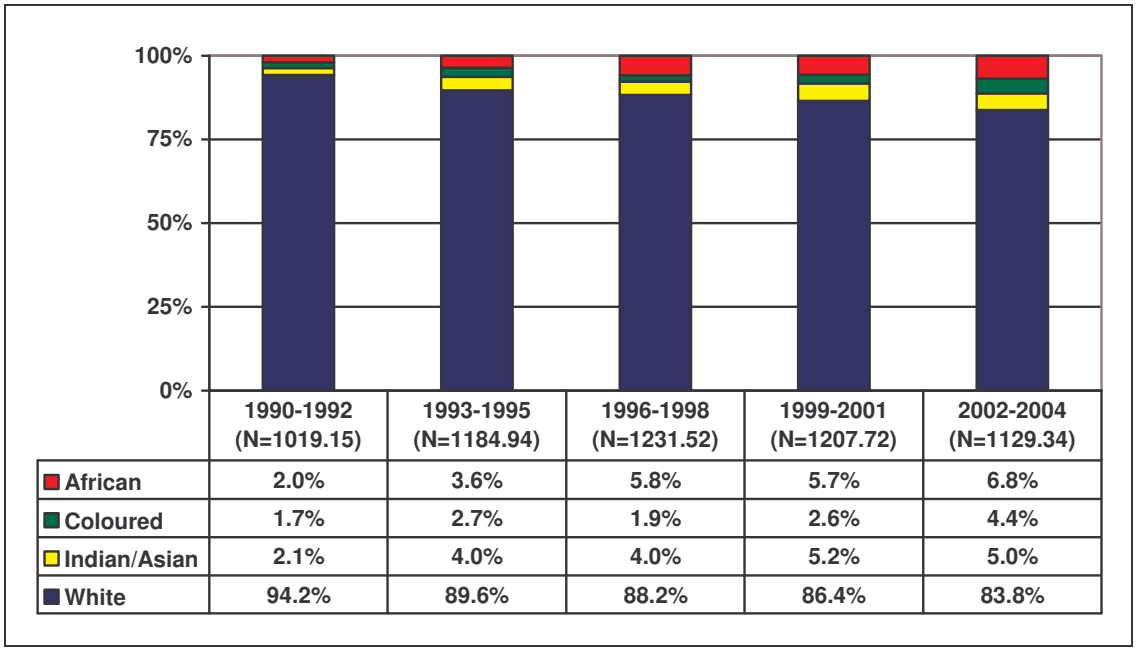
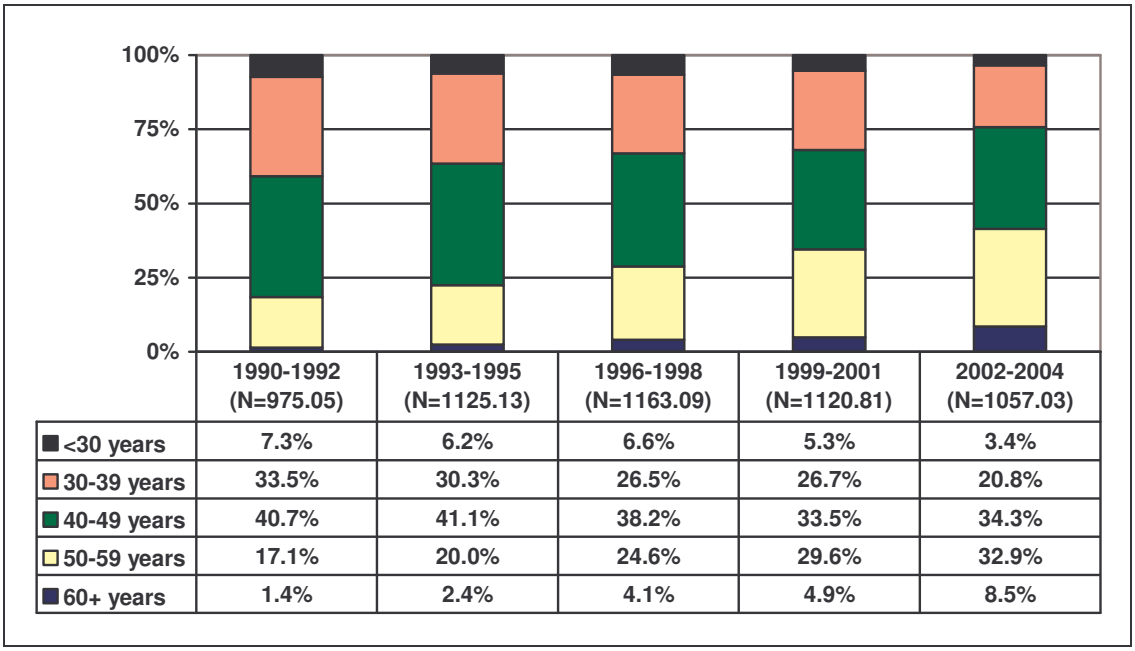


Figure 6.92: Percentage distribution of article equivalents in Other Social Sciences, by race of authors



	1990-1992 (N=1019.15)	1993-1995 (N=1184.94)	1996-1998 (N=1231.52)	1999-2001 (N=1207.72)	2002-2004 (N=1129.34)
African	2.0%	3.6%	5.8%	5.7%	6.8%
Coloured	1.7%	2.7%	1.9%	2.6%	4.4%
Indian/Asian	2.1%	4.0%	4.0%	5.2%	5.0%
White	94.2%	89.6%	88.2%	86.4%	83.8%

Figure 6.93: Percentage distribution of article equivalents in Other Social Sciences, by age of authors

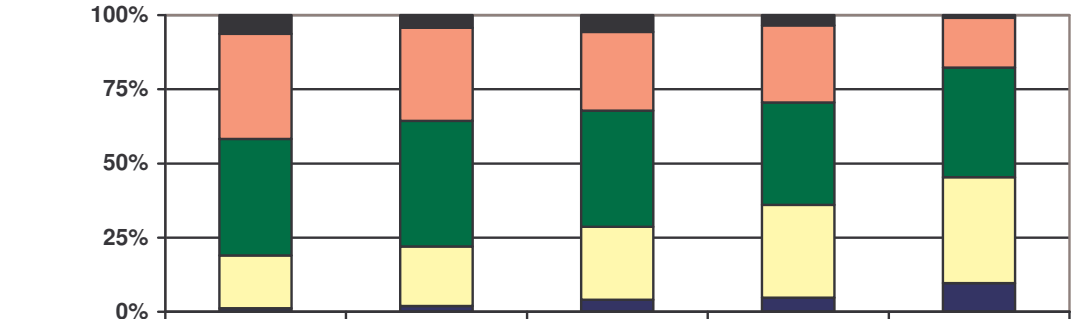


	1990-1992 (N=975.05)	1993-1995 (N=1125.13)	1996-1998 (N=1163.09)	1999-2001 (N=1120.81)	2002-2004 (N=1057.03)
<30 years	7.3%	6.2%	6.6%	5.3%	3.4%
30-39 years	33.5%	30.3%	26.5%	26.7%	20.8%
40-49 years	40.7%	41.1%	38.2%	33.5%	34.3%
50-59 years	17.1%	20.0%	24.6%	29.6%	32.9%
60+ years	1.4%	2.4%	4.1%	4.9%	8.5%

Table 6.19: Summary statistics of article equivalents by top 20% of authors in Other Social Sciences

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Other social sciences	6127	8873.94	1225	5464.54	61.6%

Figure 6.94: Percentage distribution of article equivalents in Other Social Sciences, by age of top 20% of authors



	1990-1992 (N=733.14)	1993-1995 (N=786.80)	1996-1998 (N=860.67)	1999-2001 (N=785.38)	2002-2004 (N=657.40)
<30 years	6.3%	4.3%	5.7%	3.4%	0.9%
30-39 years	35.4%	31.3%	26.4%	26.0%	16.7%
40-49 years	39.3%	42.4%	39.2%	34.5%	37.0%
50-59 years	17.8%	20.1%	24.5%	31.2%	35.7%
60+ years	1.2%	1.9%	4.1%	4.8%	9.6%

6.5.17 Language & linguistics

Figure 6.95: Percentage distribution of article equivalents in Language & Linguistics, by gender of authors

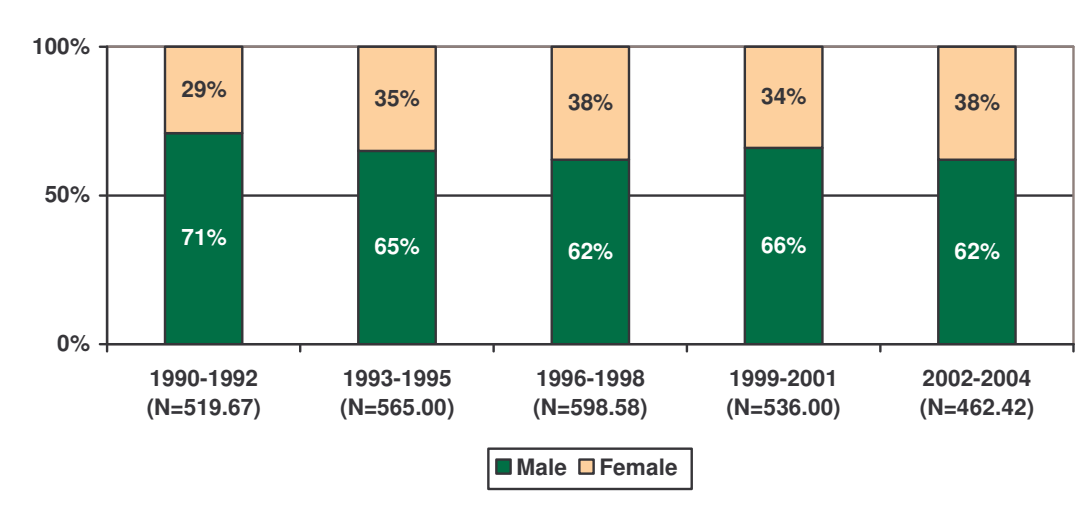
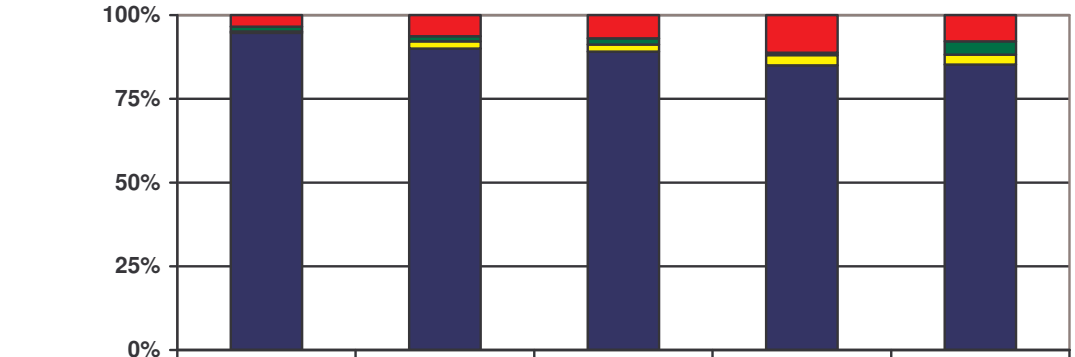
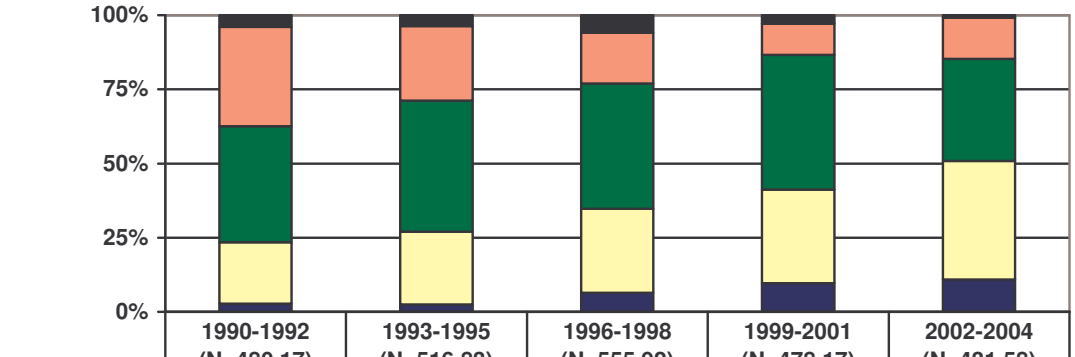


Figure 6.96: Percentage distribution of article equivalents in Language & Linguistics, by race of authors



	1990-1992 (N=510.17)	1993-1995 (N=557.17)	1996-1998 (N=602.75)	1999-2001 (N=516.67)	2002-2004 (N=455.58)
African	3.4%	6.3%	6.9%	11.2%	7.8%
Coloured	1.5%	1.5%	1.9%	0.8%	4.0%
Indian/Asian	0.4%	2.2%	2.1%	3.0%	3.0%
White	94.7%	90.0%	89.2%	85.0%	85.3%

Figure 6.97: Percentage distribution of article equivalents in Language & Linguistics, by age of authors

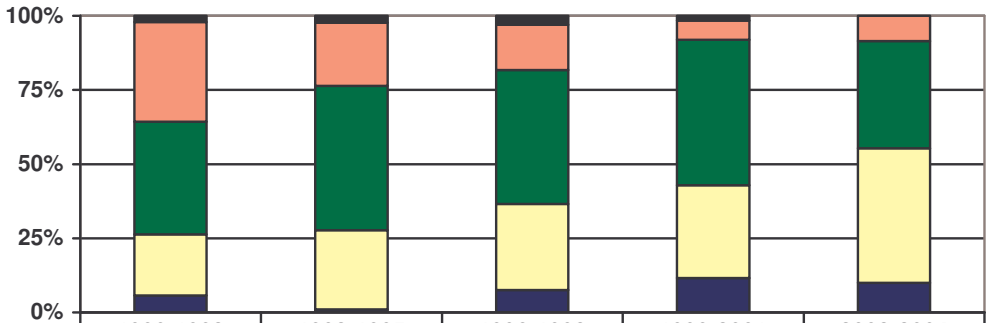


	1990-1992 (N=480.17)	1993-1995 (N=516.83)	1996-1998 (N=555.92)	1999-2001 (N=478.17)	2002-2004 (N=431.58)
<30 years	4.0%	3.7%	5.9%	2.8%	0.8%
30-39 years	33.5%	25.1%	17.1%	10.6%	13.9%
40-49 years	39.0%	44.1%	42.3%	45.4%	34.4%
50-59 years	20.8%	24.6%	28.3%	31.6%	40.0%
60+ years	2.7%	2.4%	6.4%	9.6%	10.9%

Table 6.20: Summary statistics of article equivalents by top 20% of authors in Language & Linguistics

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Language & linguistics	1229	3511.92	246	2058.25	58.6%

Figure 6.98: Percentage distribution of article equivalents in Language & Linguistics, by age of top 20% of authors



	1990-1992 (N=323.83)	1993-1995 (N=335.50)	1996-1998 (N=384.17)	1999-2001 (N=322.17)	2002-2004 (N=285.40)
<30 years	2.2%	2.3%	3.0%	1.6%	0.0%
30-39 years	35.5%	21.3%	15.3%	6.5%	8.5%
40-49 years	40.0%	48.6%	45.2%	49.0%	36.2%
50-59 years	21.7%	26.7%	29.0%	31.2%	45.4%
60+ years	6.0%	1.0%	7.5%	11.6%	9.9%

6.5.18 Law

Figure 6.99: Percentage distribution of article equivalents in Law, by gender of authors

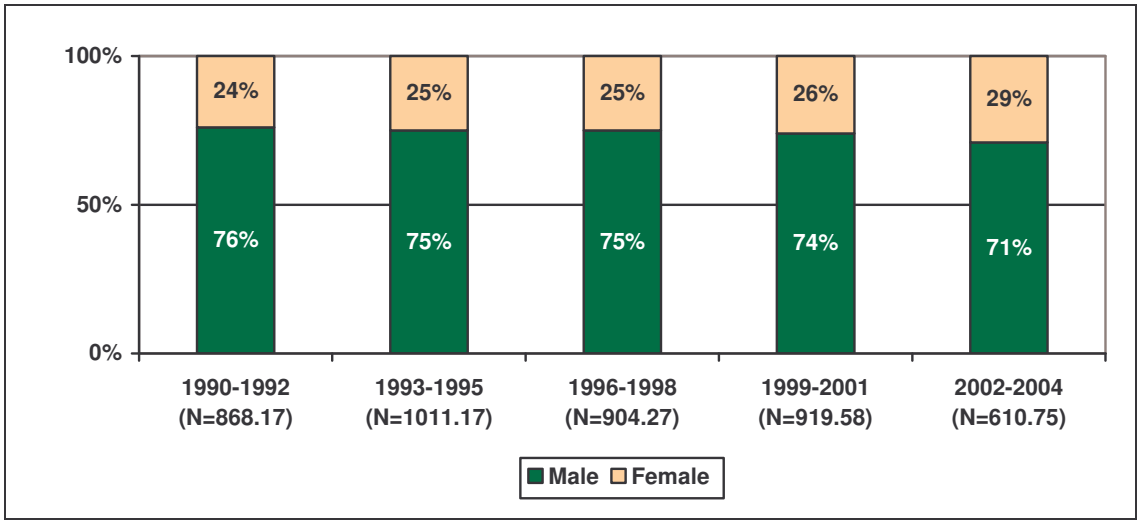
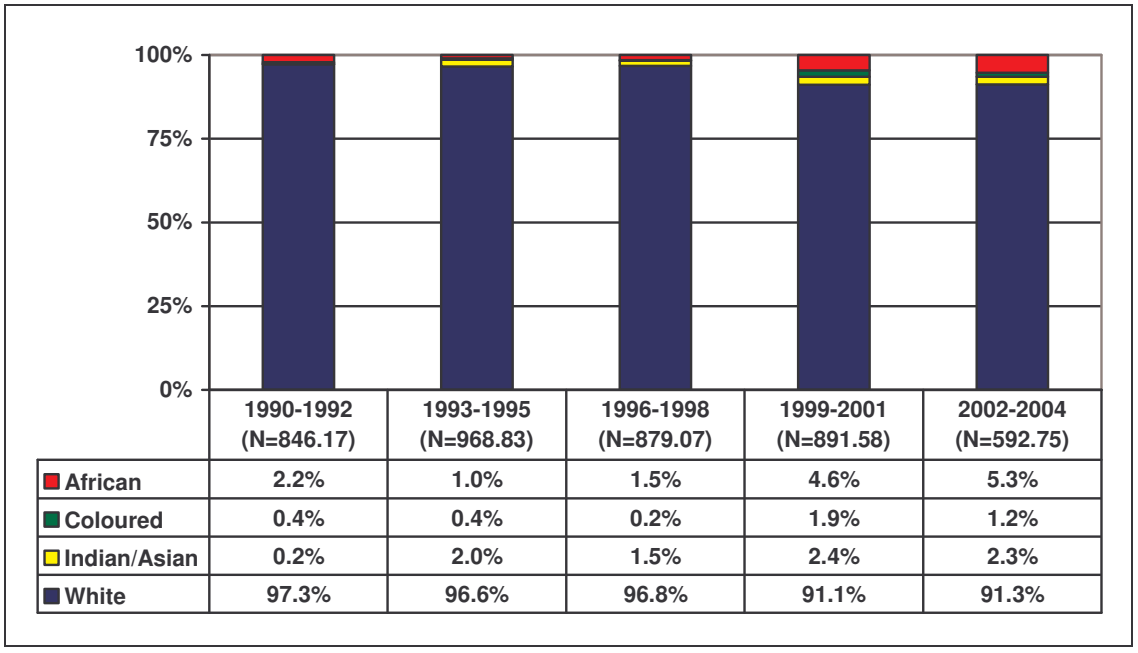
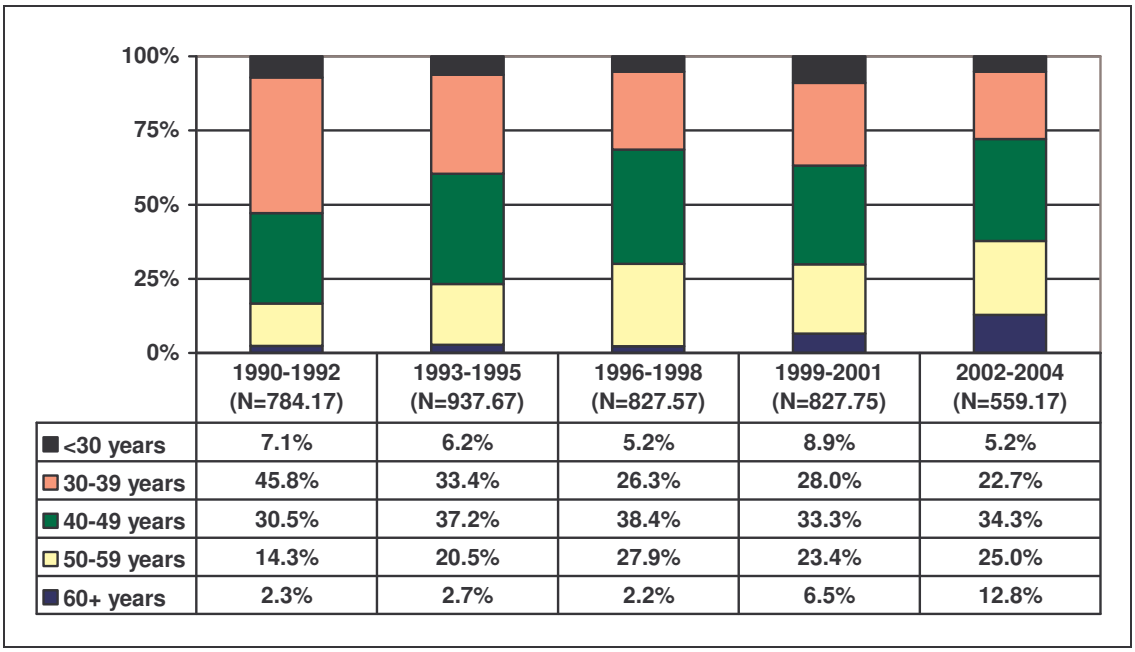


Figure 6.100: Percentage distribution of article equivalents in Law, by race of authors



	1990-1992 (N=846.17)	1993-1995 (N=968.83)	1996-1998 (N=879.07)	1999-2001 (N=891.58)	2002-2004 (N=592.75)
African	2.2%	1.0%	1.5%	4.6%	5.3%
Coloured	0.4%	0.4%	0.2%	1.9%	1.2%
Indian/Asian	0.2%	2.0%	1.5%	2.4%	2.3%
White	97.3%	96.6%	96.8%	91.1%	91.3%

Figure 6.101: Percentage distribution of article equivalents in Law, by age of authors

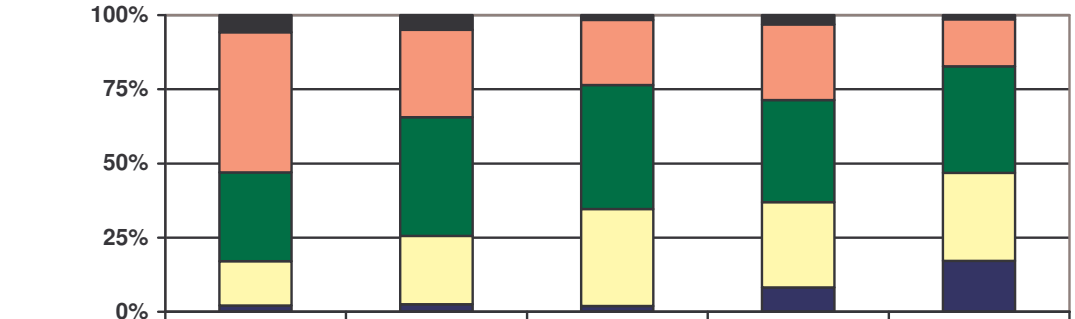


	1990-1992 (N=784.17)	1993-1995 (N=937.67)	1996-1998 (N=827.57)	1999-2001 (N=827.75)	2002-2004 (N=559.17)
<30 years	7.1%	6.2%	5.2%	8.9%	5.2%
30-39 years	45.8%	33.4%	26.3%	28.0%	22.7%
40-49 years	30.5%	37.2%	38.4%	33.3%	34.3%
50-59 years	14.3%	20.5%	27.9%	23.4%	25.0%
60+ years	2.3%	2.7%	2.2%	6.5%	12.8%

Table 6.21: Summary statistics of article equivalents by top 20% of authors in Law

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Law	892	5217.39	178	3650.97	70.0%

Figure 6.102: Percentage distribution of article equivalents in Law, by age of top 20% of authors



	1990-1992 (N=666.50)	1993-1995 (N=716.00)	1996-1998 (N=617.77)	1999-2001 (N=588.00)	2002-2004 (N=368.50)
<30 years	5.8%	5.0%	1.6%	3.1%	1.4%
30-39 years	47.2%	29.4%	22.0%	25.5%	15.9%
40-49 years	30.0%	40.1%	41.8%	34.4%	36.0%
50-59 years	15.0%	23.1%	32.7%	28.8%	29.6%
60+ years	2.1%	2.5%	1.9%	8.2%	17.2%

6.5.19 Religion

Figure 6.103: Percentage distribution of article equivalents in Religion, by gender of authors

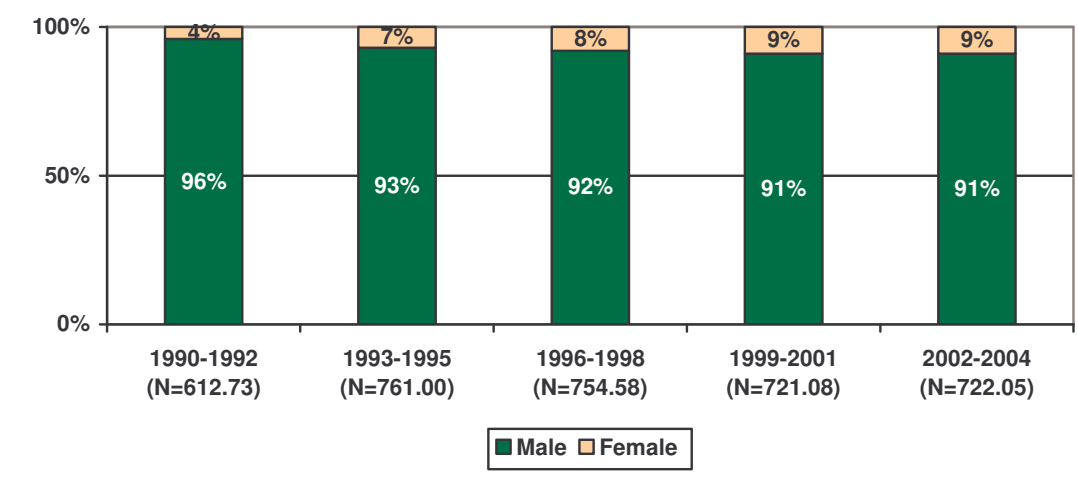
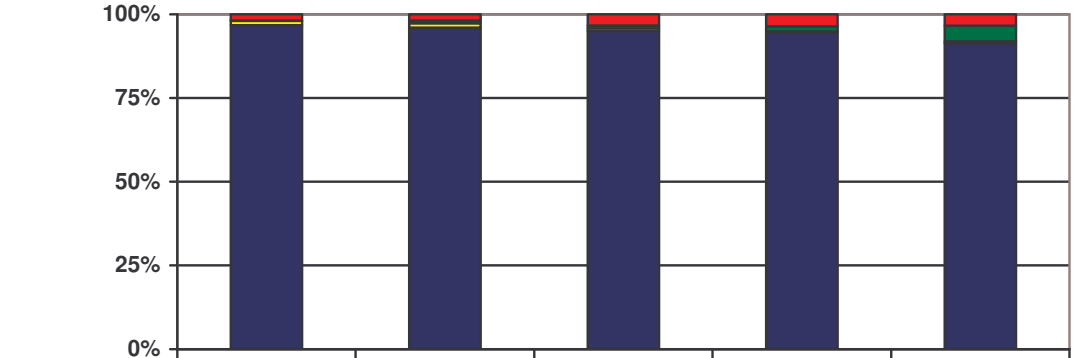
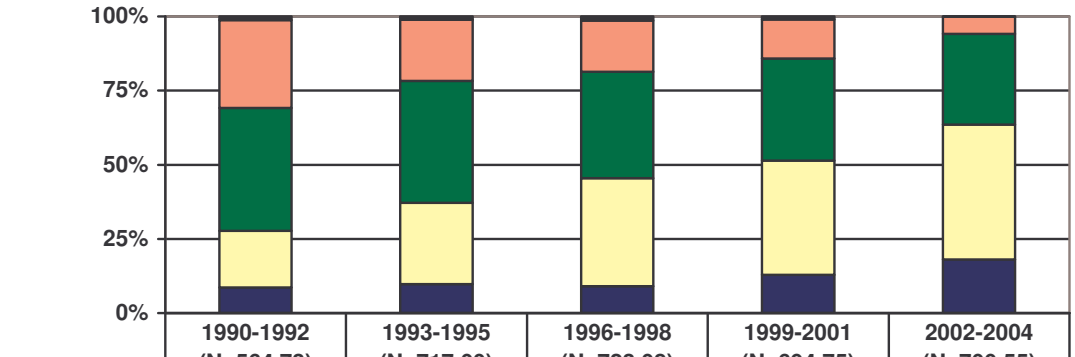


Figure 6.104: Percentage distribution of article equivalents in Religion, by race of authors



	1990-1992 (N=625.23)	1993-1995 (N=775.50)	1996-1998 (N=755.83)	1999-2001 (N=726.08)	2002-2004 (N=718.25)
African	1.9%	1.9%	3.3%	3.6%	3.4%
Coloured	0.1%	0.8%	0.9%	1.5%	4.7%
Indian/Asian	1.2%	1.3%	0.8%	0.3%	0.5%
White	96.8%	96.0%	95.0%	94.6%	91.4%

Figure 6.105: Percentage distribution of article equivalents in Religion, by age of authors

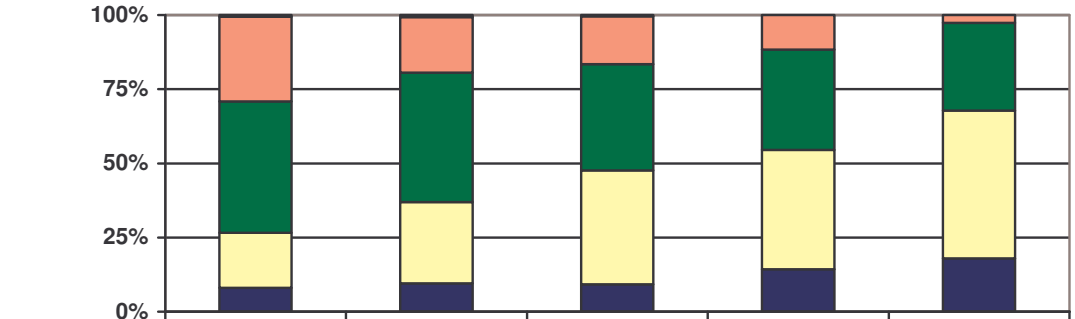


	1990-1992 (N=564.73)	1993-1995 (N=717.00)	1996-1998 (N=723.08)	1999-2001 (N=694.75)	2002-2004 (N=700.55)
<30 years	1.2%	1.1%	1.4%	1.0%	0.1%
30-39 years	29.7%	20.6%	17.3%	13.2%	5.8%
40-49 years	41.4%	41.1%	35.8%	34.4%	30.5%
50-59 years	19.1%	27.5%	36.5%	38.5%	45.4%
60+ years	8.6%	9.7%	9.0%	12.9%	18.1%

Table 6.22: Summary statistics of article equivalents by top 20% of authors in Religion

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Religion	1059	4987.55	212	3450.05	69.2%

Figure 6.106: Percentage distribution of article equivalents in Religion, by age of top 20% of authors



	1990-1992 (N=443.70)	1993-1995 (N=565.50)	1996-1998 (N=551.58)	1999-2001 (N=559.60)	2002-2004 (N=573.60)
<30 years	0.6%	0.7%	0.4%	0.0%	0.0%
30-39 years	28.5%	18.7%	16.1%	11.7%	2.6%
40-49 years	44.3%	43.6%	35.9%	33.8%	29.6%
50-59 years	18.6%	27.5%	38.4%	40.3%	49.8%
60+ years	8.0%	9.5%	9.2%	14.3%	18.0%

6.5.20 Other humanities & arts

Figure 6.107: Percentage distribution of article equivalents in Other Humanities & Arts, by gender of authors

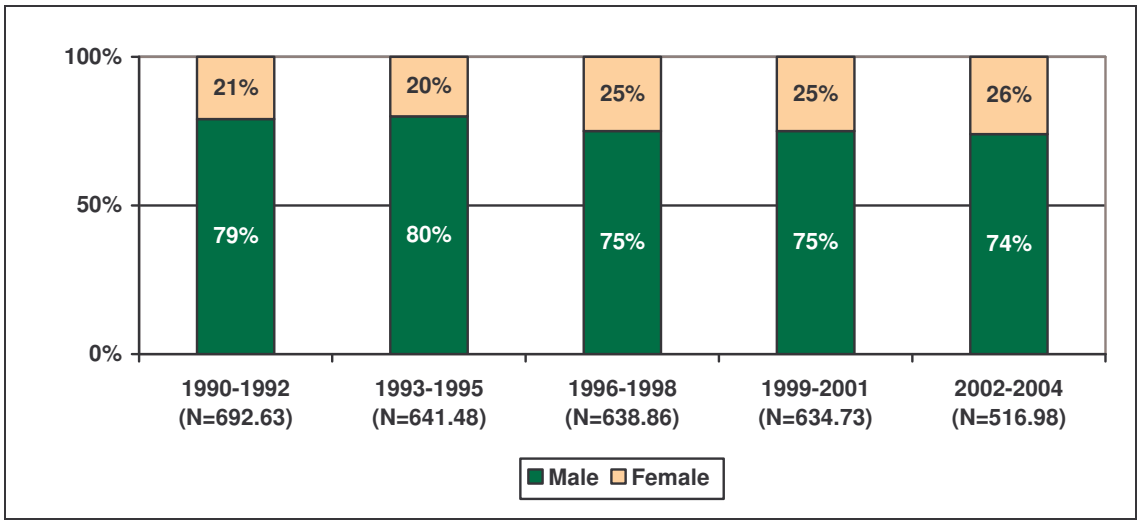
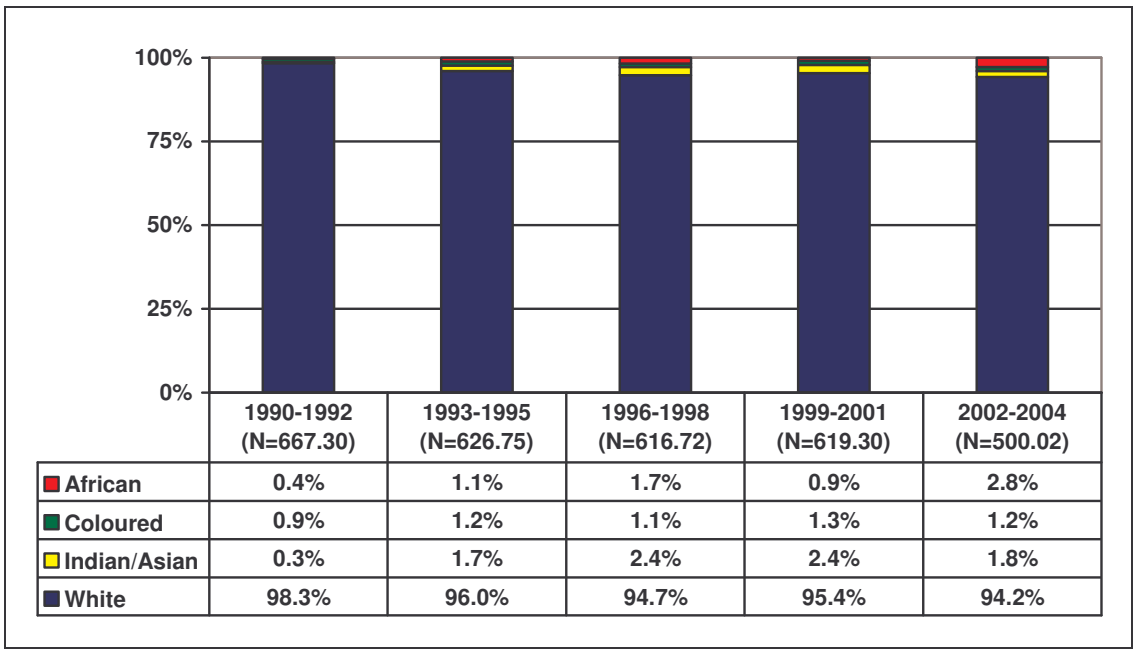
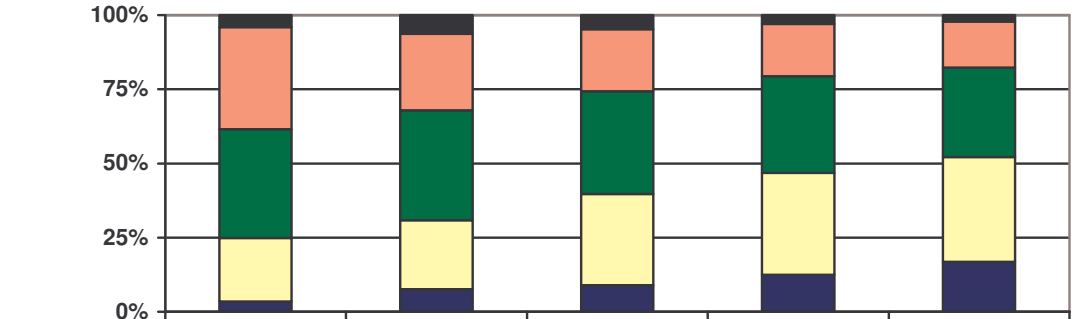


Figure 6.108: Percentage distribution of article equivalents in Other Humanities & Arts by race of authors



	1990-1992 (N=667.30)	1993-1995 (N=626.75)	1996-1998 (N=616.72)	1999-2001 (N=619.30)	2002-2004 (N=500.02)
African	0.4%	1.1%	1.7%	0.9%	2.8%
Coloured	0.9%	1.2%	1.1%	1.3%	1.2%
Indian/Asian	0.3%	1.7%	2.4%	2.4%	1.8%
White	98.3%	96.0%	94.7%	95.4%	94.2%

Figure 6.109: Percentage distribution of article equivalents in Other Humanities & Arts, by age of authors

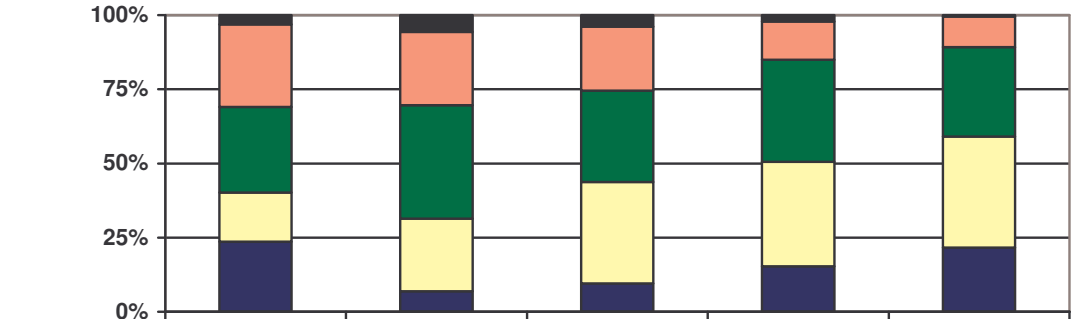


	1990-1992 (N=629.10)	1993-1995 (N=584.32)	1996-1998 (N=586.52)	1999-2001 (N=593.48)	2002-2004 (N=478.34)
<30 years	4.1%	6.3%	4.8%	2.9%	2.1%
30-39 years	34.3%	25.8%	20.9%	17.7%	15.6%
40-49 years	36.7%	37.0%	34.6%	32.6%	30.2%
50-59 years	21.4%	23.3%	30.8%	34.3%	35.3%
60+ years	3.4%	7.6%	8.9%	12.5%	16.9%

Table 6.23: Summary statistics of article equivalents by top 20% of authors in Other Humanities & Arts

Scientific field	All South African authors		Top 20% of South African authors		% of article equivalents produced by top 20%
	Count	Total article equivalents	Count	Total article equivalents	
Other humanities & arts	2006	4276.56	401	2500.89	58.5%

Figure 6.110: Percentage distribution of article equivalents in Other Humanities & Arts, by age of top 20% of authors



	1990-1992 (N=397.70)	1993-1995 (N=386.57)	1996-1998 (N=382.32)	1999-2001 (N=384.17)	2002-2004 (N=292.03)
<30 years	4.0%	5.7%	3.9%	2.1%	0.5%
30-39 years	35.3%	24.6%	21.6%	12.9%	10.2%
40-49 years	36.7%	38.3%	30.7%	34.4%	30.2%
50-59 years	21.0%	24.4%	34.3%	35.3%	37.4%
60+ years	30.0%	6.9%	9.5%	15.3%	21.6%

6.5.21 Summary

Table 6.24: Summary of author gender and race demographics per scientific field, 1990-1992 and 2002-2004

Scientific field	Gender		Race	
	% of article equivalents by female authors		% of article equivalents by African/ coloured/ Indian authors	
	1990-92	2002-04	1990-92	2002-04
Agricultural Sciences	14%	24%	1%	7%
Biological Sciences	15%	25%	3%	8%
Chemical Sciences	10%	19%	4%	16%
Earth Sciences	15%	25%	1%	5%
Mathematical Sciences & ICCT	9%	13%	5%	9%
Physical Sciences	5%	7%	6%	12%
Multidisciplinary Sciences	13%	22%	2%	4%
Engineering & Applied Technologies	6%	11%	3%	10%
Basic Health	20%	30%	8%	17%
Clinical Health	14%	27%	8%	16%
Public / Community Health	26%	50%	6%	15%

Scientific field	Gender		Race	
	% of article equivalents by female authors		% of article equivalents by African/ coloured/ Indian authors	
	1990-92	2002-04	1990-92	2002-04
Economic & Management Sciences	11%	21%	4%	11%
Education	27%	50%	7%	21%
Psychology	29%	26%	7%	11%
Sociology & Related Studies	27%	34%	10%	12%
Other Social Sciences	32%	33%	6%	16%
Language & Linguistics	29%	38%	5%	15%
Law	24%	29%	3%	9%
Religion	4%	9%	3%	9%
Other Humanities & Arts	21%	26%	2%	6%

- As far as Gender of publishing author is concerned, we have seen a general increase in the number of female authors across ALL FIELDS but one (Psychology). Female authors are best represented in the fields of Education and Public and Community Health (50%) followed by substantive proportions (more than 33%) in Language and Linguistics, Sociology and other Social Sciences. The biggest increases in female representation have been in the Health Sciences as well as in the Agricultural, Biological and Engineering Sciences.
- As far as Race of publishing author is concerned, we have also witnessed a general increase in the number of black authors in ALL FIELDS. Given the small proportions of black authors in all fields in 1990, it is not surprising that some fields have recorded high percentage increases. The fields of Chemical Sciences, Basic Health, Education, Social Sciences and Language and Linguistics now (in 2004) have the highest proportions of black authors.

Table 6.25: Summary of author age demographics per scientific field, 1990-1992 and 2002-2004

Scientific field	All authors				Top 20% of authors			
	% of article equivalents by persons <30 years		% of article equivalents by persons 50+ years		% of article equivalents by persons <30 years		% of article equivalents by persons 50+ years	
	1990-92	2002-04	1990-92	2002-04	1990-92	2002-04	1990-92	2002-04
Agricultural Sciences	8%	3%	23%	42%	7%	1%	24%	46%
Biological Sciences	7%	5%	20%	41%	7%	3%	21%	44%
Chemical Sciences	6%	7%	32%	47%	6%	5%	34%	**53%**
Earth Sciences	7%	3%	18%	42%	5%	1%	18%	47%
Mathematical Sciences & ICCT	8%	2%	21%	34%	6%	22%	0%	37%
Physical Sciences	8%	5%	34%	49%	7%	2%	35%	**54%**

Scientific field	All authors				Top 20% of authors			
	% of article equivalents by persons <30 years		% of article equivalents by persons 50+ years		% of article equivalents by persons <30 years		% of article equivalents by persons 50+ years	
	1990-92	2002-04	1990-92	2002-04	1990-92	2002-04	1990-92	2002-04
Multidisciplinary Sciences	8%	2%	25%	53%	6%	<1%	23%	**61%**
Engineering & Applied Technologies	10%	5%	26%	39%	8%	3%	27%	42%
Basic Health	5%	4%	27%	42%	4%	2%	29%	48%
Clinical Health	2%	2%	31%	48%	2%	1%	32%	**54%**
Public / Community Health	6%	3%	32%	46%	6%	2%	31%	**55%**
Economic & Management Sciences	6%	5%	21%	36%	3%	<1%	22%	44%
Education	2%	1%	19%	52%	1%	0%	12%	**74%**
Psychology	5%	3%	15%	32%	4%	0%	15%	33%
Sociology & Related Studies	9%	4%	17%	38%	8%	2%	17%	43%
Other Social Sciences	7%	3%	19%	41%	6%	<1%	19%	45%
Language & Linguistics	4%	<1%	23%	51%	2%	0%	22%	**55%**
Law	7%	5%	17%	38%	6%	1%	17%	47%
Religion	1%	<1%	28%	64%	<1%	0%	27%	**68%**
Other Humanities & Arts	4%	2%	25%	52%	4%	<1%	24%	**59%**

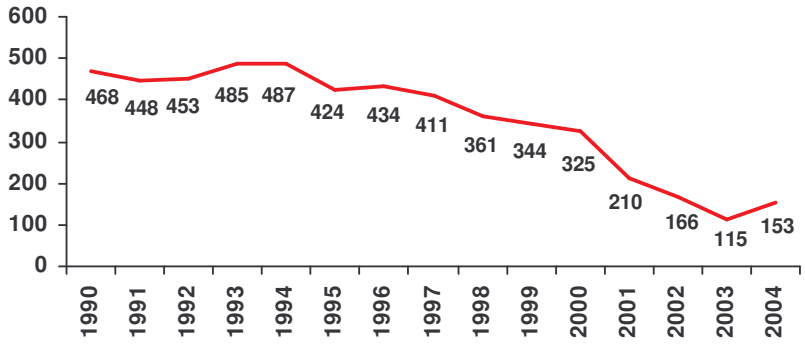
- All twenty fields have witness a significant ageing of publishing scientists over the period 1990 to 2004.
- In eight of these fields, more than HALF of all outputs are now being produced by authors over the age of 50. The majority of these fields are in the Humanities and Social Sciences and the Health Sciences.
- This general trend also means that production of output by authors under the age of 30 has declined significantly in ALL fields except for Mathematics (where the small sample might have an effect on these trends).

CHAPTER 7
PROFILE OF BOOKS AND REPORTS

7.1 OVERVIEW OF BOOK OUTPUT

Figure 7.1 presents the distribution of unique book titles by year. The data suggest a clear decline since the mid-nineties. Even if one takes into account that coverage of the later years might not be as complete as in the early years the trend is clearly downward.

Figure 7.1: Book output per year



7.2 PUBLISHER INFORMATION

The 5 540 unique book titles were published by 723 individual publishers or publishing houses. However, nearly half of all titles (46%) were published by 10 publishing houses. In total the “top” 30 publishers produced approximately 65% of all titles. The number of titles by publishing house (in descending order) for these 30 publishers is listed in Table 7.2.

Table 7.1: Book titles by publisher

Publishers	Book titles	Col %
HSRC	505	8.2
Juta	495	8.1
WRC	446	7.3
University of Cape Town	291	4.7
Witwatersrand University Press	273	4.4
University of Natal/ UKZN Press	211	3.4
University of Port Elizabeth	180	2.9
UNISA	173	2.8
Van Schaik	150	2.4
University of Pretoria	126	2.1
Dept. of Transport	123	2.0
CSIR	100	1.6
University of Stellenbosch	90	1.5
Oxford University Press	84	1.4
PU for CHE	61	1.0
University of the Free State	58	0.9
Govt. Printer	56	0.9
Southern Book Publishers	54	0.8
Development Bank of Southern Africa	53	0.8
David Philip	50	0.8
ARC	46	0.7
Rhodes University	46	0.7
Africa Institute of South Africa	45	0.7
Vista University	43	0.7
Heinemann	40	0.6
Jonathan Ball Publishers	38	0.6
IDASA	36	0.5
Tafelberg	36	0.5
Ravan Press	35	0.5
South African Institute of International Affairs	34	0.5
Medical Research Council	34	0.5

The next three slides present a breakdown of the relative contribution of the major publishing houses in three sectors: science council and government sector, higher education sector and commercial publishing.

Figure 7.2: Science council & government output

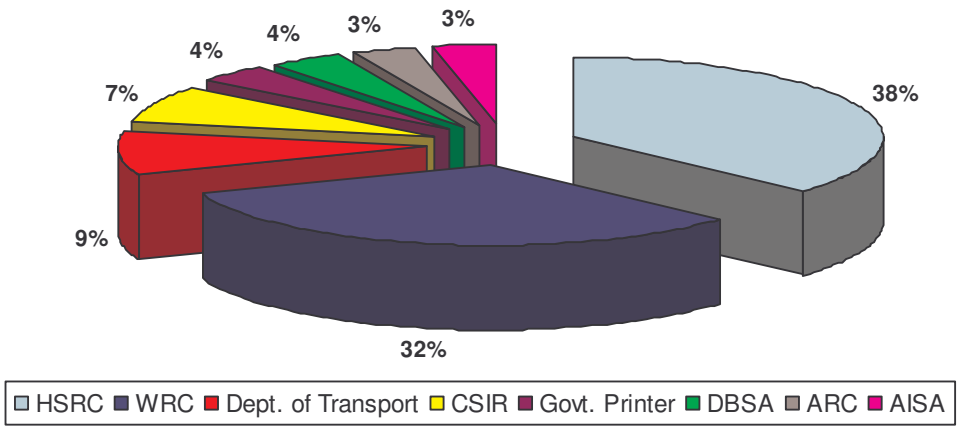
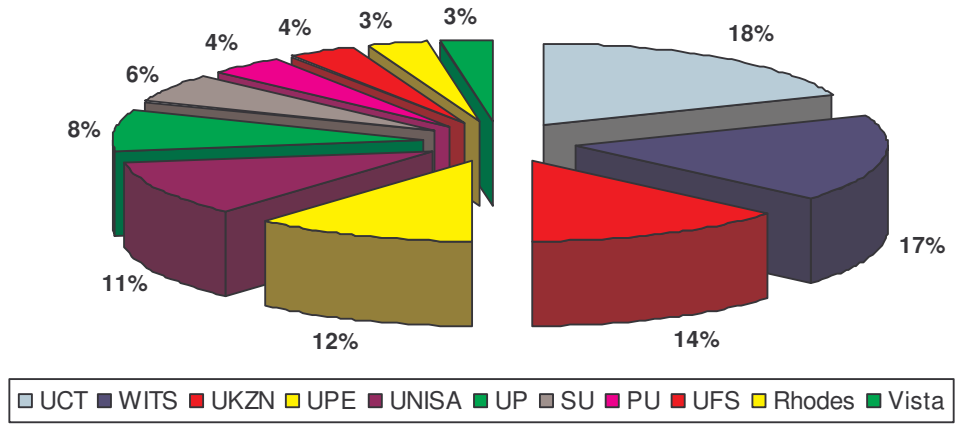
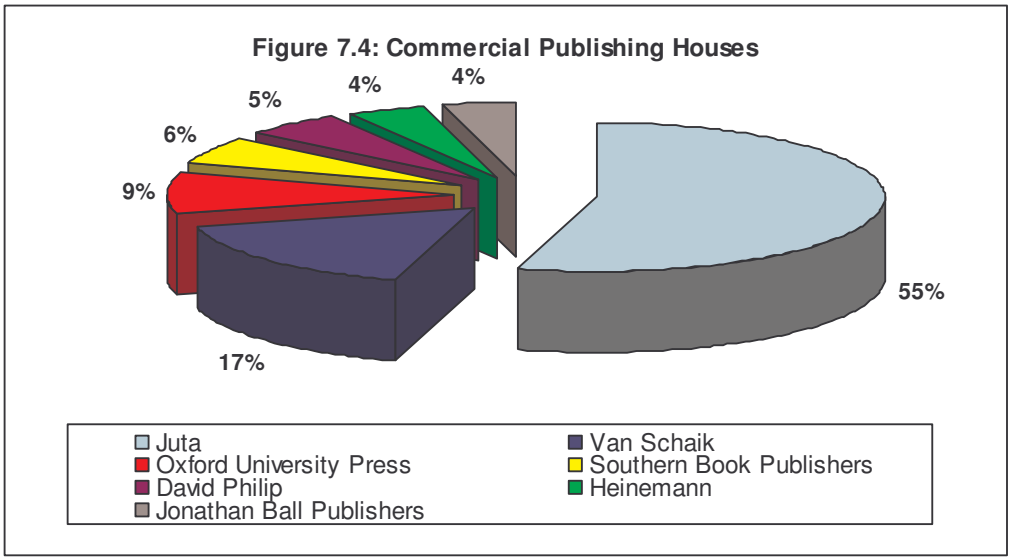


Figure 7.3: University Publishing Houses





7.3 BOOK OUTPUT BY AUTHOR DEMOGRAPHICS

Demographic analyses on the authorships (n = 8349) were conducted. The results for the gender (Figure 7.5), race (Figure 7.6) and age (Figure 7.7) distributions are presented below. Interestingly enough, these distributions are very similar to the demographic profiles for article output.

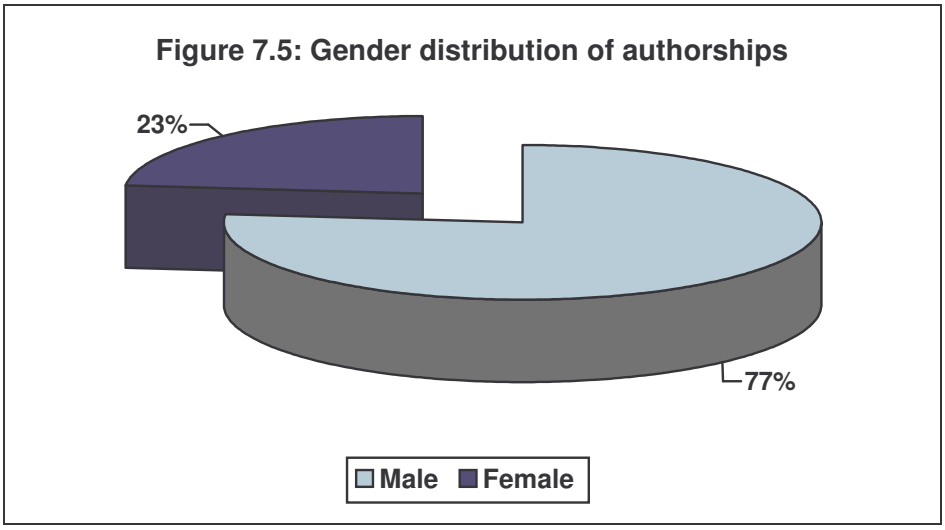


Figure 7.6: Race distribution of authorships

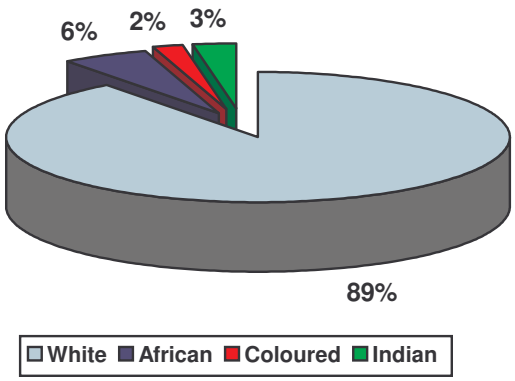
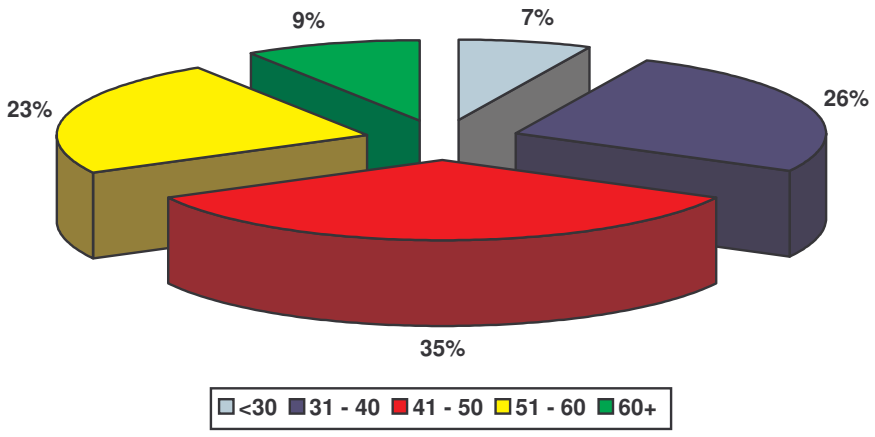


Figure 7.7: Age distribution of book authors



7.4 BOOK OUTPUT BY SCIENTIFIC FIELD

The breakdown by scientific field is provided in Table 7.2 below. As one would expect, book production is dominated by the humanities, social and economic sciences (more than 70% of total production). However, significant proportions of books are also published in the health sciences (3.3%), biological sciences (4.6%), earth sciences (8.6%) and engineering and applied technologies (8.6%)

Table 7.2: Book titles by scientific field

Scientific field	N	Col %
Agricultural sciences	112	2.0
Biological sciences	255	4.6
Chemical sciences	6	0.1
Earth sciences	477	8.6
Mathematical sciences & ICCT	54	0.9
Physical sciences	40	0.7
Engineering & applied technologies	476	8.6
Basic health	17	0.3
Clinical health	91	1.6
Public/ community health	79	1.4
Economic & management sciences	817	14.7
Education	419	7.6
Psychology	71	1.3
Other social sciences	1768	31.9
Language & linguistics	41	0.7
Law	352	6.3
Other humanities & arts	140	2.5
History	326	5.9
Total	**5541**	

Next, we present the annual book production by scientific field. We have decided to set the threshold for production to at least 100 books published over the 15 year period. This results in annual figures for 10 fields.

Figure 7.8: Book output in agricultural sciences

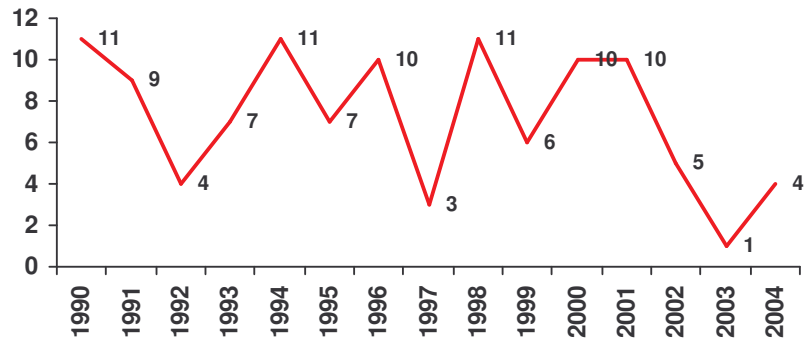


Figure 7.9: Book output in biological sciences

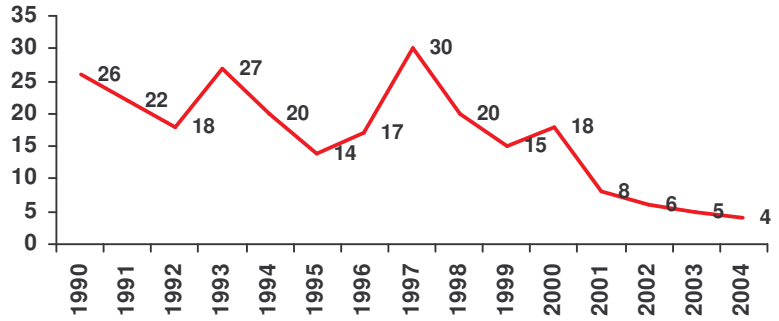


Figure 7.10: Book output in earth sciences

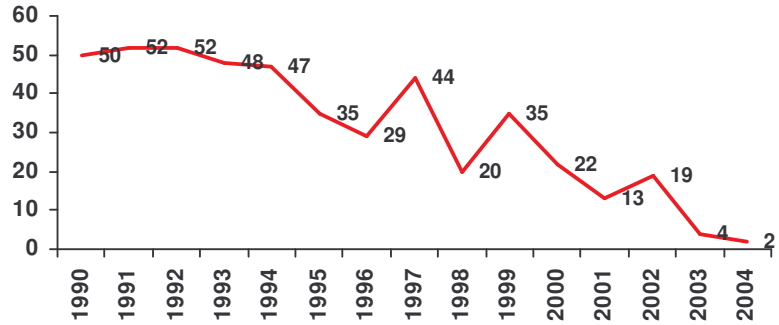
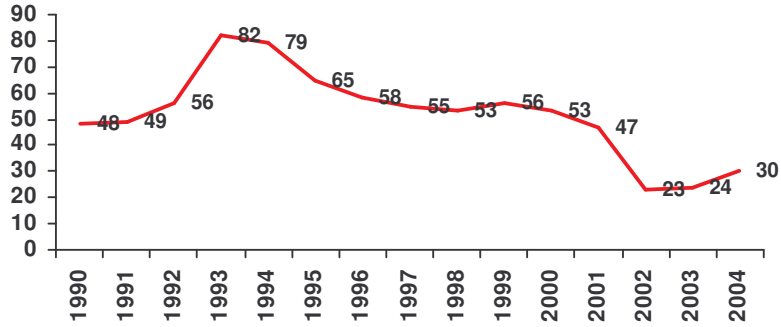


Figure 7.11: Book output in economic and management sciences



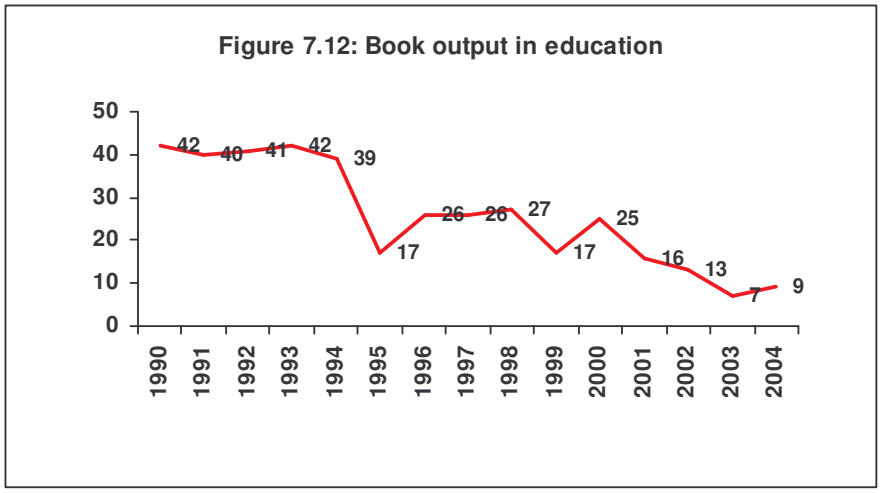


Figure 7.12: Book output in education
50
40
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26
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2004

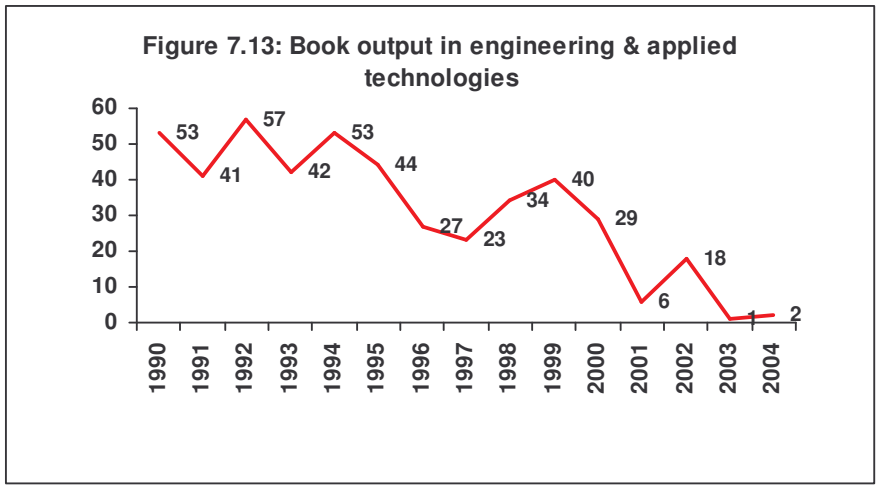
Figure 7.13: Book output in engineering & applied technologies
60
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44
27
23
34
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29
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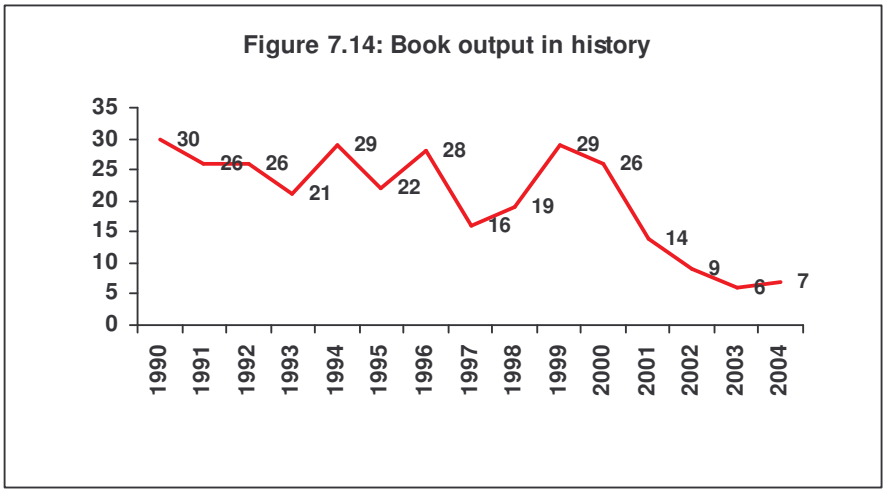
Figure 7.14: Book output in history
35
30
25
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19
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26
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2004

Figure 7.15: Book output in law

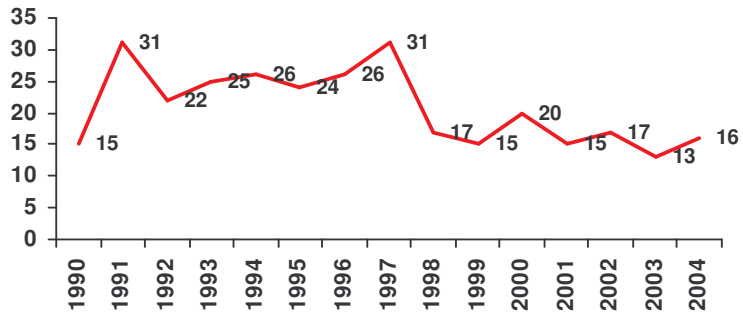


Figure 7.16: Book output in other humanities & arts

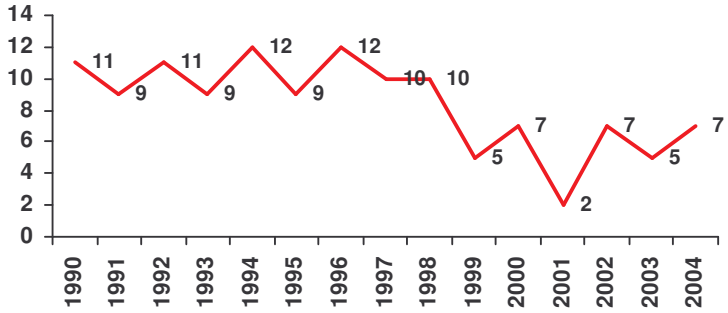
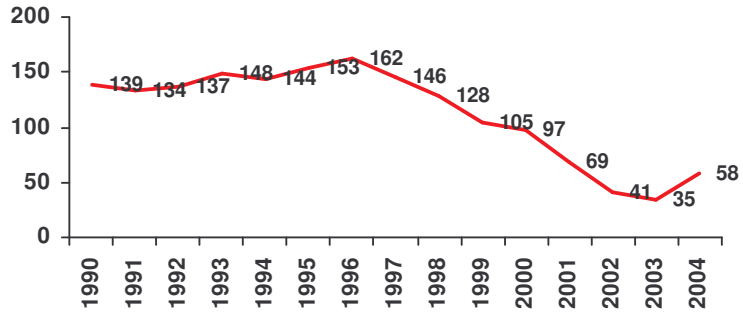


Figure 7.17: Book output in other social sciences



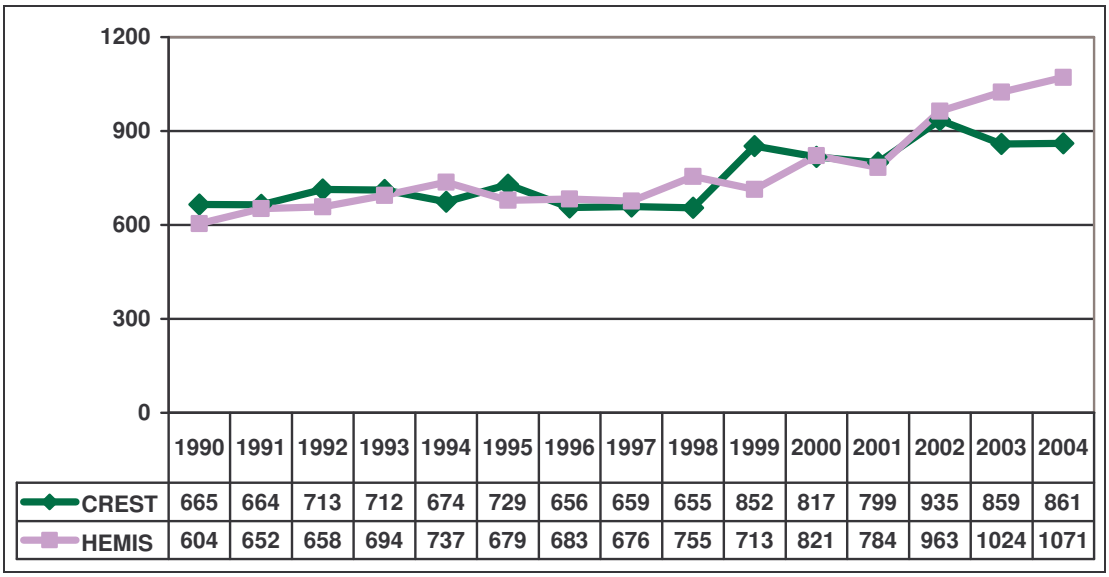
CHAPTER 8
PROFILE OF DOCTORAL DISSERTATIONS

8.1 INTRODUCTION

The doctoral thesis or dissertation is generally accepted to be the culminating product of specialist research training in any field of science or scholarship. It is, by definition, the terminal product of research training in which the doctoral candidate demonstrates his or her ability to contribute to a specific field of science. Being awarded a doctoral degree often marks the beginning of an individual's formal entry into a career in science or academia. Although it is certainly the case that many doctoral graduates nowadays find a career outside higher education or scientific institutions, it remains the key "mechanism' through which science reproduces itself. In addition, the research embodied in the doctoral study often sparks a career of publishing in that field. In this sense the "doctorate" contributes in two ways to the national knowledgebase: through the newly qualified person who embodies new knowledge in a particular field and through new codified knowledge in the form of publications that flow from the dissertation.

The importance of the doctoral study and doctoral graduates for a national science system has been forefronted in South Africa in recent years against the discourse of regenerating our scientific workforce. The well-established fact of the greying of the active scientific workforce also means that it becomes even more imperative that we produce ever-increasing numbers of doctoral graduates. The official Department of Education (HEMIS) data show a gradual increase in numbers of doctoral graduates over the past fifteen years (Figure 8.1). The average annual increase is in fact 3.9%.

Figure 8.1: Annual distribution of CREST and HEMIS doctoral dissertation figures, 1990 to 2004[20]



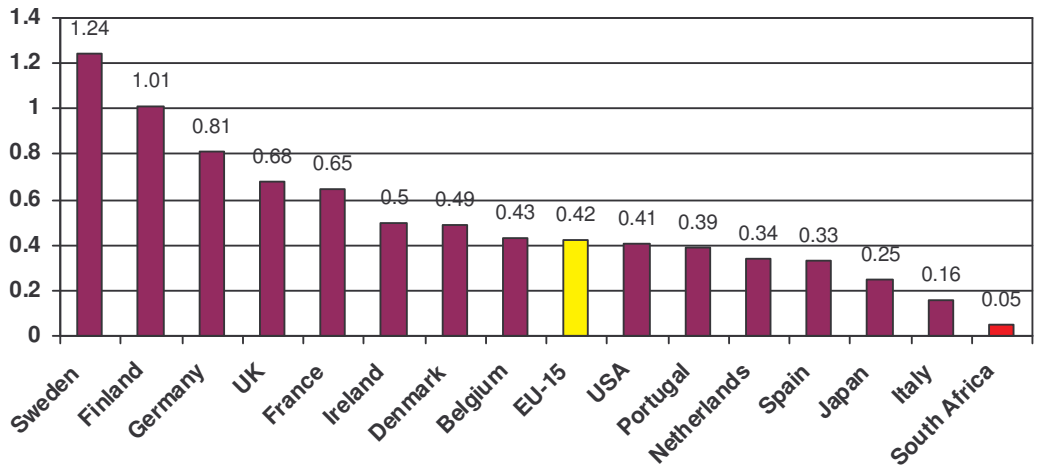
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CREST	665	664	713	712	674	729	656	659	655	852	817	799	935	859	861
HEMIS	604	652	658	694	737	679	683	676	755	713	821	784	963	1024	1071

[20] This figure presents the official annual figures of doctoral graduates as released by the DoE. In addition, we present the number of dissertation titles that CREST has managed to obtain for the respective years (cf. Section 3.4.). With the exception of the past two years – where it is very difficult still to get information on dissertation titles from all universities – the two data sets are very similar.

A comparison with international data, however, clearly shows that South Africa is producing too few doctoral graduates. In the *Third European Report on S&T Indicators* produced by the European Commission in 2003, statistics is produced on the ratio of PhD's in science and engineering per 1 000 of the age group 25 -34 for the year 2000 (Figure 8.2 below).

In 2000 South Africa produced 370 PhD's in S&E. The official census statistics put the population for 2001 (the closest year) for the age group 25-34 at approximately 7 275 000. This translates into a ratio of 0.05 PhD's per 1000 of the population in the age group. As Figure 8-2 shown, this does not compare well with the EU-15 average of 0.42 or with smaller countries like Portugal.

Figure 8.2: PhD's in S&E per 1000 in the 25-34 age group (2000)



The challenge to produce more PhDs has been recognized by national science agencies, including the National Research Foundation. The NRF refers to their initiative as the "PhD as driver" programme. In their Programme Document released in March 2006[21], they formulate the rationale behind this initiative as follows:

> *"Responding to challenges facing the South African National System of Innovation (NSI) the NRF identified a key driver for all its programmes,* ***"the production of large numbers of high quality PhDs that are required to provide the bedrock for an innovative and entrepreneurial knowledge society". I****nherent in the understanding of PhD as a driver, is that the entire education system must be effective, from pre-school to primary, through senior phase and eventually at tertiary level. Efforts to de-link the different parts of the chain will render the implementation of any strategies less effective and unsustainable in the longer term. While proposed interventions are concentrated at postgraduate level, the NRF will continue to advocate at policy level for an effective education system and will also work alongside other stakeholders in advocating for an effective and efficient education system in its entirety.*
>
> *NRF programmes (IRDP included) should be placed within the broader context of initiatives within the country that are aimed at developing skills and capacity for*

[21] Source: NRF, 2006, Institutional Research Development Programme, Irdp, Programme Framework (2007-2011).

accelerated and sustainable economic growth. Putting PhD as a driver would enable the NRF to contribute significantly to the achievement of skills and economic development programmes such as Accelerated and Shared Growth Initiative of South Africa (ASGISA).

The reference to greater efficiency derives from an earlier statement in this document where it is pointed out that SA higher education institutions only produce on average 1000 doctoral graduates from a pool of 500 000+ enrolled students. It therefore "takes 500 students to produce 1 doctorate"! However, as we will argue below, this is a deeply flawed argument that needs to be interrogated in more detail.

The medium- to long-term objectives of the IRDP are thus formulated as follows:

- Increase the quantity and quality of PhDs (key driver) and other research outputs such as journal articles, books, technological innovations etc, from supported niche areas
- Increase substantially the number of rated researchers
- Promotion of staff development
- Facilitation of institutional partnerships within and beyond South Africa's borders.
- Support for a thriving research environment that will enable South African Institutions to increase their world rankings

More specifically, a number of targets are set, including increasing the number of doctoral graduates to around 3000 in the medium-term.

There are at least three reasons why we would argue that the NRF is wrong in attributing the low output of PhD's easily to inefficiencies in the system.

First reason: The basis for the calculation is wrong

First, it is a well-known fact that student attrition rates are highest during the undergraduate year and in fact during the first six months of university study. By taking the number of students who enrol as the basis for such a calculation is simply misleading. The number of 1000 refers to graduates, but the 500 000 to the number of students enrolled in 2003. As Table 8.1 below shows, a less misleading ratio will divide the number of doctoral graduates by the number of bachelor graduates. If one takes the total number of bachelor graduates as basis for the calculation, the ratio for the past 15 years averages at 40 to 1 ("It takes 40 bachelor graduates to produce one PhD").

However, one could go a step further. The HEMIS figures distinguish further between General and Professional Bachelor graduates. An even fairer calculation would exclude the category of "professional" bachelors since very few of these students continue with any post-graduate studies. The ratio of doctoral graduates to general bachelor graduates on average for the period 1990-2004 is 28 to 1. But it is also worth noting that this ratio has been improving significantly over the past five year to stand at 22 to 1 in 2004.

Finally, it is also worth looking at how many Masters students it takes to produce one doctoral student. The average for the past 15 years is just over 6 to 1, although this ratio is worse than it was in the late nineties. Again, it is worth keeping in mind that a very large

proportion of Masters graduates (approximately one third) are MBA graduates where very few student continue with doctoral studies anyway.

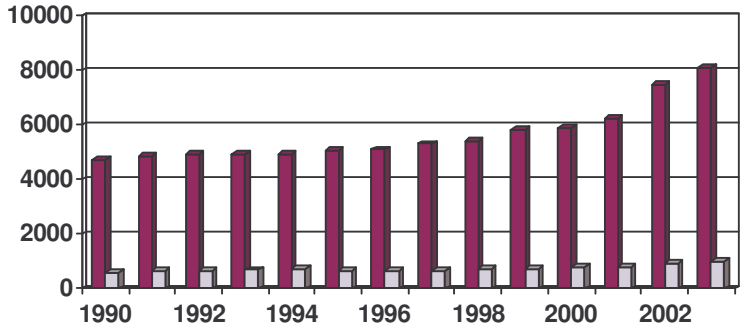
Table 8.1: Student graduation figures for the period 1990-2004

YEAR	General UG 1st Bach.	Prof 1st Bach	Total Bach	Hons	Masters	Doc	General Bach/ Doc	Total Bach/Doc	M/D
1990	16655.7	7573.9	24229.6	5986.6	2942.0	604	27.58	40.11525	4.870861
1991	18434.8	8795.9	27230.8	6649.0	3266.0	652	28.27	41.76498	5.009202
1992	19254.6	9019.9	28274.5	6726.0	3418.0	658	29.26	42.97043	5.194529
1993	19795.4	9071.0	28866.4	7211.5	3570.0	694	28.52	41.59423	5.144092
1994	21948.1	9659.9	31608.0	7201.4	3494.5	737	29.78	42.88742	4.74152
1995	23796.6	10801.8	34598.4	7747.2	3848.3	679	35.05	50.95491	5.66757
1996	24752.6	10876.0	35628.6	7793.1	4005.3	683	36.24	52.16483	5.864261
1997	25733.2	11017.0	36750.2	8259.7	4258.7	676	38.07	54.36425	6.299794
1998	24938.3	10759.0	35697.3	7873.0	4435.0	755	33.03	47.28124	5.874172
1999	22149.0	10729.0	32878.0	7070.0	4728.0	713	31.06	46.1122	6.631136
2000	22468.0	11584.0	34052.0	9233.0	5704.0	821	27.37	41.47625	6.947625
2001	21640.0	10515.0	32155.0	9984.0	6055.0	784	27.60	41.01403	7.723214
2002	23000.0	10709.0	33709.0	11606.0	6667.0	963	23.88	35.00415	6.923157
2003	23188.0	10922.0	34110.0	13516.0	7182.0	1024	22.64	33.31055	7.013672
2004	24162.0	13186.0	37348.0	14771.0	7552.0	1071	22.56	34.87208	7.051354
	331916.4	**155219.5**	**487135.9**	**131627.5**	**71125.7**	**11514.0**	**28.83**	**42.30814**	**6.177326**

Second reason: Exponential increases in post-graduate enrolments

This ratio should also be read against the background of an exponential increase in doctoral enrolments over this period. As Figure 8.3 below shows, the number of doctoral enrolment has increased significantly- especially over the past 6-8 years. This means that the average number of doctoral students to supervise has increased hugely (especially since increases in the number of academic staff have been much smaller). Given this added responsibility (or "burden") of supervising many more doctoral students, it is quite remarkable that the system has in fact managed to graduate more doctoral students at all. This speaks to greater efficiency in the system and certainly not less!

Figure 8.3: Doctoral enrolments (1990-2004)



Third reason: Continuing inequities in the HE system

More than ten years after the advent of a democratic government in South Africa and during a period that have witnessed various higher education reforms, South African universities perform very differently when they are compared in terms of both research and post-graduate production. Six universities – UCT, Stellenbosch, Pretoria, UNISA, KZN and WITS – produced two thirds of all doctorates over this period. This proportion has changed very little over time (Table 8.2 below).

One of the implications of these institutional skewnesses for the calculation of the ratio's of undergraduate to doctoral graduates, is that it is obviously much more fair to compare the number of doctoral graduates of these six universities with their bachelor graduate number. This will even further reduce the ratio.

Table 8.2: Doctoral graduates by University for the period 1990-2004

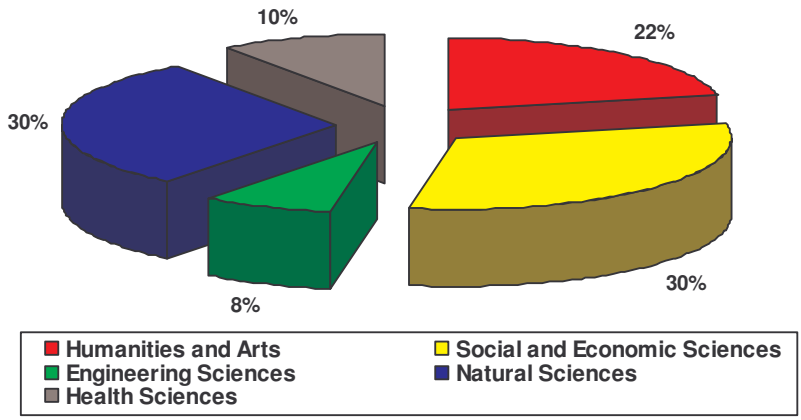
Institution	1990-1992	1993-1995	1996-1998	1999-2001	2002-2004	Total	Col %
Nelson Mandela Metropolitan University	71	62	64	55	72	324	2.88
North West University	88	122	102	170	221	703	6.25
Rhodes University	57	65	71	81	124	398	3.54
Stellenbosch University	223	213	207	258	282	1183	10.52
University of Cape Town	212	232	232	277	291	1244	11.06
University of Fort Hare	8	3	4	2	6	23	0.20

Institution	1990-1992	1993-1995	1996-1998	1999-2001	2002-2004	Total	Col %
University of Johannesburg	138	148	163	211	118	778	6.92
University of Kwazulu Natal	185	203	194	179	225	986	8.76
University of Limpopo	17	9	18	24	36	104	0.92
University of Pretoria	322	357	286	378	482	1825	16.22
University of South Africa	294	267	235	308	181	1285	11.42
University of the Free State	159	149	132	171	206	817	7.26
University of the Western Cape	16	17	21	68	67	189	1.68
University of the Witwatersrand	228	231	199	206	243	1107	9.84
University of Venda	0	0	1	2	2	5	0.04
University of Zululand	6	17	14	50	78	165	1.47
Vista University	18	20	27	27	20	112	1.00
Walter Sisulu University of Technology	0	0	0	1	1	2	0.02
Total output	**2042**	**2115**	**1970**	**2468**	**2655**	**11250**	**1.00**

8.2 DOCTORAL OUTPUT BY BROAD FIELD

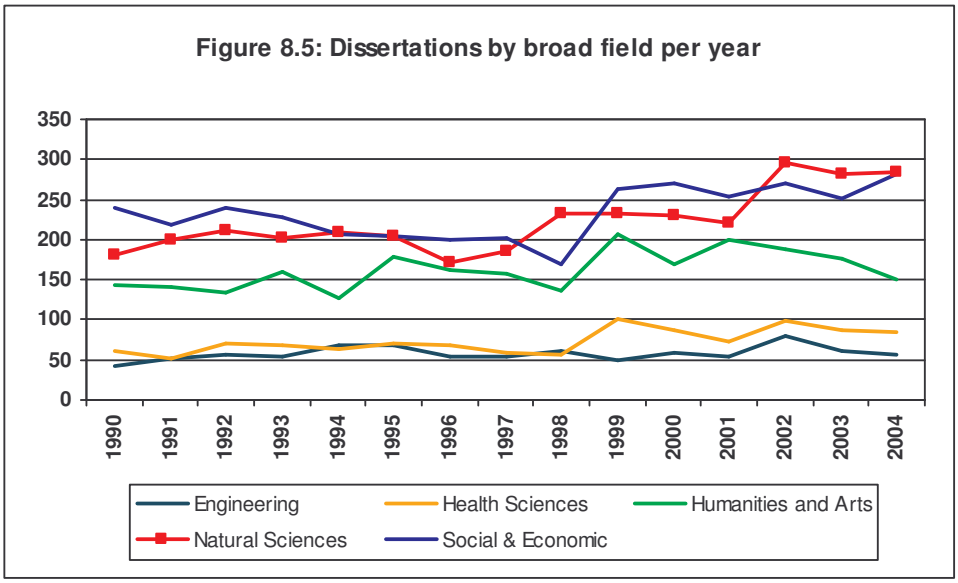
Our analysis in this section is based on a database compiled by CREST for this purpose (cf Section 3.4). The output of doctoral dissertations by broad scientific field (Figure 8.4) shows that slightly more than half (52%) of all doctoral studies has been in the humanities and social sciences. This is in line with the field distribution of article output.

Figure 8.4: Doctoral dissertations by broad field



The output per year (Figure 8.5) reveals smaller shifts over years (which is to be expected given the relatively small annual output) and a general increase in output for the natural and social sciences over the fifteen year period.

Figure 8.5: Dissertations by broad field per year



8.3 DOCTORAL OUTPUT BY SCIENTIFIC FIELD

In this section, we present more detailed analyses per scientific field, namely basic demographics, and the proportional contribution of the top 5 universities to each field.

8.3.1 Agricultural sciences

Figure 8.6: Share of doctoral dissertations in Agricultural Sciences, by year period and data source

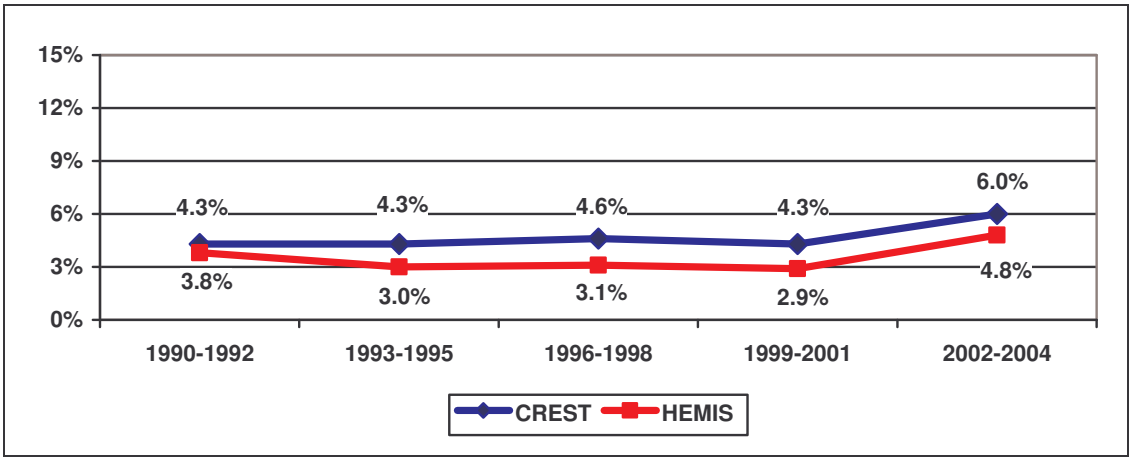


Table 8.3: Race-by-gender profile of doctoral dissertations in Agricultural Sciences, by year period

Race x gender	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
	Count	%	Count	%	Count	%	Count	%	Count	%
African women	0.0	0.0%	0.0	0.0%	1.0	1.6%	7.0	10.3%	9.0	6.2%
African men	4.0	5.5%	2.0	3.2%	4.0	6.3%	22.0	32.4%	66.0	45.3%
Coloured women	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.0	0.7%
Coloured men	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	2.0	1.4%
Indian women	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.0	0.7%
Indian men	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.0	0.7%
White women	5.0	6.8%	8.0	12.7%	2.9	4.6%	10.0	14.7%	23.7	16.2%
White men	64.0	87.7%	53.0	84.1%	55.5	87.5%	29.0	42.6%	42.0	28.8%
Total	**73.0**	**100.0%**	**63.0**	**100.0%**	**63.4**	**100.0%**	**68.0**	**100.0%**	**145.7**	**100.0%**

Source: HEMIS dataset of doctoral graduates

Table 8.4: Proportional contribution of top 5 universities to doctoral dissertations in Agricultural Sciences, by year period

University	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
	Count	%	Count	%	Count	%	Count	%	Count	%
UP	30	34.5%	37	40.2%	30	33.0%	37	34.9%	51	31.9%
UFS	14	16.1%	16	17.4%	23	25.3%	29	27.4%	49	30.6%
SU	22	25.3%	21	22.8%	13	14.3%	19	17.9%	22	13.8%
UKZN	13	14.9%	16	17.4%	15	16.5%	12	11.3%	19	11.9%
NWU	1	1.1%	2	2.2%	5	5.5%	5	4.7%	4	2.5%
OTHER	7	8.0%	0	0.0%	5	5.5%	4	3.8%	15	9.4%
Total	**87**	**100.0 %**	**92**	**100.0 %**	**91**	**100.0 %**	**106**	**100.0 %**	**160**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.2 Biological sciences

Figure 8.7: Share of doctoral dissertations in Biological Sciences, by year period and data source

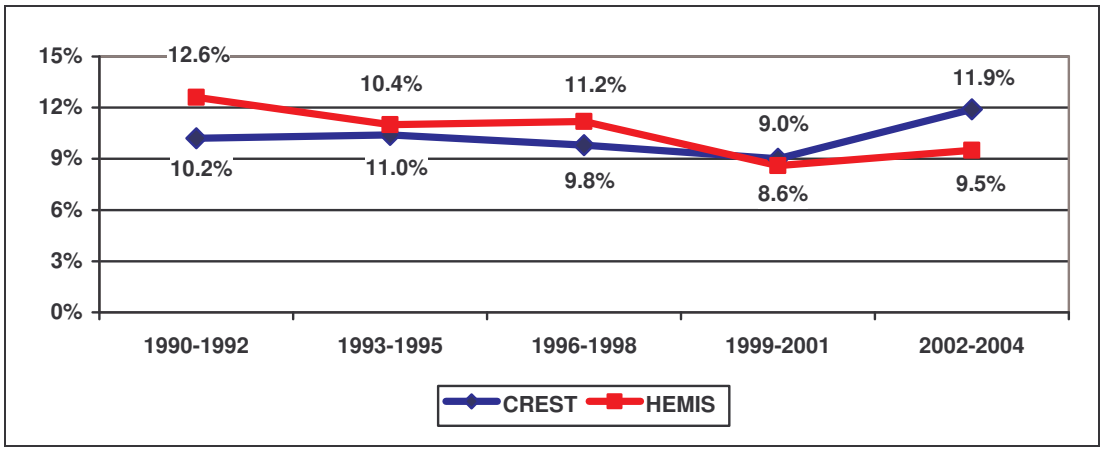


Table 8.5: Race-by-gender profile of doctoral dissertations in Biological Sciences, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	1.0	0.4%	0.0	0.0%	7.0	3.0%	2.0	1.0%	24.0	8.3%
African men	6.0	2.5%	5.0	2.2%	11.0	4.8%	19.5	9.8%	40.5	13.9%
Coloured women	0.0	0.0%	0.0	0.0%	1.0	0.4%	2.0	1.0%	7.0	2.4%
Coloured men	3.0	1.3%	0.0	0.0%	5.8	2.5%	9.0	4.5%	10.0	3.4%
Indian women	0.0	0.0%	0.0	0.0%	2.0	0.9%	6.0	3.0%	10.0	3.4%
Indian men	0.0	0.0%	5.0	2.2%	3.0	1.3%	1.0	0.5%	10.0	3.4%
White women	78.0	32.6%	81.0	35.7%	87.0	37.6%	82.0	41.3%	90.3	31.1%
White men	151.0	63.2%	136.0	59.9%	114.5	49.5%	77.0	38.8%	99.0	34.0%
Total	**239.0**	**100%**	**227.0**	**100%**	**231.3**	**100%**	**198.5**	**100%**	**290.8**	**100%**

Source: HEMIS dataset of doctoral graduates

Table 8.6: Proportional contribution of top 5 universities to doctoral dissertations in Biological Sciences, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	Count	%	Count	%	Count	%	Count	%	Count	%
UCT	52	24.9%	36	16.4%	35	18.0%	40	17.9%	52	16.5%
UKZN	33	15.8%	35	15.9%	34	17.5%	23	10.3%	39	12.4%
UP	21	10.0%	29	13.2%	24	12.4%	28	12.6%	49	15.6%
RHODES	16	7.7%	25	11.4%	22	11.3%	27	12.1%	46	14.6%
WITS	32	15.3%	29	13.2%	28	14.4%	23	10.3%	20	6.3%
OTHER	55	26.3%	66	30.0%	51	26.3%	82	36.8%	109	34.6%
Total	**209**	**100%**	**220**	**100%**	**194**	**100%**	**223**	**100%**	**315**	**100%**

Source: CREST dataset of doctoral dissertations

8.3.3 Chemical sciences

Figure 8.8: Share of doctoral dissertations in Chemical Sciences, by year period and data source

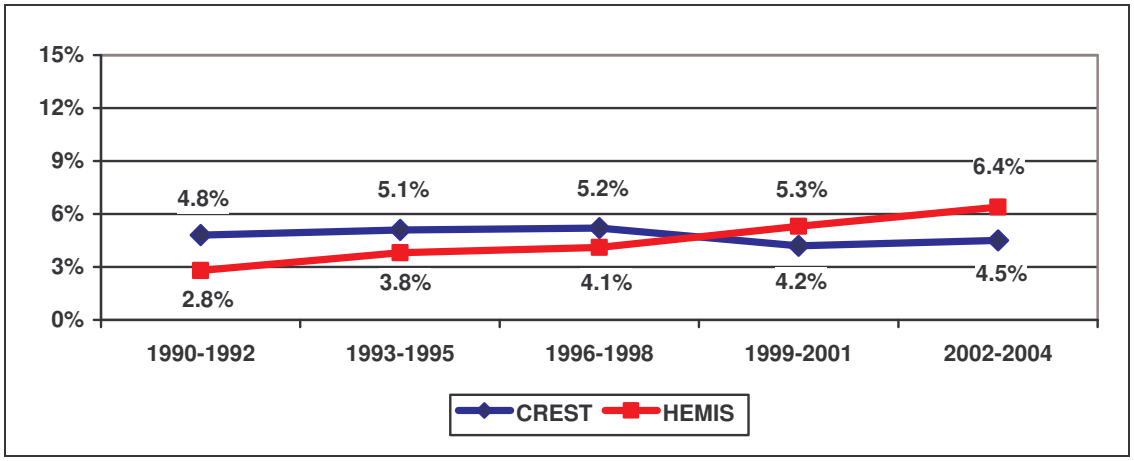


Table 8.7: Race-by-gender profile of doctoral dissertations in Chemical Sciences, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	0.0	0.0%	0.0	0.0%	1.0	1.2%	6.0	4.9%	9.3	4.8%
African men	1.0	1.9%	5.0	6.3%	6.0	7.1%	19.0	15.4%	32.3	16.7%
Coloured women	0.0	0.0%	0.0	0.0%	3.0	3.5%	2.0	1.6%	6.0	3.1%
Coloured men	2.0	3.8%	2.0	2.5%	4.0	4.7%	8.0	6.5%	7.0	3.6%
Indian women	1.0	1.9%	1.0	1.3%	3.0	3.5%	4.0	3.3%	13.0	6.7%
Indian men	4.1	7.7%	3.0	3.8%	4.0	4.7%	5.0	4.1%	10.0	5.2%
White women	22.0	41.5%	23.0	29.1%	25.0	29.4%	38.0	30.9%	51.0	26.3%
White men	23.0	43.2%	45.0	57.0%	39.0	45.9%	41.0	33.3%	65.5	33.7%
Total	**53.1**	**100.0 %**	**79.0**	**100.0 %**	**85.0**	**100.0 %**	**123.0**	**100.0 %**	**194.2**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.8: Proportional contribution of top 5 universities to doctoral dissertations in Chemical Sciences, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
WITS	22	22.4%	28	25.9%	15	14.7%	17	16.3%	15	12.5%
UCT	12	12.2%	16	14.8%	15	14.7%	10	9.6%	22	18.3%
UP	16	16.3%	15	13.9%	9	8.8%	17	16.3%	12	10.0%
UKZN	9	9.2%	12	11.1%	17	16.7%	5	4.8%	12	10.0%
RHODES	5	5.1%	6	5.6%	9	8.8%	13	12.5%	11	9.2%
OTHER	34	34.7%	31	28.7%	37	36.3%	42	40.4%	48	40.0%
Total	**98**	**100%**	**108**	**100%**	**102**	**100%**	**104**	**100%**	**120**	**100%**

Source: CREST dataset of doctoral dissertations

8.3.4 Earth sciences

Figure 8.9: Share of doctoral dissertations in Earth Sciences, by year period and data source

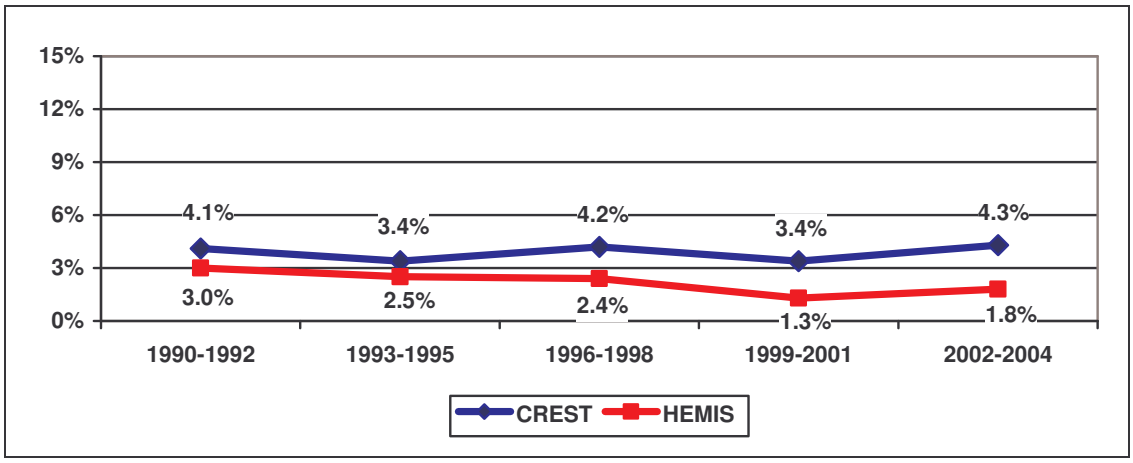


Table 8.9: Race-by-gender profile of doctoral dissertations in Earth Sciences, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
African men	0.0	0.0%	1.0	1.9%	4.0	8.2%	3.5	11.7%	8.5	15.0%
Coloured women	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Coloured men	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.0	3.3%	3.0	5.3%
Indian women	1.0	1.8%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Indian men	1.0	1.8%	1.0	1.9%	1.0	2.1%	2.0	6.7%	0.0	0.0%
White women	6.0	10.6%	4.0	7.7%	9.0	18.5%	6.0	20.0%	16.5	29.2%
White men	48.5	85.8%	46.0	88.5%	34.7	71.2%	17.5	58.3%	28.5	50.4%
Total	**56.5**	**100%**	**52.0**	**100%**	**48.7**	**100%**	**30.0**	**100%**	**56.5**	**100%**

Source: HEMIS dataset of doctoral graduates

Table 8.10: Proportional contribution of top 5 universities to doctoral dissertations in Earth Sciences, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	Count	%	Count	%	Count	%	Count	%	Count	%
UCT	21	25.3%	14	19.7%	17	20.5%	14	16.5%	13	11.5%
WITS	12	14.5%	15	21.1%	10	12.0%	13	15.3%	23	20.4%
UP	11	13.3%	5	7.0%	10	12.0%	20	23.5%	13	11.5%
UKZN	13	15.7%	12	16.9%	11	13.3%	9	10.6%	12	10.6%
UFS	3	3.6%	4	5.6%	4	4.8%	8	9.4%	11	9.7%
OTHER	23	27.7%	21	29.6%	31	37.3%	21	24.7%	41	36.3%
Total	**83**	**100%**	**71**	**100%**	**83**	**100%**	**85**	**100%**	**113**	**100%**

Source: CREST dataset of doctoral dissertations

8.3.5 Mathematical sciences & ICCT

Figure 8.10: Share of doctoral dissertations in Mathematical Sciences & ICCT, by year period and data source

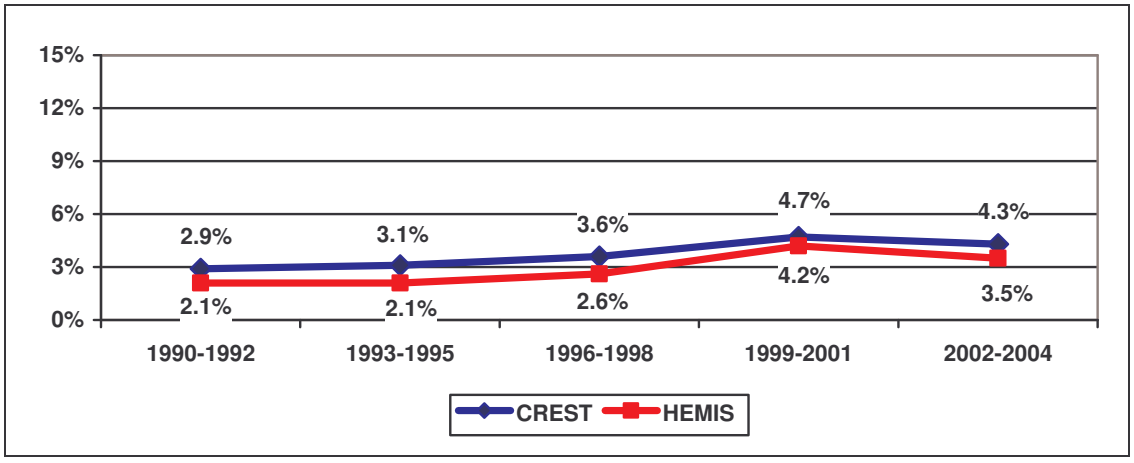


Table 8.11: Race-by-gender profile of doctoral dissertations in Mathematical Sciences & ICCT, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.0	1.0%	3.8	3.6%
African men	4.0	10.0%	1.0	2.3%	5.3	9.9%	12.5	12.9%	25.8	24.0%
Coloured women	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.0	0.9%
Coloured men	0.0	0.0%	3.0	6.8%	5.3	9.8%	3.0	3.1%	2.0	1.9%
Indian women	1.0	2.5%	0.0	0.0%	0.0	0.0%	1.0	1.0%	1.0	0.9%
Indian men	0.7	1.7%	4.7	10.6%	5.0	9.3%	3.0	3.1%	11.0	10.2%
White women	6.0	15.0%	11.3	25.8%	16.7	31.0%	29.5	30.4%	28.0	26.0%
White men	28.3	70.8%	24.0	54.5%	21.6	40.1%	47.0	48.5%	35.0	32.5%
Total	**40.0**	**100.0 %**	**44.0**	**100.0 %**	**53.8**	**100.0 %**	**97.0**	**100.0 %**	**107.7**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.12: proportional contribution of top 5 universities to doctoral dissertations in Mathematical Sciences & ICCT, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
UCT	9	15.0%	16	24.2%	10	14.3%	15	13.0%	24	20.9%
UP	5	8.3%	15	22.7%	8	11.4%	20	17.4%	25	21.7%
UKZN	7	11.7%	7	10.6%	13	18.6%	15	13.0%	14	12.2%
WITS	8	13.3%	6	9.1%	8	11.4%	14	12.2%	15	13.0%
UJ	9	15.0%	7	10.6%	7	10.0%	10	8.7%	11	9.6%
OTHER	22	36.7%	15	22.7%	24	34.3%	41	35.7%	26	22.6%
Total	**60**	**100.0%**	**66**	**100.0 %**	**70**	**100.0 %**	**115**	**100.0 %**	**115**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.6 Physical sciences

Figure 8.11: Share of doctoral dissertations in Physical Sciences, by year period and data source

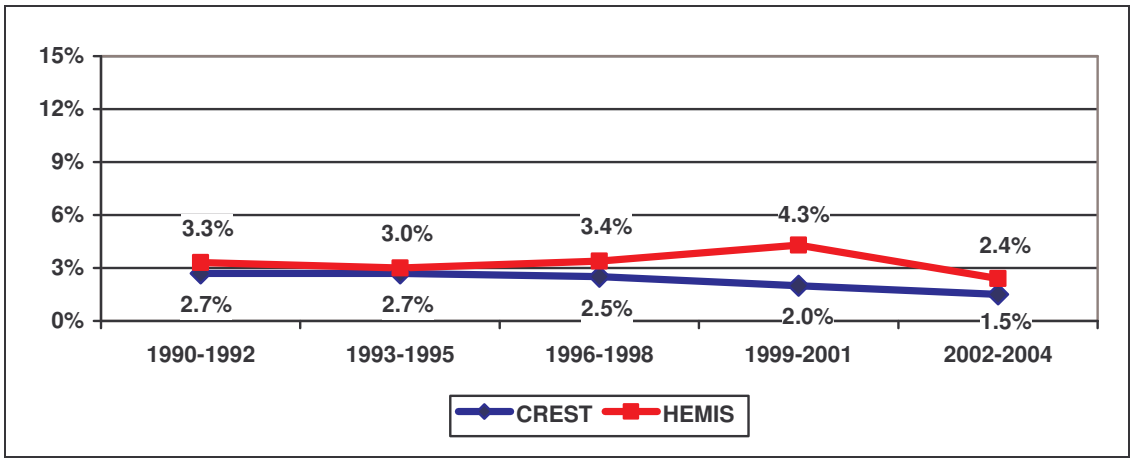


Table 8.13: Race-by-gender profile of doctoral dissertations in Physical Sciences, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.3	1.3%	3.8	5.3%
African men	0.0	0.0%	4.0	6.5%	6.7	9.5%	12.0	12.1%	20.8	28.7%
Coloured women	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.3	1.3%	0.0	0.0%
Coloured men	2.0	3.2%	0.0	0.0%	5.0	7.0%	3.3	3.3%	4.0	5.5%
Indian women	0.0	0.0%	1.0	1.6%	0.0	0.0%	0.3	0.3%	2.0	2.8%
Indian men	0.1	0.1%	2.1	3.3%	3.0	4.2%	1.5	1.5%	5.0	6.9%
White women	8.0	12.9%	8.3	13.6%	13.1	18.4%	26.5	26.8%	17.0	23.4%
White men	52.1	83.8%	46.2	75.0%	43.2	60.9%	53.0	53.5%	20.0	27.5%
Total	**62.2**	**100.0 %**	**61.5**	**100.0 %**	**71.0**	**100.0 %**	**99.0**	**100.0 %**	**72.7**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.14: Proportional contribution of top 5 universities to doctoral dissertations in Physical Sciences, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	Count	%	Count	%	Count	%	Count	%	Count	%
WITS	11	20.0%	12	20.7%	10	20.4%	11	22.0%	8	20.0%
UKZN	8	14.5%	12	20.7%	7	14.3%	6	12.0%	3	7.5%
UCT	8	14.5%	6	10.3%	11	22.4%	4	8.0%	5	12.5%
SU	10	18.2%	2	3.4%	3	6.1%	6	12.0%	4	10.0%
NWU	3	5.5%	6	10.3%	2	4.1%	3	6.0%	6	15.0%
OTHER	15	27.3%	20	34.5%	16	32.7%	20	40.0%	14	35.0%
Total	**55**	**100.0 %**	**58**	**100.0 %**	**49**	**100.0 %**	**50**	**100.0 %**	**40**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.7 Engineering & applied technologies

Figure 8.12: Share of doctoral dissertations in Engineering & Applied Technologies, by year period and data source

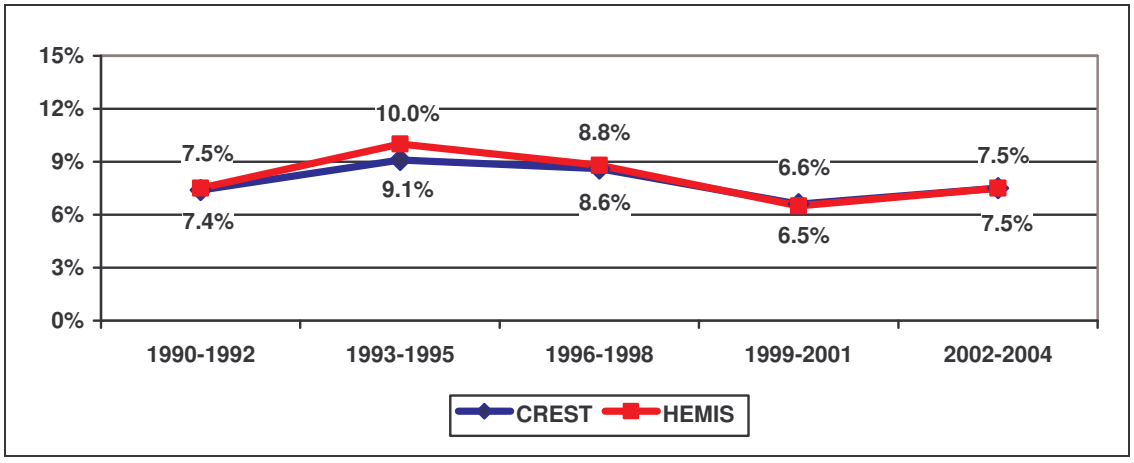


Table 8.15: Race-by-gender profile of doctoral dissertations in Engineering & Applied Technologies, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	0.0	0.0%	0.0	0.0%	2.0	1.1%	1.0	0.7%	2.0	0.9%
African men	1.0	0.7%	2.0	1.0%	7.0	3.8%	8.0	5.3%	21.0	9.2%
Coloured women	0.0	0.0%	0.0	0.0%	0.0	0.0%	2.0	1.3%	1.0	0.4%
Coloured men	0.0	0.0%	2.0	1.0%	0.0	0.0%	2.0	1.3%	0.0	0.0%
Indian women	0.0	0.0%	0.0	0.0%	0.0	0.0%	3.0	2.0%	3.0	1.3%
Indian men	1.0	0.7%	4.0	1.9%	2.0	1.1%	5.0	3.3%	9.0	3.9%
White women	1.0	0.7%	8.0	3.9%	21.0	11.5%	17.0	11.3%	21.0	9.2%
White men	139.8	97.9%	191.0	92.3%	150.0	82.4%	112.0	74.7%	171.5	75.1%
Total	**142.8**	**100.0 %**	**207.0**	**100.0 %**	**182.0**	**100.0 %**	**150.0**	**100.0 %**	**228.5**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.16: Proportional contribution of top 5 universities to doctoral dissertations in Engineering & Applied Technologies, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
WITS	50	33.1%	59	30.6%	40	23.5%	35	21.6%	36	18.2%
SU	16	10.6%	39	20.2%	28	16.5%	37	22.8%	43	21.7%
UCT	17	11.3%	33	17.1%	42	24.7%	37	22.8%	25	12.6%
UP	38	25.2%	29	15.0%	25	14.7%	28	17.3%	24	12.1%
UJ	9	6.0%	21	10.9%	20	11.8%	9	5.6%	23	11.6%
OTHER	21	13.9%	12	6.2%	15	8.8%	16	9.9%	47	23.7%
Total	**151**	**100.0 %**	**193**	**100.0 %**	**170**	**100.0 %**	**162**	**100.0 %**	**198**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.8 Basic health

Figure 8.13: Share of doctoral dissertations in Basic Health, by year period and data source

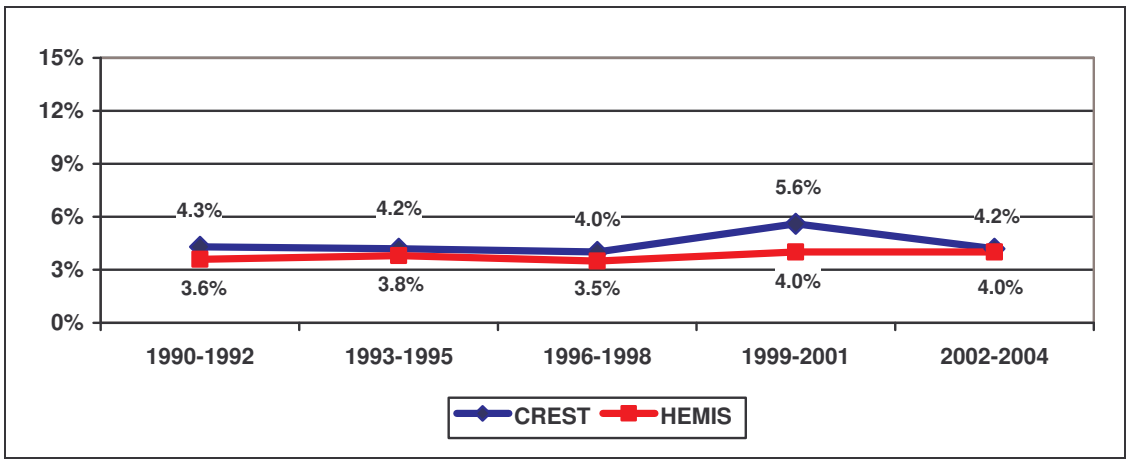


Table 8.17: Race-by-gender profile of doctoral dissertations in Basic Health, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	1.0	1.5%	0.0	0.0%	2.0	2.8%	6.3	6.7%	15.0	12.2%
African men	0.0	0.0%	1.0	1.3%	1.0	1.4%	8.0	8.6%	14.0	11.4%
Coloured women	1.0	1.5%	2.0	2.6%	3.0	4.2%	3.3	3.5%	7.0	5.7%
Coloured men	0.0	0.0%	8.0	10.2%	2.0	2.8%	3.3	3.5%	4.0	3.3%
Indian women	0.0	0.0%	3.2	4.1%	2.0	2.8%	6.8	7.2%	7.0	5.7%
Indian men	3.9	5.7%	2.0	2.6%	2.0	2.8%	1.5	1.6%	3.0	2.4%
White women	24.0	34.8%	21.0	26.9%	31.0	43.4%	33.3	35.7%	42.0	34.1%
White men	39.0	56.7%	41.0	52.4%	28.5	39.9%	31.0	33.2%	31.0	25.2%
Total	**68.9**	**100.0 %**	**78.2**	**100.0 %**	**71.5**	**100.0 %**	**93.3**	**100.0 %**	**123.0**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.18: Proportional contribution of top 5 universities to doctoral dissertations in Basic Health, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	Count	%	Count	%	Count	%	Count	%	Count	%
UCT	20	22.7%	29	32.6%	26	33.3%	55	40.1%	37	33.3%
WITS	30	34.1%	27	30.3%	22	28.2%	33	24.1%	32	28.8%
SU	15	17.0%	10	11.2%	5	6.4%	12	8.8%	14	12.6%
UP	5	5.7%	12	13.5%	10	12.8%	9	6.6%	13	11.7%
UFS	7	8.0%	4	4.5%	6	7.7%	9	6.6%	2	1.8%
OTHER	11	12.5%	7	7.9%	9	11.5%	19	13.9%	13	11.7%
Total	**88**	**100.0%**	**89**	**100.0 %**	**78**	**100.0 %**	**137**	**100.0 %**	**111**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.9 Clinical & public health

Figure 8.14: Share of doctoral dissertations in Clinical & Public Health, by year period and data source

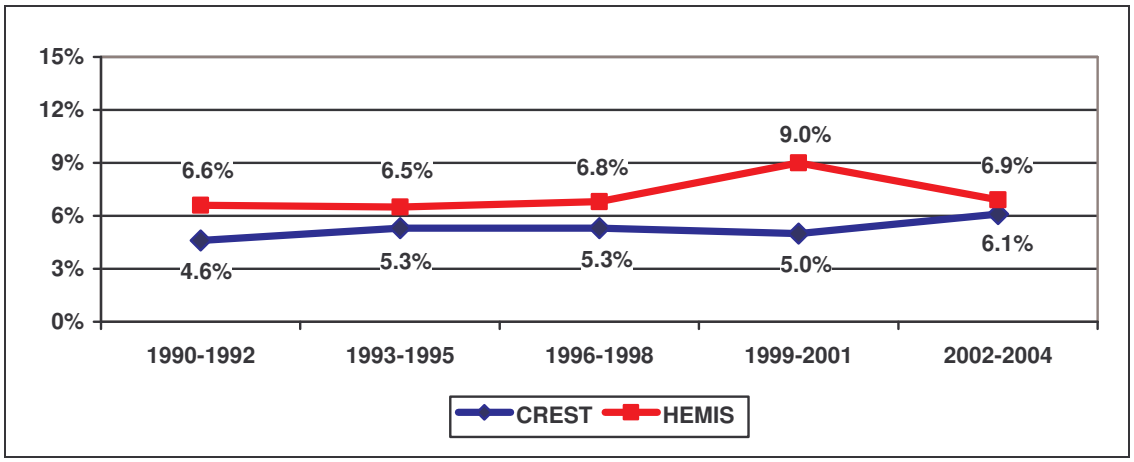


Table 8.19: Race-by-gender profile of doctoral dissertations in Clinical & Public Health, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	0.0	0.0%	3.0	2.2%	13.0	9.3%	27.5	13.1%	23.0	10.9%
African men	0.0	0.0%	0.0	0.0%	4.0	2.9%	17.0	8.1%	7.3	3.5%
Coloured women	0.0	0.0%	0.0	0.0%	1.0	0.7%	3.5	1.7%	6.0	2.8%
Coloured men	1.0	0.8%	2.0	1.5%	2.0	1.4%	1.5	0.7%	5.0	2.4%
Indian women	3.0	2.4%	4.8	3.5%	3.0	2.1%	4.0	1.9%	10.0	4.7%
Indian men	7.0	5.6%	2.0	1.5%	3.0	2.1%	3.0	1.4%	14.0	6.6%
White women	46.0	36.8%	60.5	44.7%	65.0	46.4%	82.7	39.5%	85.0	40.2%
White men	68.0	54.4%	63.0	46.6%	49.0	35.0%	70.0	33.5%	61.0	28.9%
Total	**125.0**	**100.0 %**	**135.3**	**100.0 %**	**140.0**	**100.0 %**	**209.2**	**100.0 %**	**211.3**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.20: Proportional contribution of top 5 universities to doctoral dissertations in Clinical & Public Health, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Clinical Health										
UCT	14	23.3%	16	27.6%	6	10.7%	12	20.0%	16	16.0%
NWU	2	3.3%	7	12.1%	7	12.5%	13	21.7%	17	17.0%
SU	12	20.0%	6	10.3%	11	19.6%	7	11.7%	10	10.0%
UP	9	15.0%	8	13.8%	8	14.3%	6	10.0%	11	11.0%
WITS	7	11.7%	8	13.8%	15	26.8%	3	5.0%	9	9.0%
OTHER	16	26.7%	13	22.4%	9	16.1%	19	31.7%	37	37.0%
Total	**60**	**100.0 %**	**58**	**100.0 %**	**56**	**100.0 %**	**60**	**100.0 %**	**100**	**100.0 %**
Public / Community Health										
UJ	5	14.7%	15	27.8%	9	18.8%	14	22.2%	2	3.3%
UNISA	5	14.7%	7	13.0%	6	12.5%	18	28.6%	5	8.2%
NWU	2	5.9%	4	7.4%	7	14.6%	7	11.1%	9	14.8%
UP	3	8.8%	4	7.4%	4	8.3%	6	9.5%	9	14.8%
UFS	8	23.5%	1	1.9%	6	12.5%	1	1.6%	6	9.8%
OTHER	11	32.4%	23	42.6%	16	33.3%	17	27.0%	30	49.2%
Total	**34**	**100.0 %**	**54**	**100.0 %**	**48**	**100.0 %**	**63**	**100.0 %**	**61**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.10 Economics & management sciences

Figure 8.15: Share of doctoral dissertations in Economics & Management Sciences, by year period and data source

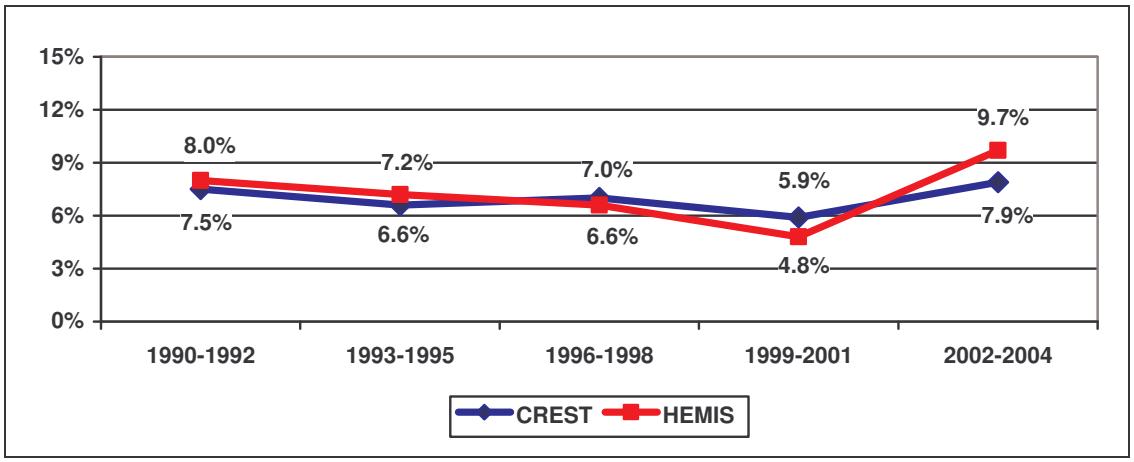


Table 8.21: Race-by-gender profile of doctoral dissertations in Economics & Management Sciences, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	0.0	0.0%	0.0	0.0%	1.0	0.7%	2.0	1.8%	12.0	4.1%
African men	1.0	0.7%	4.0	2.7%	7.0	5.1%	13.0	11.7%	58.5	19.8%
Coloured women	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.0	0.9%	3.0	1.0%
Coloured men	1.0	0.7%	0.0	0.0%	3.0	2.2%	2.0	1.8%	4.0	1.4%
Indian women	1.0	0.7%	1.0	0.7%	2.3	1.7%	1.0	0.9%	14.0	4.7%
Indian men	5.0	3.3%	4.0	2.7%	4.0	2.9%	5.0	4.5%	29.0	9.8%
White women	21.0	13.9%	24.0	16.0%	26.0	19.1%	28.0	25.2%	54.0	18.3%
White men	122.2	80.8%	117.0	78.0%	93.0	68.2%	59.0	53.2%	121.0	40.9%
Total	**151.2**	**100.0 %**	**150.0**	**100.0 %**	**136.3**	**100.0 %**	**111.0**	**100.0 %**	**295.5**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.22: Proportional contribution of top 5 universities to doctoral dissertations in Economics & Management Sciences, by year period

University	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
	Count	%	Count	%	Count	%	Count	%	Count	%
UP	25	16.3%	30	21.6%	27	19.7%	32	22.1%	54	25.8%
UNISA	38	24.8%	24	17.3%	27	19.7%	22	15.2%	17	8.1%
UJ	14	9.2%	19	13.7%	24	17.5%	19	13.1%	16	7.7%
UKZN	15	9.8%	20	14.4%	11	8.0%	10	6.9%	21	10.0%
SU	19	12.4%	10	7.2%	14	10.2%	15	10.3%	15	7.2%
OTHER	42	27.5%	36	25.9%	34	24.8%	47	32.4%	86	41.1%
Total	**153**	**100.0 %**	**139**	**100.0 %**	**137**	**100.0 %**	**145**	**100.0 %**	**209**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.11 Education

Figure 8.16: Share of doctoral dissertations in Education, by year period and data source

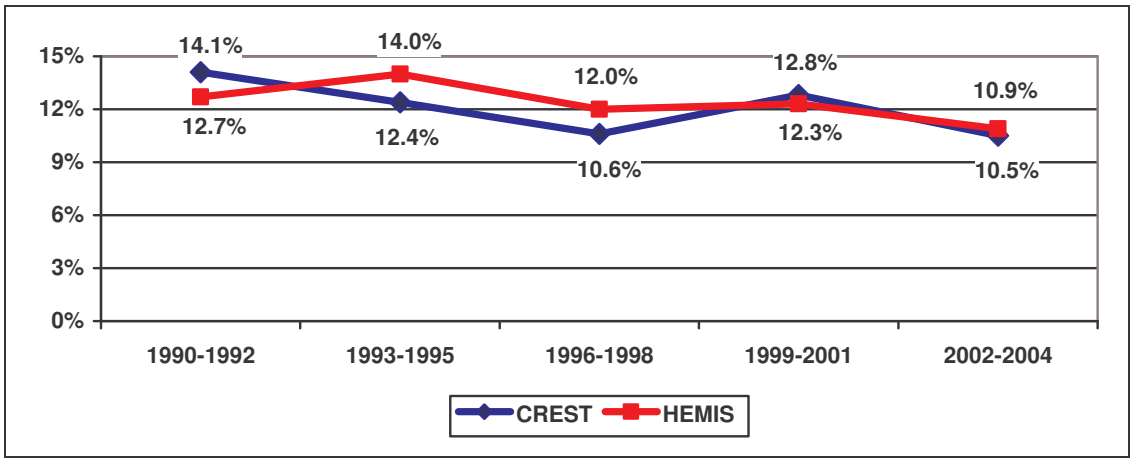


Table 8.23: Race-by-gender profile of doctoral dissertations in Education, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	2.0	0.8%	7.0	2.4%	2.0	0.8%	29.5	10.3%	29.0	8.7%
African men	13.0	5.4%	24.0	8.3%	37.7	15.1%	53.5	18.7%	83.0	24.9%
Coloured women	0.0	0.0%	1.0	0.3%	2.0	0.8%	6.0	2.1%	11.0	3.3%
Coloured men	8.0	3.3%	14.0	4.8%	3.0	1.2%	11.5	4.0%	22.0	6.6%
Indian women	2.0	0.8%	2.0	0.7%	5.0	2.0%	10.0	3.5%	26.0	7.8%
Indian men	7.0	2.9%	7.0	2.4%	16.0	6.4%	19.0	6.6%	20.0	6.0%
White women	82.0	33.9%	112.3	38.7%	93.8	37.7%	96.3	33.7%	92.0	27.5%
White men	128.0	52.9%	123.0	42.4%	89.2	35.9%	60.0	21.0%	51.0	15.3%
Total	**242.0**	**100.0 %**	**290.3**	**100.0 %**	**248.7**	**100.0 %**	**285.8**	**100.0 %**	**334.0**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.24: Proportional contribution of top 5 universities to doctoral dissertations in Education, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
UNISA	74	25.7%	66	25.2%	55	26.4%	77	24.4%	42	15.1%
UP	63	21.9%	59	22.5%	27	13.0%	41	13.0%	50	17.9%
UJ	43	14.9%	24	9.2%	37	17.8%	62	19.7%	13	4.7%
SU	20	6.9%	24	9.2%	21	10.1%	21	6.7%	24	8.6%
NWU	13	4.5%	25	9.5%	12	5.8%	19	6.0%	21	7.5%
UFS	20	6.9%	17	6.5%	11	5.3%	17	5.4%	25	9.0%
OTHER	55	19.1%	47	17.9%	45	21.6%	78	24.8%	104	37.3%
Total	**288**	**100.0 %**	**262**	**100.0 %**	**208**	**100.0 %**	**315**	**100.0 %**	**279**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.12 Psychology

Figure 8.17: Share of doctoral dissertations in Psychology, by year period and data source

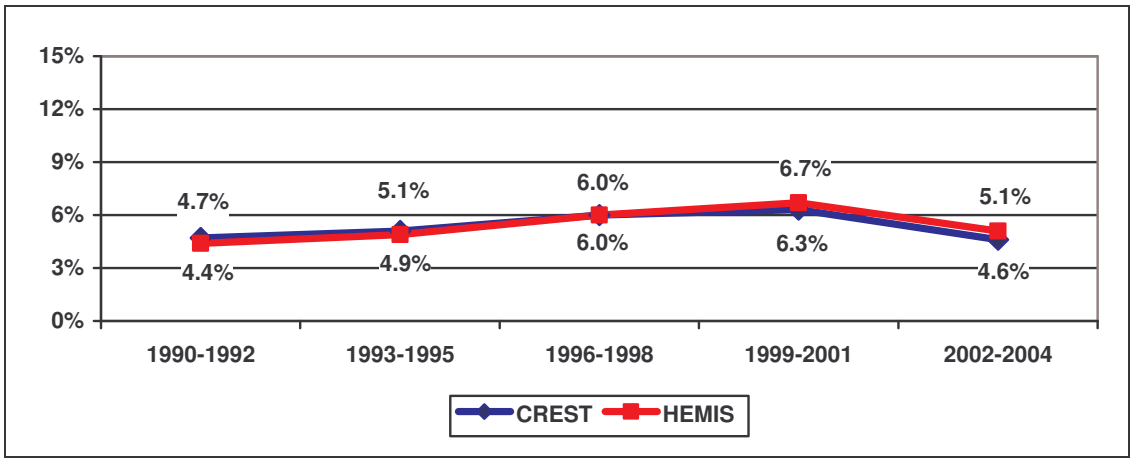


Table 8.25: Race-by-gender profile of doctoral dissertations in Psychology, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	0.0	0.0%	2.0	2.0%	1.0	0.8%	7.5	4.9%	10.5	6.8%
African men	0.0	0.0%	3.0	2.9%	6.0	4.8%	14.0	9.1%	8.8	5.7%
Coloured women	1.0	1.2%	1.0	1.0%	2.0	1.6%	4.0	2.6%	2.0	1.3%
Coloured men	2.0	2.4%	1.0	1.0%	1.0	0.8%	1.0	0.6%	5.0	3.2%
Indian women	1.0	1.2%	0.0	0.0%	2.0	1.6%	2.0	1.3%	2.0	1.3%
Indian men	2.0	2.4%	1.0	1.0%	2.0	1.6%	2.0	1.3%	0.0	0.0%
White women	22.0	26.2%	38.0	37.3%	67.0	54.0%	77.2	50.1%	88.0	57.0%
White men	56.0	66.7%	56.0	54.9%	43.0	34.7%	46.5	30.2%	38.0	24.6%
Total	**84.0**	**100.0 %**	**102.0**	**100.0 %**	**124.0**	**100.0 %**	**154.2**	**100.0 %**	**154.3**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.26: Proportional contribution of top 5 universities to doctoral dissertations in Psychology, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	Count	%	Count	%	Count	%	Count	%	Count	%
UNISA	21	22.1%	24	22.2%	24	20.3%	23	14.8%	8	6.5%
UP	14	14.7%	17	15.7%	15	12.7%	23	14.8%	23	18.7%
UFS	11	11.6%	22	20.4%	11	9.3%	16	10.3%	24	19.5%
UJ	11	11.6%	9	8.3%	21	17.8%	22	14.2%	11	8.9%
NWU	2	2.1%	5	4.6%	5	4.2%	12	7.7%	17	13.8%
OTHER	36	37.9%	31	28.7%	42	35.6%	59	38.1%	40	32.5%
Total	**95**	**100.0 %**	**108**	**100.0 %**	**118**	**100.0 %**	**155**	**100.0 %**	**123**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.13 Sociology & related studies

Figure 8.18: Share of doctoral dissertations in Sociology & Related Studies, by year period and data source

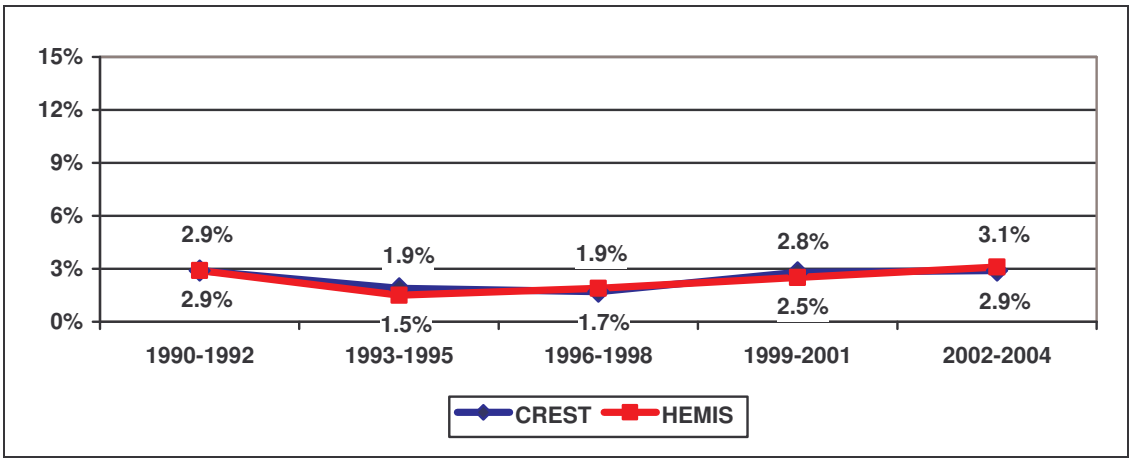


Table 8.27: Race-by-gender profile of doctoral dissertations in Sociology & Related Studies, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	Count	%	Count	%	Count	%	Count	%	Count	%
African women	1.0	1.8%	0.0	0.0%	2.0	5.0%	5.0	8.5%	8.0	8.5%
African men	4.0	7.3%	2.0	6.3%	6.0	15.0%	7.0	11.9%	22.5	23.9%
Coloured women	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.0	1.7%	1.0	1.1%
Coloured men	0.0	0.0%	2.0	6.3%	1.0	2.5%	1.0	1.7%	1.0	1.1%
Indian women	0.0	0.0%	2.0	6.3%	2.0	5.0%	3.0	5.1%	4.5	4.8%
Indian men	1.0	1.8%	0.0	0.0%	0.0	0.0%	2.0	3.4%	3.0	3.2%
White women	21.0	38.5%	12.0	37.5%	15.0	37.5%	21.0	35.6%	26.0	27.7%
White men	27.5	50.5%	14.0	43.8%	14.0	35.0%	19.0	32.2%	28.0	29.8%
Total	**54.5**	**100.0 %**	**32.0**	**100.0 %**	**40.0**	**100.0 %**	**59.0**	**100.0 %**	**94.0**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.28: Proportional contribution of top 5 universities to doctoral dissertations in Sociology & Related Studies, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	Count	%	Count	%	Count	%	Count	%	Count	%
UNISA	14	23.7%	8	20.0%	5	15.2%	12	17.1%	11	14.3%
UKZN	3	5.1%	5	12.5%	3	9.1%	9	12.9%	11	14.3%
UP	12	20.3%	3	7.5%	3	9.1%	11	15.7%	2	2.6%
NWU	7	11.9%	7	17.5%	1	3.0%	5	7.1%	9	11.7%
WITS	3	5.1%	3	7.5%	6	18.2%	7	10.0%	9	11.7%
OTHER	20	33.9%	14	35.0%	15	45.5%	26	37.1%	35	45.5%
Total	**59**	**100.0 %**	**40**	**100.0 %**	**33**	**100.0 %**	**70**	**100.0 %**	**77**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.14 Other social sciences

Figure 8.19: Share of doctoral dissertations in Other Social Sciences, by year period and data source

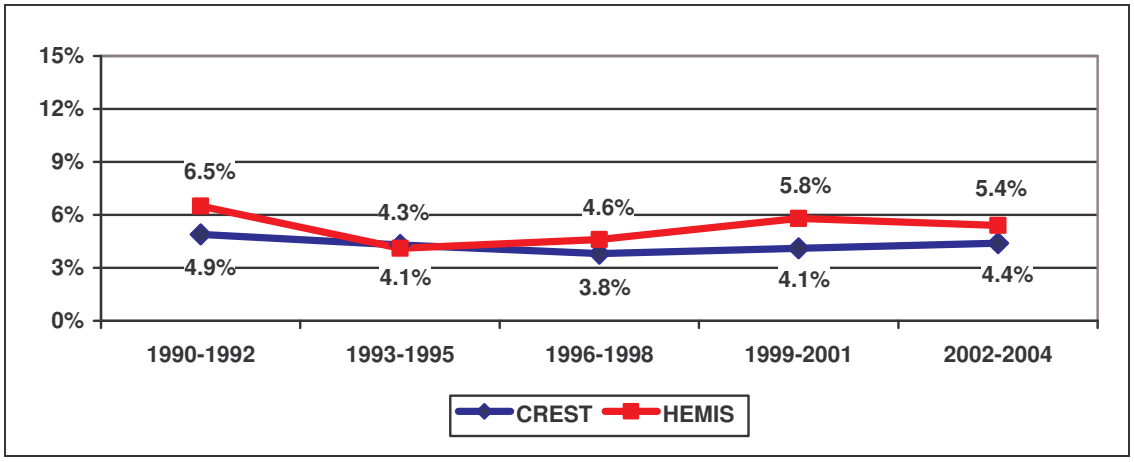


Table 8.29: Race-by-gender profile of doctoral dissertations in Other Social Sciences, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	1.0	0.8%	1.0	1.2%	6.0	6.3%	9.0	6.7%	13.5	8.2%
African men	4.0	3.2%	1.0	1.2%	9.0	9.4%	15.8	11.7%	29.8	18.1%
Coloured women	0.0	0.0%	1.0	1.2%	1.0	1.0%	0.0	0.0%	4.0	2.4%
Coloured men	3.0	2.4%	0.0	0.0%	1.0	1.0%	1.0	0.7%	2.0	1.2%
Indian women	1.0	0.8%	1.7	2.0%	2.0	2.1%	0.5	0.4%	4.0	2.4%
Indian men	7.0	5.6%	1.0	1.2%	0.0	0.0%	2.5	1.9%	8.0	4.9%
White women	56.0	45.0%	47.0	55.5%	41.0	42.7%	50.3	37.4%	64.5	39.1%
White men	52.5	42.2%	32.0	37.8%	35.9	37.4%	55.3	41.2%	39.0	23.7%
Total	**124.5**	**100.0 %**	**84.6**	**100.0 %**	**95.8**	**100.0 %**	**134.3**	**100.0 %**	**164.8**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.30: Proportional contribution of top 5 universities to doctoral dissertations in Other Social Sciences, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	Count	%	Count	%	Count	%	Count	%	Count	%
UP	16	15.8%	15	16.5%	14	18.7%	18	17.6%	39	33.1%
UNISA	16	15.8%	15	16.5%	13	17.3%	10	9.8%	12	10.2%
UFS	16	15.8%	12	13.2%	4	5.3%	7	6.9%	9	7.6%
UJ	12	11.9%	9	9.9%	7	9.3%	12	11.8%	3	2.5%
SU	9	8.9%	6	6.6%	10	13.3%	6	5.9%	9	7.6%
OTHER	32	31.7%	34	37.4%	27	36.0%	49	48.0%	46	39.0%
Total	**101**	**100.0 %**	**91**	**100.0 %**	**75**	**100.0 %**	**102**	**100.0 %**	**118**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.15 Language & linguistics

Figure 8.20: Share of doctoral dissertations in Language & Linguistics, by year period and data source

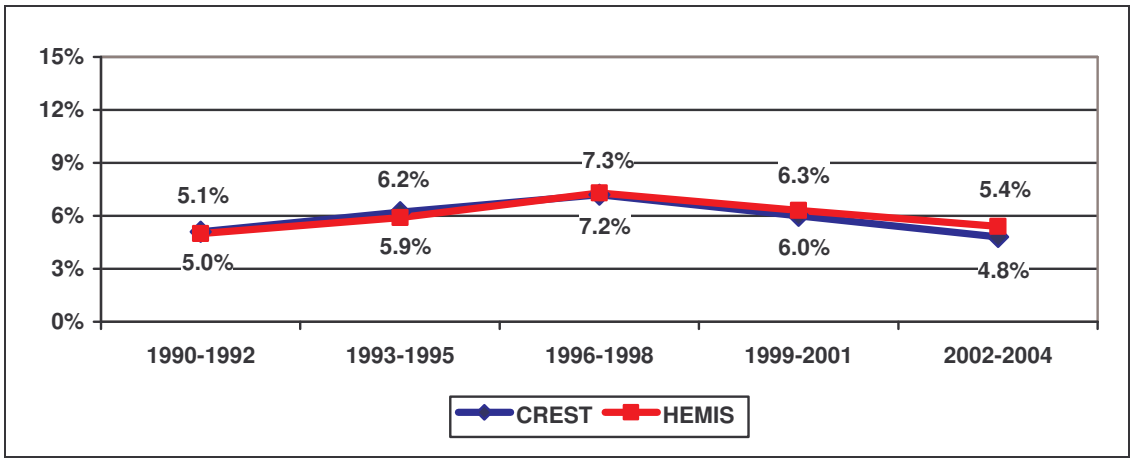


Table 8.31: Race-by-gender profile of doctoral dissertations in Language & Linguistics, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	1	1.1%	4	3.3%	8.0	5.3%	10.0	6.9%	21.0	12.8%
African men	6	6.3%	11	8.9%	25.0	16.6%	37.0	25.4%	40.0	24.5%
Coloured women	0	0.0%	0	0.0%	2.0	1.3%	1.0	0.7%	0.0	0.0%
Coloured men	0	0.0%	2	1.6%	1.0	0.7%	4.0	2.7%	3.0	1.8%
Indian women	1	1.1%	2	1.6%	3.0	2.0%	4.0	2.7%	5.5	3.4%
Indian men	0	0.0%	2	1.6%	1.0	0.7%	0.0	0.0%	6.0	3.7%
White women	45	47.4%	55.5	45.1%	68.2	45.4%	62.0	42.6%	50.0	30.6%
White men	42	44.2%	46.5	37.8%	42.0	28.0%	27.5	18.9%	38.0	23.2%
Total	**95**	**100.0 %**	**123**	**100.0 %**	**150.2**	**100.0 %**	**145.5**	**100.0 %**	**163.5**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.32: Proportional contribution of top 5 universities to doctoral dissertations in Language & Linguistics, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
UNISA	26	25.0%	39	29.5%	18	12.8%	28	19.0%	11	8.6%
UCT	8	7.7%	21	15.9%	17	12.1%	25	17.0%	18	14.1%
NWU	13	12.5%	14	10.6%	12	8.5%	15	10.2%	10	7.8%
SU	11	10.6%	6	4.5%	14	9.9%	13	8.8%	16	12.5%
UKZN	9	8.7%	12	9.1%	17	12.1%	13	8.8%	5	3.9%
OTHER	37	35.6%	40	30.3%	63	44.7%	53	36.1%	68	53.1%
Total	**104**	**100.0 %**	**132**	**100.0 %**	**141**	**100.0 %**	**147**	**100.0 %**	**128**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.16 Law

Figure 8.21: Share of doctoral dissertations in Law, by year period and data source

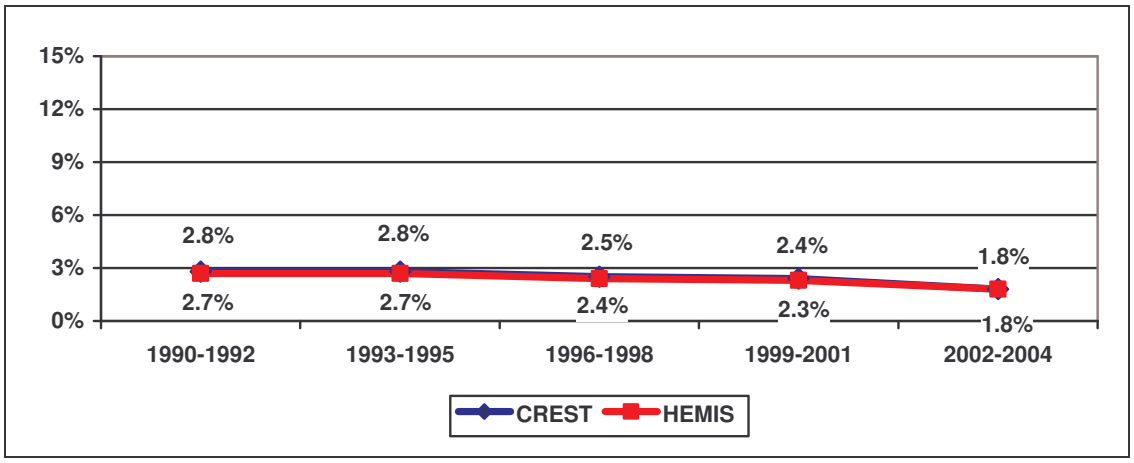


Table 8.33: Race-by-gender profile of doctoral dissertations in Law, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	0.0	0.0%	0.0	0.0%	0.0	0.0%	2.0	3.7%	2.0	3.7%
African men	1.0	2.0%	5.0	9.1%	4.0	8.2%	7.0	13.0%	10.0	18.5%
Coloured women	0.0	0.0%	0.0	0.0%	1.0	2.0%	1.0	1.9%	1.0	1.9%
Coloured men	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.0	1.9%	0.0	0.0%
Indian women	0.0	0.0%	0.0	0.0%	1.0	2.0%	0.0	0.0%	1.0	1.9%
Indian men	1.0	2.0%	0.0	0.0%	0.0	0.0%	1.0	1.9%	1.0	1.9%
White women	13.0	25.5%	16.0	29.1%	18.0	36.7%	17.0	31.5%	19.0	35.2%
White men	36.0	70.6%	34.0	61.8%	25.0	51.0%	25.0	46.3%	20.0	37.0%
Total	**51.0**	**100.0 %**	**55.0**	**100.0 %**	**49.0**	**100.0 %**	**54.0**	**100.0 %**	**54.0**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.34: Proportional contribution of top 5 universities to doctoral dissertations in Law, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	Count	%	Count	%	Count	%	Count	%	Count	%
UNISA	19	32.8%	19	31.7%	18	36.7%	13	22.4%	9	18.4%
UP	10	17.2%	15	25.0%	7	14.3%	6	10.3%	13	26.5%
SU	6	10.3%	4	6.7%	6	12.2%	7	12.1%	2	4.1%
UCT	7	12.1%	3	5.0%	2	4.1%	5	8.6%	4	8.2%
UJ	2	3.4%	6	10.0%	2	4.1%	6	10.3%	3	6.1%
OTHER	14	24.1%	13	21.7%	14	28.6%	21	36.2%	18	36.7%
Total	**58**	**100.0 %**	**60**	**100.0 %**	**49**	**100.0 %**	**58**	**100.0 %**	**49**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.17 Religion

Figure 8.22: Share of doctoral dissertations in Religion, by year period and data source

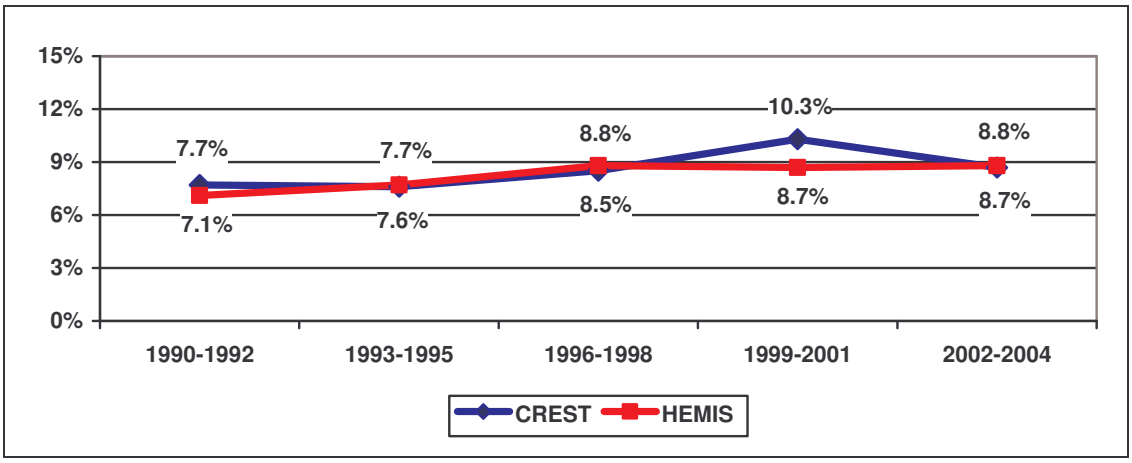


Table 8.35: Race-by-gender profile of doctoral dissertations in Religion, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	1.0	0.7%	0.0	0.0%	1.0	0.5%	1.0	0.5%	4.0	1.5%
African men	10.0	7.4%	8.0	5.0%	15.0	8.2%	30.0	14.9%	52.0	19.4%
Coloured women	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.0	0.5%	3.0	1.1%
Coloured men	3.0	2.2%	5.0	3.1%	6.0	3.3%	15.0	7.5%	12.0	4.5%
Indian women	1.0	0.7%	2.0	1.2%	1.7	0.9%	2.0	1.0%	5.0	1.9%
Indian men	2.0	1.5%	5.0	3.1%	9.0	4.9%	13.0	6.5%	22.0	8.2%
White women	7.0	5.2%	11.0	6.9%	13.3	7.3%	13.0	6.5%	21.5	8.0%
White men	110.5	82.1%	129.4	80.7%	136.1	74.7%	126.0	62.7%	149.0	55.5%
Total	**134.5**	**100.0 %**	**160.4**	**100.0 %**	**182.1**	**100.0 %**	**201.0**	**100.0 %**	**268.5**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.36: Proportional contribution of top 5 universities to doctoral dissertations in Religion, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
UNISA	52	33.1%	47	29.2%	51	30.4%	71	27.8%	45	19.4%
UP	23	14.6%	32	19.9%	38	22.6%	50	19.6%	56	24.1%
SU	29	18.5%	31	19.3%	31	18.5%	36	14.1%	31	13.4%
NWU	9	5.7%	12	7.5%	8	4.8%	27	10.6%	43	18.5%
UKZN	11	7.0%	14	8.7%	12	7.1%	14	5.5%	16	6.9%
OTHER	33	21.0%	25	15.5%	28	16.7%	57	22.4%	41	17.7%
Total	**157**	**100.0 %**	**161**	**100.0 %**	**168**	**100.0 %**	**255**	**100.0 %**	**232**	**100.0 %**

Source: CREST dataset of doctoral dissertations

8.3.18 Other humanities & arts

Figure 8.23: Share of doctoral dissertations in Other Humanities & Arts, by year period and data source

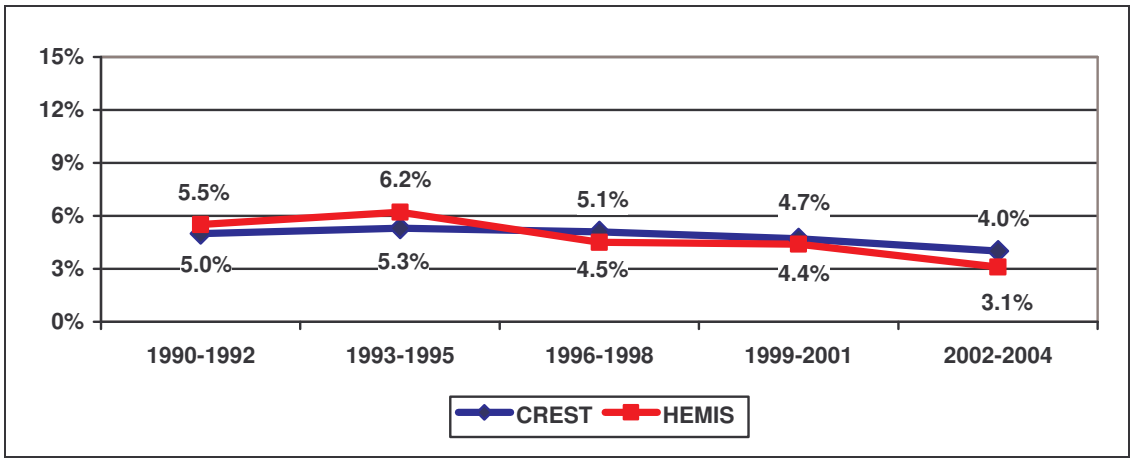


Table 8.37: Race-by-gender profile of doctoral dissertations in Other Humanities & Arts, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
Race x gender	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
African women	0.0	0.0%	0.0	0.0%	0.0	0.0%	2.0	2.0%	2.0	2.1%
African men	4.0	3.8%	5.0	3.9%	4.0	4.3%	14.3	13.9%	18.0	18.8%
Coloured women	0.0	0.0%	0.0	0.0%	1.0	1.1%	0.0	0.0%	3.0	3.1%
Coloured men	2.0	1.9%	3.0	2.4%	7.0	7.6%	3.5	3.4%	2.0	2.1%
Indian women	0.0	0.0%	0.3	0.3%	0.0	0.0%	2.5	2.4%	2.0	2.1%
Indian men	6.0	5.8%	0.0	0.0%	1.0	1.1%	3.5	3.4%	3.0	3.1%
White women	29.0	27.9%	48.0	37.7%	35.5	38.4%	30.3	29.6%	33.5	34.9%
White men	63.0	60.6%	71.1	55.8%	44.0	47.5%	46.3	45.2%	32.5	33.9%
Total	**104.0**	**100.0 %**	**127.4**	**100.0 %**	**92.5**	**100.0 %**	**102.3**	**100.0 %**	**96.0**	**100.0 %**

Source: HEMIS dataset of doctoral graduates

Table 8.38: Proportional contribution of top 5 universities to doctoral dissertations in Other Humanities & Arts, by year period

	1990-1992		1993-1995		1996-1998		1999-2001		2002-2004	
University	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
SU	15	14.7%	21	18.6%	10	10.0%	20	17.2%	17	15.9%
UCT	16	15.7%	13	11.5%	16	16.0%	13	11.2%	15	14.0%
UP	7	6.9%	13	11.5%	11	11.0%	16	13.8%	24	22.4%
UKZN	15	14.7%	14	12.4%	14	14.0%	18	15.5%	8	7.5%
UNISA	13	12.7%	13	11.5%	10	10.0%	14	12.1%	9	8.4%
OTHER	36	35.3%	39	34.5%	39	39.0%	35	30.2%	34	31.8%
Total	**102**	**100.0 %**	**113**	**100.0 %**	**100**	**100.0 %**	**116**	**100.0 %**	**107**	**100.0 %**

Source: CREST dataset of doctoral dissertations

CHAPTER 9
PROFILE OF SCIENTIFIC COLLABORATION

9.1 INTRODUCTION

One of the effects of apartheid has been to isolate South African science in various ways: lack of contact with visiting scientists and scholars, lack of access to key materials and books in the humanities and social sciences and lack of collaboration in scientific endeavours. We have previously referred to this as an "isolationist scientific culture". With the advent of democracy in 1994, science was set to open up with a concomitant increase in scientific collaboration.

Scientific collaboration takes various forms. In this analysis we use one measure only – the extent of c-authorship with non-South African authors. Our main intent was to investigate whether there has been a significant increase in the degree to which South African authors co-author with one or more foreign authors and how this differs for different scientific fields.

As our findings show, it is not always easy or even possible to establish the country or institutional affiliation of different authors of an article. This explains why there are still significant proportions of foreign affiliations that remain unknown.

The main findings from our analyses are the following:

- All fields of science have witnessed significant (three- or fourfold) increases in foreign collaboration over the past fifteen years.
- Scientific co-authorship patterns vary across scientific field as one would expect with the highest foreign co-authorship in the field of physics and the lowest in humanities.
- The largest (threefold or more) increases occurred in agriculture, biological sciences, chemical sciences, earth sciences, all the health sciences, psychology, sociology and other social sciences and also language and linguistics.
- Foreign co-authorship is dominated in most field by collaboration with American and British authors, but also with significant co0authors from Germany, the Netherlands, France, other European countries and Australia.

9.2 COLLABORATION BY SCIENTIFIC FIELD

9.2.1 Agricultural sciences

Table 9.1: Distribution of foreign co-authorship by three year intervals for Agriculture

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	1793.27	96.3%	68.89	3.7%	1862.17
1993-1995	1699.50	95.0%	89.17	5.0%	1788.67
1996-1998	1661.98	91.9%	145.81	8.1%	1807.78
1999-2001	1700.53	88.0%	231.77	12.0%	1932.30
2002-2004	1563.67	83.6%	307.00	16.4%	1870.67
Total	**8418.95**	**90.9%**	**842.64**	**9.1%**	**9261.59**

Table 9.2: List of countries co-authoring in the field of Agriculture

Country	USA	United Kingdom	Australia	France	Germany	Canada	Kenya	Italy	Israel	Belgium	Other	Unknown	Total
Equivalents	35.04	34.66	14.81	10.1	8.85	7.79	6.68	5.81	5.79	4.63	66.99	641.51	**842.64**
%	4.20%	4.10%	1.80%	1.20%	1.10%	0.90%	0.80%	0.70%	0.70%	0.50%	7.90%	76.10%	**100.00%**

9.2.2 Biological sciences

Table 9.3: Distribution of foreign co-authorship by three year intervals for the Biological sciences

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	1296.02	92.5%	105.50	7.5%	1401.52
1993-1995	1389.36	91.3%	132.56	8.7%	1521.91
1996-1998	1322.84	86.0%	214.92	14.0%	1537.76
1999-2001	1552.97	79.9%	389.49	20.1%	1942.47
2002-2004	1442.62	74.4%	495.58	25.6%	1938.20
Total	**7003.81**	**84.0%**	**1338.05**	**16.0%**	**8341.86**

Table 9.4: List of countries co-authoring in the field of the Biological sciences

Country	USA	United Kingdom	Germany	Australia	France	Canada	Japan	Belgium	The Netherlands	Spain	Other	Unknown	Total
Equivalents	72.93	49.06	37.42	15.67	14.01	12.31	11.1	10.54	7.06	6.68	60.16	1041.1	**1338.05**
%	5.50%	3.70%	2.80%	1.20%	1.00%	0.90%	0.80%	0.80%	0.50%	0.50%	4.50%	77.80%	**100.00%**

9.2.3 Chemical sciences

Table 9.5: Distribution of foreign co-authorship by three year intervals for Chemical sciences

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	666.78	94.6%	38.00	5.4%	704.78
1993-1995	709.40	91.0%	69.79	9.0%	779.19
1996-1998	678.26	87.3%	98.45	12.7%	776.71
1999-2001	759.61	85.1%	133.18	14.9%	892.79
2002-2004	801.22	81.7%	179.27	18.3%	980.49
Total	**3615.26**	**87.5%**	**518.69**	**12.5%**	**4133.96**

Table 9.6: List of countries co-authoring in the field of Chemical sciences

Country	USA	Germany	United Kingdom	Japan	Italy	The Netherlands	Israel	Russia	France	Belgium	Other	Unknown	Total
Equivalents	22.82	21.8	11.36	10.04	7.44	5.25	5.19	4.65	4.26	3.74	25.25	396.9	**518.69**
%	4.40%	4.20%	2.20%	1.90%	1.40%	1.00%	1.00%	0.90%	0.80%	0.70%	4.90%	76.50%	**100.00%**

9.2.4 Earth sciences

Table 9.7: Distribution of foreign co-authorship by three year intervals for Earth sciences

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	1335.18	93.0%	100.30	7.0%	1435.47
1993-1995	1337.44	92.0%	115.62	8.0%	1453.06
1996-1998	1327.76	87.1%	196.77	12.9%	1524.53
1999-2001	1420.30	82.1%	309.16	17.9%	1729.46
2002-2004	1417.87	75.8%	452.99	24.2%	1870.86
Total	**6838.54**	**85.3%**	**1174.83**	**14.7%**	**8013.38**

Table 9.8: List of countries co-authoring in the field of Earth sciences

Country	USA	United Kingdom	Germany	Australia	France	Canada	The Netherlands	Israel	Russia	Austria	Other	Unknown	Total
Equivalents	50.26	36.65	27.35	19.35	18.16	12.91	6.11	5.5	5.39	5.2	60.33	927.63	**1174.83**
%	4.30%	3.10%	2.30%	1.60%	1.50%	1.10%	0.50%	0.50%	0.50%	0.40%	5.10%	79.00%	**100.00%**

9.2.5 Mathematical sciences & ICCT

Table 9.9: Distribution of foreign co-authorship by three year intervals for Mathematical sciences and ICCT

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	367.67	91.8%	32.83	8.2%	400.50
1993-1995	385.49	85.9%	63.15	14.1%	448.64
1996-1998	406.02	84.5%	74.27	15.5%	480.28
1999-2001	529.53	83.5%	104.94	16.5%	634.47
2002-2004	497.35	78.9%	132.81	21.1%	630.17
Total	**2186.05**	**84.3%**	**408.01**	**15.7%**	**2594.06**

Table 9.10: List of countries co-authoring in the field of Mathematical sciences and ICCT

Country	USA	Germany	Israel	Italy	The Netherlands	Australia	India	France	Hungary	Finland	Other	Unknown	Total
Equivalents	20.99	5.53	5.5	5.28	4.67	4	3.83	3.62	2.67	2.5	22.04	327.38	**408.01**
%	5.10%	1.40%	1.30%	1.30%	1.10%	1.00%	0.90%	0.90%	0.70%	0.60%	5.40%	80.20%	**100.00%**

9.2.6 Physical sciences

Table 9.11: Distribution of foreign co-authorship by three year intervals for Physical sciences

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	691.83	83.9%	133.11	16.1%	824.93
1993-1995	886.01	82.2%	191.40	17.8%	1077.41
1996-1998	711.77	71.5%	284.21	28.5%	995.98
1999-2001	769.29	69.7%	334.43	30.3%	1103.72
2002-2004	712.59	69.6%	310.57	30.4%	1023.16
Total	**3771.48**	**75.1%**	**1253.72**	**24.9%**	**5025.20**

Table 9.12: List of countries co-authoring in the field of Physical sciences

Country	USA	Germany	United Kingdom	Australia	France	Russia	Japan	Italy	Poland	Belgium	Other	Unknown	Total
Equivalents	78.54	70.29	35.89	23.87	17.95	15.52	15.38	14.3	13.32	11.62	102.23	854.8	**1253.72**
%	6.30%	5.60%	2.90%	1.90%	1.40%	1.20%	1.20%	1.10%	1.10%	0.90%	8.20%	68.20%	**100.00%**

9.2.7 Multidisciplinary sciences

Table 9.13: Distribution of foreign co-authorship by three year intervals for Multidisciplinary sciences

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	500.20	95.8%	21.83	4.2%	522.03
1993-1995	486.91	94.5%	28.37	5.5%	515.28
1996-1998	475.41	87.1%	70.35	12.9%	545.77
1999-2001	486.39	85.5%	82.36	14.5%	568.75
2002-2004	322.63	84.2%	60.50	15.8%	383.13
Total	**2271.54**	**89.6%**	**263.41**	**10.4%**	**2534.95**

Table 9.14: List of countries co-authoring in the field of Multidisciplinary sciences

Country	United Kingdom	USA	France	Australia	Germany	Russia	Canada	Kenya	Switzerland	Japan	Other	Unknown	**Total**
Equivalents	13.53	12.51	10.38	6.79	3.54	2.47	1.5	1.25	1.24	1.08	8.2	200.92	**263.41**
%	5.10%	4.80%	3.90%	2.60%	1.30%	0.90%	0.60%	0.50%	0.50%	0.40%	3.10%	76.30%	**100.00%**

9.2.8 Engineering & applied technologies

Table 9.15: Distribution of foreign co-authorship by three year intervals for Engineering and Applied Technologies

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	1029.12	93.8%	67.60	6.2%	1096.73
1993-1995	1250.56	93.6%	85.23	6.4%	1335.79
1996-1998	1250.65	90.5%	131.28	9.5%	1381.93
1999-2001	1417.40	88.3%	187.41	11.7%	1604.81
2002-2004	1411.72	85.6%	237.23	14.4%	1648.95
Total	**6359.45**	**90.0%**	**708.76**	**10.0%**	**7068.20**

Table 9.16: List of countries co-authoring in the field of Engineering and Applied Technologies

Country	USA	Germany	United Kingdom	Australia	France	Russia	Israel	Japan	Poland	Belgium	Other	Unknown	Total
Equivalents	35.68	21.87	15.81	10.18	9.18	6.59	5.93	5.86	5.68	5.45	50.03	536.5	**708.76**
%	5.00%	3.10%	2.20%	1.40%	1.30%	0.90%	0.80%	0.80%	0.80%	0.80%	7.10%	75.70%	**100.00%**

9.2.9 Basic health

Table 9.17: Distribution of foreign co-authorship by three year intervals for Basic Health sciences

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	1150.99	92.9%	88.12	7.1%	1239.11
1993-1995	1186.34	90.7%	121.79	9.3%	1308.13
1996-1998	1261.76	88.0%	172.40	12.0%	1434.17
1999-2001	1397.24	80.9%	329.62	19.1%	1726.87
2002-2004	1114.68	74.5%	380.96	25.5%	1495.64
Total	**6111.02**	**84.8%**	**1092.89**	**15.2%**	**7203.91**

Table 9.18: List of countries co-authoring in the field of Basic Health sciences

Country	USA	United Kingdom	Germany	France	Belgium	Australia	Italy	Japan	Canada	The Netherlands	Other	Unknown	Total
Equivalents	75.74	46.2	21.9	11.42	11.3	10.75	9.75	8.99	8.24	6.37	67.02	815.23	**1092.89**
%	6.90%	4.20%	2.00%	1.00%	1.00%	1.00%	0.90%	0.80%	0.80%	0.60%	6.10%	74.60%	**100.00%**

9.2.10 Clinical health

Table 9.19: Distribution of foreign co-authorship by three year intervals for Clinical Health sciences

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	2445.51	95.9%	105.24	4.1%	2550.75
1993-1995	2391.25	94.0%	151.43	6.0%	2542.67
1996-1998	2476.62	91.1%	241.33	8.9%	2717.95
1999-2001	2836.32	85.7%	473.13	14.3%	3309.45
2002-2004	2271.63	81.3%	522.32	18.7%	2793.95
Total	**12421.33**	**89.3%**	**1493.44**	**10.7%**	**13914.77**

Table 9.20: List of countries co-authoring in the field of Clinical Health sciences

Country	USA	United Kingdom	Belgium	Canada	Germany	Australia	Switzerland	France	The Netherlands	Austria	Other	Unknown	Total
Equivalents	100.55	66.74	18.45	15.22	14.8	14.68	12.17	10.75	9.65	7.65	87.1	1135.68	**1493.44**
%	6.70%	4.50%	1.20%	1.00%	1.00%	1.00%	0.80%	0.70%	0.60%	0.50%	5.80%	76.00%	**100.00%**

9.2.11 Public & community health

Table 9.21: Distribution of foreign co-authorship by three year intervals for Public and Community Health sciences

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	498.76	96.8%	16.46	3.2%	515.21
1993-1995	343.07	95.0%	18.02	5.0%	361.09
1996-1998	462.17	89.8%	52.35	10.2%	514.51
1999-2001	669.25	90.0%	74.28	10.0%	743.53
2002-2004	453.13	80.9%	107.32	19.1%	560.45
Total	**2426.37**	**90.0%**	**268.42**	**10.0%**	**2694.80**

Table 9.22: List of countries co-authoring in the field of Public and Community Health sciences

Country	United Kingdom	USA	Kenya	Canada	Zambia	Nigeria	The Netherlands	Switzerland	France	Belgium	Other	Unknown	Total
Equivalents	17.62	14.45	2.17	2	1.87	1.85	1.8	1.8	1.2	1.13	11.83	210.7	**268.42**
%	6.60%	5.40%	0.80%	0.70%	0.70%	0.70%	0.70%	0.70%	0.40%	0.40%	4.40%	78.50%	**100.00%**

9.2.12 Economics & management sciences

Table 9.23: Distribution of foreign co-authorship by three year intervals for Economics and Management sciences

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	342.83	96.9%	10.83	3.1%	353.67
1993-1995	465.67	98.1%	8.92	1.9%	474.59
1996-1998	470.78	96.2%	18.80	3.8%	489.58
1999-2001	471.22	93.2%	34.39	6.8%	505.61
2002-2004	509.77	91.3%	48.39	8.7%	558.16
Total	**2260.27**	**94.9%**	**121.33**	**5.1%**	**2381.60**

Table 9.24: List of countries co-authoring in the field of Economics and Management sciences

Country	United Kingdom	USA	The Netherlands	Australia	Ghana	Canada	Indonesia	New Zealand	Norway	Singapore	Other	Unknown	Total
Equivalents	15.33	5.28	2.08	1.2	1	0.87	0.75	0.5	0.5	0.5	1	92.32	**121.33**
%	12.60%	4.40%	1.70%	1.00%	0.80%	0.70%	0.60%	0.40%	0.40%	0.40%	0.80%	76.10%	**100.00%**

9.2.13 Education

Table 9.25: Distribution of foreign co-authorship by three year intervals for Education

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	413.17	98.6%	5.75	1.4%	418.92
1993-1995	431.92	96.8%	14.15	3.2%	446.07
1996-1998	469.78	96.4%	17.68	3.6%	487.46
1999-2001	613.18	97.0%	18.67	3.0%	631.85
2002-2004	642.24	95.7%	29.14	4.3%	671.38
Total	**2570.29**	**96.8%**	**85.39**	**3.2%**	**2655.68**

Table 9.26: List of countries co-authoring in the field of Education

Country	USA	The Netherlands	United Kingdom	Canada	Nigeria	Hong Kong	Australia	Ghana	Singapore	Unknown	Total
Equivalents	3.55	2.42	2.17	1.25	0.5	0.33	0.25	0.14	0.11	74.66	**85.39**
%	4.20%	2.80%	2.50%	1.50%	0.60%	0.40%	0.30%	0.20%	0.10%	87.40%	**100.00%**

9.2.14 Psychology

Table 9.27: Distribution of foreign co-authorship by three year intervals for Psychology

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	324.75	97.0%	9.92	3.0%	334.67
1993-1995	300.45	95.4%	14.65	4.6%	315.10
1996-1998	433.64	93.8%	28.87	6.2%	462.51
1999-2001	331.90	89.1%	40.50	10.9%	372.40
2002-2004	357.08	82.9%	73.81	17.1%	430.89
Total	**1747.82**	**91.2%**	**167.74**	**8.8%**	**1915.57**

Table 9.28: List of countries co-authoring in the field of Psychology

Country	USA	United Kingdom	Australia	Germany	Canada	China	The Netherlands	Israel	NIGERIA	Cameroon	Other	Unknown	Total
Equivalents	13.08	8.59	4.01	3.12	2.22	2.01	1.51	1.31	0.71	0.5	4.16	126.52	**167.74**
%	7.80%	5.10%	2.40%	1.90%	1.30%	1.20%	0.90%	0.80%	0.40%	0.30%	2.50%	75.40%	**100.00%**

9.2.15 Sociology & related studies

Table 9.29: Distribution of foreign co-authorship by three year intervals for Sociology and related studies

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	664.03	97.2%	18.90	2.8%	682.93
1993-1995	787.42	96.9%	25.13	3.1%	812.55
1996-1998	713.43	96.3%	27.32	3.7%	740.74
1999-2001	672.81	93.8%	44.53	6.2%	717.33
2002-2004	794.83	90.0%	88.26	10.0%	883.09
Total	**3632.52**	**94.7%**	**204.13**	**5.3%**	**3836.65**

Table 9.30: List of countries co-authoring in the field of Sociology and related studies

Country	USA	Canada	United Kingdom	Australia	Germany	Sweden	Swaziland	Belgium	India	Zambia	Other	Unknown	Total
Equivalents	20.77	4.7	3.73	1.48	0.73	0.5	0.5	0.5	0.33	0.25	0.51	170.14	**204.13**
%	10.20%	2.30%	1.80%	0.70%	0.40%	0.20%	0.20%	0.20%	0.20%	0.10%	0.20%	83.30%	**100.00%**

9.2.16 Other social sciences

Table 9.31: Distribution of foreign co-authorship by three year intervals for Other Social sciences

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	1618.65	97.0%	50.72	3.0%	1669.37
1993-1995	1796.10	95.6%	82.68	4.4%	1878.79
1996-1998	1801.93	94.0%	114.75	6.0%	1916.68
1999-2001	1812.28	92.4%	149.76	7.6%	1962.05
2002-2004	1844.97	89.2%	223.71	10.8%	2068.68
Total	**8873.94**	**93.5%**	**621.63**	**6.5%**	**9495.57**

Table 9.32: List of countries co-authoring in the field of Other Social sciences

Country	USA	United Kingdom	Canada	Germany	Swaziland	Australia	The Netherlands	Zimbabwe	New Zealand	Namibia	Other	Unknown	Total
Equivalents	25.62	16.9	8.26	5.15	4.33	4.1	3.6	3.28	3.08	2.25	19.75	525.3	**621.63**
%	4.10%	2.70%	1.30%	0.80%	0.70%	0.70%	0.60%	0.50%	0.50%	0.40%	3.20%	84.50%	**100.00%**

9.2.17 Language & linguistics

Table 9.33: Distribution of foreign co-authorship by three year intervals for Language and Linguistics

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	670.50	99.8%	1.50	0.2%	672.00
1993-1995	716.67	99.4%	4.50	0.6%	721.17
1996-1998	773.33	99.0%	7.50	1.0%	780.83
1999-2001	690.50	98.3%	12.00	1.7%	702.50
2002-2004	660.92	97.1%	19.83	2.9%	680.75
Total	**3511.92**	**98.7%**	**45.33**	**1.3%**	**3557.25**

Table 9.34: List of countries co-authoring in the field of Language and Linguistics

Country	Equivalents	%
USA	1.50	3.31%
United Kingdom	1.00	2.21%
Unknown	42.83	94.49%
Total	**45.33**	**100.00%**

9.2.18 Law

Table 9.35: Distribution of foreign co-authorship by three year intervals for Law

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	1076.33	98.1%	20.83	1.9%	1097.17
1993-1995	1191.50	97.8%	27.00	2.2%	1218.50
1996-1998	1071.17	98.6%	15.03	1.4%	1086.20
1999-2001	1084.50	99.3%	7.67	0.7%	1092.17
2002-2004	793.89	97.4%	21.13	2.6%	815.02
Total	**5217.39**	**98.3%**	**91.66**	**1.7%**	**5309.06**

Table 9.36: List of countries co-authoring in the field of Law

Country	Equivalents	%
Belgium	7.00	7.6%
Swaziland	2.50	2.7%
Canada	1.83	2.0%
USA	1.37	1.5%
United Kingdom	0.83	0.9%
Unknown	78.13	85.2%
Total	**91.66**	**100.0%**

9.2.19 Religion

Table 9.37: Distribution of foreign co-authorship by three year intervals for Religious studies

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	870.30	99.3%	6.00	0.7%	876.30
1993-1995	1039.17	98.3%	18.50	1.7%	1057.67
1996-1998	989.67	98.6%	14.50	1.4%	1004.17
1999-2001	995.33	98.4%	16.00	1.6%	1011.33
2002-2004	1093.08	96.3%	42.00	3.7%	1135.08
Total	**4987.55**	**98.1%**	**97.00**	**1.9%**	**5084.55**

Table 9.38: List of countries co-authoring in the field of Religious studies

Country	Equivalents	%
Malawi	8.00	8.2%
Unknown	89.00	91.8%
Total	**97.00**	**100.0%**

9.2.20 Other humanities & arts

Table 9.39: Distribution of foreign co-authorship by three year intervals for Other Humanities and Arts

Year	SA author article equivalents	SA %	Foreign author article equivalents	Foreign %	Total article equivalents (Unknown excl)
1990-1992	942.47	97.5%	23.70	2.5%	966.17
1993-1995	867.05	98.8%	10.62	1.2%	877.67
1996-1998	870.86	97.7%	20.94	2.3%	891.80
1999-2001	824.61	96.0%	34.64	4.0%	859.25
2002-2004	771.57	93.3%	54.98	6.7%	826.55
Total	**4276.56**	**96.7%**	**144.87**	**3.3%**	**4421.43**

Table 9.40: List of countries co-authoring in the field of Other Humanities and Arts

Country	USA	United Kingdom	Canada	The Netherlands	Senegal	Malawi	Belgium	Australia	Portugal	Germany	Other	Unknown	Total
Equivalents	12	2.95	1.31	1	1	1	0.5	0.5	0.25	0.25	0.33	123.77	**144.87**
%	8.30%	2.00%	0.90%	0.70%	0.70%	0.70%	0.30%	0.30%	0.20%	0.20%	0.20%	85.40%	**100.00%**

CHAPTER 10

PROFILE OF THE VISIBILITY OF SOUTH AFRICAN PUBLIC SCIENCE

10.1 INTRODUCTION

The objective of this chapter is to compare, within each of the 36 top / strategic fields, the citation profile of South Africa to that of 10 benchmarking countries. We present in Section 10.2 the bibliometric indicators for South Africa and the 10 benchmarking countries, as produced by the CWTS. The selection of the benchmarking countries, as well as an explanation of the various bibliometric indicators used, can be found in Chapter 3, Section 3.6.

10.2 NATIONAL BENCHMARKING BY STRATEGIC FIELD

10.2.1 Chemical engineering

Table 10.1: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Chemical Engineering, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	5 530	654	42 094	5.04	7.61	0.98	1.19	34%	32%
Turkey	3 438	2 506	12 666	2.35	3.68	0.96	0.68	36%	48%
Brazil	2 190	1 639	7 391	2.28	3.37	0.80	0.77	32%	50%
Argentina	1 433	499	6 998	3.52	4.88	0.76	0.92	28%	44%
Portugal	1 417	192	7 596	3.77	5.36	0.86	0.95	30%	36%
Egypt	1 153	585	3 555	2.05	3.08	0.68	0.45	34%	46%
Mexico	1 104	1 047	4 679	2.97	4.24	0.80	0.87	30%	48%
Singapore	1 059	58	5 079	3.01	4.80	0.84	1.04	37%	41%
RSA	**980**	**980**	**4 969**	**3.75**	**5.07**	**0.79**	**0.85**	**26%**	**35%**
Chile	497	288	1 920	2.33	3.86	0.74	0.68	40%	45%
Malaysia	394	332	1 264	2.43	3.21	0.95	0.80	24%	53%

10.2.2 Electrical & electronic engineering

Table 10.2: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Electrical & Electronic Engineering, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	6 893	815	27 289	2.58	3.96	0.84	0.83	35%	49%
Singapore	6 418	353	19 167	2.14	2.99	0.78	0.76	28%	53%
Brazil	3 028	2 266	11 352	2.76	3.75	0.84	0.82	26%	51%
Turkey	2 171	1 582	6 987	2.07	3.22	0.78	0.78	36%	59%
Egypt	1 318	668	3 588	1.88	2.72	0.74	0.47	31%	57%
Portugal	1 293	175	4 814	2.53	3.72	0.77	0.79	32%	50%
Mexico	1 236	1 173	4 132	2.28	3.34	0.86	0.82	32%	56%
RSA	**831**	**831**	**2 539**	**2.23**	**3.06**	**0.60**	**0.56**	**27%**	**50%**
Malaysia	466	393	620	0.88	1.33	0.50	0.40	34%	68%
Argentina	379	132	1 310	2.47	3.46	0.78	0.82	28%	51%
Chile	263	152	642	1.89	2.44	0.81	0.85	22%	56%

10.2.3 Materials science

Table 10.3: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Materials Science, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	17 353	2 051	112 241	4.00	6.47	0.76	0.84	38%	37%
Brazil	8 260	6 183	40 154	3.07	4.86	0.83	0.78	37%	43%
Singapore	6 511	358	33 853	3.51	5.20	0.94	0.97	32%	40%
Turkey	6 070	4 424	25 045	2.28	4.13	0.69	0.63	45%	51%
Egypt	4 608	2 337	16 218	2.21	3.52	0.64	0.46	37%	45%
Portugal	4 471	605	22 495	3.09	5.03	0.87	0.86	39%	46%
Mexico	3 828	3 632	16 436	2.90	4.29	0.76	0.71	32%	45%
Argentina	2 676	932	13 704	3.20	5.12	0.72	0.71	37%	40%
RSA	**1 746**	**1 746**	**10 151**	**4.04**	**5.81**	**0.83**	**0.81**	**30%**	**36%**
Malaysia	1 146	966	4 667	2.83	4.07	0.96	0.74	30%	45%
Chile	945	548	5 012	2.68	5.30	0.59	0.52	50%	42%

10.2.4 Mechanical engineering & mechanics

Table 10.4: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Mechanical Engineering & Mechanics, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Singapore	2 725	150	10 861	2.45	3.99	0.89	0.89	39%	45%
Spain	2 576	304	13 566	3.38	5.27	0.93	1.06	36%	46%
Turkey	2 174	1 585	6 287	1.81	2.89	0.86	0.71	37%	52%
Brazil	1 577	1 180	5 645	2.32	3.58	0.86	0.84	35%	49%
Portugal	1 033	140	4 107	2.49	3.98	0.90	0.88	37%	46%
Egypt	1 004	509	2 600	1.65	2.59	0.60	0.47	36%	50%
Argentina	777	271	2 723	2.33	3.50	0.76	0.84	33%	46%
Mexico	759	720	2 799	2.20	3.69	0.64	0.65	40%	49%
RSA	**713**	**713**	**2 712**	**2.54**	**3.80**	**0.77**	**0.75**	**33%**	**45%**
Chile	236	137	924	2.55	3.92	0.79	0.84	35%	44%
Malaysia	211	178	369	1.19	1.75	0.72	0.61	32%	58%

10.2.5 Metallurgy & metallurgical engineering

Table 10.5: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Metallurgy & Metallurgical Engineering, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	2 134	252	11 722	3.29	5.49	0.87	0.99	40%	42%
Brazil	1 010	756	3 693	2.07	3.66	0.66	0.67	43%	48%
RSA	**901**	**901**	**2 325**	**1.99**	**2.58**	**0.82**	**0.69**	**23%**	**56%**
Egypt	686	348	2 283	2.24	3.33	0.91	0.74	33%	48%
Argentina	590	206	3 704	3.81	6.28	0.81	1.04	39%	39%
Mexico	581	551	2 081	2.21	3.58	0.69	0.75	38%	48%
Turkey	570	415	1 355	1.51	2.38	0.62	0.66	37%	57%
Singapore	448	25	2 220	3.49	4.96	1.01	1.25	30%	43%
Portugal	311	42	1 265	2.73	4.07	0.76	0.86	33%	41%
Chile	210	122	586	1.78	2.79	0.87	0.68	36%	56%
Malaysia	37	31	111	1.89	3.00	0.88	0.61	37%	43%

10.2.6 General & internal medicine

Table 10.6: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in General & Internal Medicine, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	33 037	3 904	299 016	7.48	9.05	1.05	0.70	17%	36%
Turkey	7 883	5 746	27 165	2.96	3.45	0.83	0.43	14%	47%
RSA	**7 059**	**7 059**	**54 756**	**6.57**	**7.76**	**0.99**	**0.60**	**15%**	**37%**
Brazil	5 862	4 388	62 156	8.69	10.60	0.96	0.88	18%	33%
Argentina	4 842	1 687	48 634	8.20	10.04	1.08	0.62	18%	39%
Chile	4 021	2 330	22 108	4.41	5.50	1.17	0.32	20%	50%
Mexico	3 152	2 991	31 249	7.96	9.91	1.01	0.67	20%	38%
Singapore	2 158	119	19 688	7.80	9.12	1.10	0.86	15%	36%
Portugal	1 660	225	26 222	13.03	15.80	1.30	1.27	18%	26%
Egypt	737	374	5 566	6.35	7.55	0.77	0.64	16%	36%
Malaysia	554	467	4 185	6.65	7.55	0.83	0.69	12%	34%

10.2.7 Genetics & heredity

Table 10.7: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Genetics & Heredity, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	6 112	722	88 341	11.04	14.45	0.82	0.75	24%	18%
Brazil	3 687	2 760	28 428	5.74	7.71	0.83	0.39	26%	38%
Mexico	1 095	1 039	14 217	10.27	12.98	0.85	0.72	21%	20%
Turkey	1 025	747	11 221	8.66	10.95	0.85	0.74	21%	30%
Argentina	941	328	8 638	6.62	9.18	0.73	0.47	28%	28%
Portugal	887	120	10 720	9.15	12.09	0.87	0.72	24%	23%
RSA	**837**	**837**	**15 835**	**14.86**	**18.92**	**0.90**	**0.89**	**21%**	**15%**
Singapore	508	28	7 870	12.82	15.49	1.03	1.00	17%	24%
Chile	269	156	2 925	8.23	10.87	0.83	0.57	24%	24%
Egypt	230	117	2 497	9.09	10.86	0.87	0.67	16%	19%
Malaysia	110	93	1 583	11.54	14.39	1.17	0.88	20%	26%

10.2.8 Obstetrics, gynecology & pediatrics

Table 10.8: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Obstetrics, Gynecology & Pediatrics, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Turkey	7 179	5 233	19 327	2.34	2.69	0.78	0.42	13%	45%
Spain	3 751	443	28 309	6.37	7.55	0.94	0.80	16%	25%
Brazil	1 855	1 388	9 340	4.28	5.04	0.84	0.65	15%	34%
RSA	**1 529**	**1 529**	**11 950**	**6.74**	**7.82**	**1.00**	**0.80**	**14%**	**26%**
Singapore	731	40	4 959	5.85	6.78	0.91	0.75	14%	26%
Argentina	710	247	4 757	5.85	6.70	0.91	0.76	13%	28%
Mexico	687	652	4 970	5.92	7.23	0.88	0.75	18%	29%
Egypt	620	314	4 566	6.64	7.36	1.07	0.89	10%	30%
Chile	601	348	7 387	10.20	12.29	1.14	1.14	17%	18%
Portugal	456	62	2 456	4.50	5.39	1.00	0.70	16%	39%
Malaysia	321	271	1 343	3.80	4.18	0.84	0.53	9%	31%

10.2.9 Oncology

Table 10.9: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Oncology, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	5 149	608	77 880	12.55	15.13	1.09	0.97	17%	20%
Turkey	2 258	1 646	7 469	2.78	3.31	0.77	0.34	16%	45%
Brazil	1 153	863	11 885	8.70	10.31	0.98	0.79	16%	27%
Argentina	784	273	10 491	10.96	13.38	0.98	0.73	18%	23%
RSA	**703**	**703**	**12 426**	**15.70**	**17.68**	**1.18**	**0.99**	**11%**	**19%**
Singapore	617	34	7 466	10.19	12.10	1.04	0.98	16%	24%
Portugal	560	76	8 997	13.30	16.07	1.31	1.14	17%	24%
Mexico	513	487	5 583	8.82	10.88	1.03	0.77	19%	31%
Egypt	379	192	3 569	7.37	9.42	0.74	0.48	22%	22%
Chile	204	118	4 848	19.21	23.76	1.22	1.45	19%	20%
Malaysia	104	88	1 190	10.04	11.44	0.92	0.77	12%	24%

10.2.10 Pharmacology & pharmacy

Table 10.10: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Pharmacology & Pharmacy, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	10 553	1 247	93 677	6.66	8.88	0.86	0.71	25%	22%
Brazil	4 694	3 513	35 003	4.93	7.46	0.81	0.64	34%	31%
Turkey	3 456	2 519	16 124	3.40	4.67	0.88	0.48	27%	35%
Mexico	1 814	1 721	12 545	4.84	6.92	0.71	0.53	30%	28%
Argentina	1 808	630	13 228	5.04	7.32	0.72	0.52	31%	26%
Egypt	1 796	911	7 918	3.52	4.41	0.88	0.41	20%	25%
RSA	**1 502**	**1 502**	**12 734**	**6.74**	**8.48**	**0.87**	**0.68**	**20%**	**21%**
Portugal	1 077	146	9 560	6.14	8.88	0.80	0.76	31%	23%
Singapore	925	51	6 314	5.42	6.83	0.86	0.69	21%	28%
Chile	768	445	5 850	5.36	7.62	0.73	0.51	30%	22%
Malaysia	492	415	2 483	3.78	5.05	0.76	0.45	25%	32%

10.2.11 Public, environmental & occupational health

Table 10.11: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Public, Environmental & Occupational Health, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	4 808	568	40 958	6.51	8.52	0.95	0.84	24%	27%
Brazil	4 229	3 165	22 920	4.03	5.42	0.82	0.52	26%	38%
Mexico	2 187	2 075	13 349	4.74	6.10	0.90	0.59	22%	37%
RSA	**1 451**	**1 451**	**10 942**	**6.05**	**7.54**	**0.80**	**0.77**	**20%**	**29%**
Turkey	1 035	754	3 179	2.43	3.07	0.77	0.56	21%	46%
Egypt	784	398	5 373	5.76	6.85	0.76	0.64	16%	23%
Argentina	691	241	4 246	4.35	6.14	0.71	0.49	29%	33%
Chile	654	379	4 964	6.15	7.59	0.91	0.68	19%	31%
Singapore	510	28	4 945	8.08	9.70	1.08	1.00	17%	27%
Malaysia	475	401	3 042	5.30	6.40	0.84	0.67	17%	32%
Portugal	466	63	4 058	6.55	8.71	1.20	1.04	25%	29%

10.2.12 Surgery

Table 10.12: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Surgery, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Turkey	8 303	6 052	23 196	2.43	2.79	0.72	0.43	13%	47%
Spain	6 464	764	40 509	5.51	6.27	0.91	0.66	12%	32%
Brazil	2 778	2 079	13 530	4.27	4.87	0.89	0.66	12%	40%
RSA	**1 859**	**1 859**	**11 784**	**5.66**	**6.34**	**0.79**	**0.59**	**11%**	**32%**
Singapore	998	55	5 955	5.39	5.97	0.89	0.78	10%	34%
Mexico	794	753	4 455	4.81	5.61	0.69	0.59	14%	32%
Argentina	724	252	6 586	8.34	9.10	1.14	1.00	8%	31%
Egypt	649	329	3 134	4.04	4.83	0.71	0.54	16%	33%
Portugal	551	75	2 968	4.69	5.39	0.88	0.58	13%	39%
Chile	325	188	1 672	4.46	5.14	0.77	0.61	13%	39%
Malaysia	229	193	850	3.53	3.71	0.75	0.46	5%	40%

10.2.13 Virology, infectious diseases, immunology, parasitology & tropical medicine

Table 10.13: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	13 679	1 617	153 164	8.67	11.20	0.88	0.76	23%	23%
Brazil	9 043	6 769	72 568	5.86	8.02	0.88	0.68	27%	31%
Argentina	2 907	1 013	23 058	5.69	7.93	0.74	0.53	28%	27%
RSA	**2 628**	**2 628**	**28 120**	**8.44**	**10.70**	**1.00**	**0.82**	**21%**	**24%**
Turkey	2 258	1 646	7 821	2.78	3.46	0.76	0.41	20%	46%
Mexico	2 243	2 128	21 202	6.97	9.45	0.89	0.73	26%	26%
Portugal	1 101	149	11 473	7.87	10.42	0.97	0.76	24%	26%
Singapore	988	54	9 444	7.52	9.56	0.96	0.73	21%	25%
Egypt	922	468	7 783	6.83	8.44	0.82	0.72	19%	22%
Malaysia	662	558	4 843	5.81	7.32	0.92	0.61	21%	25%
Chile	638	370	5 336	6.26	8.36	0.81	0.60	25%	28%

10.2.14 Astronomy & astrophysics

Table 10.14: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Astronomy & Astrophysics, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	8 224	972	119 312	10.16	14.51	0.93	0.96	30%	24%
Brazil	3 874	2 900	38 331	6.63	9.89	0.63	0.62	33%	32%
Chile	3 346	1 939	60 887	13.77	18.20	1.17	1.32	24%	20%
Mexico	2 947	2 796	32 822	7.81	11.14	0.75	0.75	30%	29%
Argentina	1 811	631	18 148	6.72	10.02	0.64	0.64	33%	29%
RSA	**1 540**	**1 540**	**21 034**	**9.36**	**13.66**	**0.76**	**0.78**	**31%**	**20%**
Portugal	872	118	10 928	9.31	12.53	1.11	1.15	26%	28%
Turkey	631	460	3 338	3.59	5.29	0.45	0.38	32%	44%
Egypt	348	176	1 759	3.18	5.05	0.73	0.27	37%	59%
Singapore	30	2	98	2.00	3.27	0.16	0.18	39%	57%
Malaysia	7	6	50	6.57	7.14	1.17	0.62	8%	43%

10.2.15 Biochemistry, molecular & cell biology

Table 10.15: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Biochemistry, Molecular & Cell Biology, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	27 470	3 246	381 015	10.18	13.87	0.80	0.66	27%	19%
Brazil	10 591	7 927	89 122	5.60	8.41	0.75	0.44	33%	30%
Argentina	5 888	2 052	50 658	5.90	8.60	0.66	0.39	31%	26%
Mexico	4 262	4 044	40 551	6.97	9.51	0.74	0.53	27%	25%
Portugal	4 179	566	47 100	8.12	11.27	0.84	0.67	28%	23%
Turkey	3 746	2 730	20 592	3.96	5.50	0.94	0.42	28%	42%
RSA	**3 150**	**3 150**	**34 390**	**8.31**	**10.92**	**0.81**	**0.54**	**24%**	**21%**
Singapore	2 809	154	42 636	12.62	15.18	1.02	1.03	17%	23%
Chile	2 333	1 352	24 695	7.44	10.59	0.74	0.48	30%	22%
Egypt	1 779	902	9 536	4.06	5.36	0.76	0.31	24%	28%
Malaysia	953	804	5 567	4.33	5.84	0.84	0.36	26%	38%

10.2.16 Chemistry

Table 10.16: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Chemistry, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	54 617	6 454	550 727	6.76	10.08	0.87	0.92	33%	24%
Brazil	15 327	11 472	94 534	3.83	6.17	0.82	0.62	38%	37%
Egypt	9 937	5 039	41 108	2.59	4.14	0.76	0.33	37%	39%
Turkey	8 382	6 109	40 401	2.75	4.82	0.84	0.53	43%	44%
Argentina	7 854	2 737	48 556	3.88	6.18	0.69	0.55	37%	37%
Portugal	7 046	954	55 590	4.93	7.89	0.79	0.80	38%	30%
Mexico	6 123	5 809	37 077	4.03	6.06	0.76	0.66	34%	36%
RSA	**4 609**	**4 609**	**38 996**	**6.15**	**8.46**	**0.89**	**0.76**	**27%**	**28%**
Singapore	4 101	225	35 546	6.22	8.67	0.98	1.09	28%	28%
Chile	3 134	1 816	17 531	3.22	5.59	0.71	0.45	42%	40%
Malaysia	1 866	1 573	11 125	3.93	5.96	0.79	0.66	34%	36%

10.2.17 Dairy & animal science

Table 10.17: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Dairy & Animal Science, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Brazil	2 212	1 656	3 836	1.02	1.73	0.89	0.46	41%	65%
Spain	1 585	187	9 274	4.10	5.85	0.88	0.90	30%	32%
RSA	**825**	**825**	**2 822**	**2.42**	**3.42**	**0.96**	**0.52**	**29%**	**44%**
Turkey	518	378	862	1.08	1.66	0.80	0.55	35%	69%
Mexico	475	451	1 341	2.07	2.82	0.74	0.55	27%	48%
Argentina	390	136	2 167	4.08	5.56	0.97	0.90	26%	37%
Egypt	356	181	1 017	2.21	2.86	0.71	0.47	23%	46%
Portugal	151	20	852	4.09	5.64	1.01	1.05	27%	34%
Malaysia	127	107	585	3.57	4.61	1.14	0.76	22%	42%
Chile	66	38	311	3.00	4.71	0.68	0.55	36%	24%
Singapore	13	1	40	2.15	3.08	0.69	0.84	30%	62%

10.2.18 Ecology & environmental sciences

Table 10.18: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Ecology & Environmental Sciences, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	10 004	1 182	88 201	6.43	8.82	0.92	0.90	27%	26%
Brazil	4 024	3 012	27 107	5.16	6.74	0.95	0.82	23%	35%
RSA	**3 459**	**3 459**	**29 467**	**6.48**	**8.52**	**0.86**	**0.74**	**24%**	**27%**
Mexico	3 121	2 961	22 927	5.70	7.35	0.88	0.81	22%	33%
Turkey	2 606	1 899	9 442	2.57	3.62	0.85	0.57	29%	50%
Argentina	2 259	787	15 992	5.15	7.08	0.88	0.73	27%	32%
Chile	1 681	974	10 675	4.53	6.35	0.77	0.57	29%	32%
Portugal	1 608	218	10 420	4.53	6.48	0.88	0.83	30%	35%
Egypt	1 172	594	4 445	3.05	3.79	0.65	0.37	20%	39%
Singapore	777	43	4 425	4.53	5.69	0.91	0.71	20%	35%
Malaysia	608	513	3 707	4.89	6.10	0.94	0.71	20%	38%

10.2.19 Entomology

Table 10.19: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Entomology, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Brazil	1 893	1 417	7 125	2.35	3.76	0.81	0.71	38%	50%
Mexico	1 176	1 116	3 652	1.92	3.11	0.75	0.58	38%	53%
Spain	1 168	138	4 767	2.58	4.08	0.75	0.59	37%	45%
RSA	**1 090**	**1 090**	**4 916**	**2.82**	**4.51**	**0.88**	**0.67**	**37%**	**40%**
Argentina	684	238	2 222	1.93	3.25	0.71	0.57	41%	50%
Egypt	440	223	1 089	1.84	2.48	0.62	0.37	26%	50%
Turkey	264	192	398	0.86	1.51	0.72	0.47	43%	71%
Malaysia	222	187	1 288	4.24	5.80	0.97	1.04	27%	28%
Chile	105	61	455	2.76	4.33	1.01	1.03	36%	46%
Portugal	100	14	464	2.94	4.64	0.96	0.98	37%	40%
Singapore	37	2	226	5.24	6.11	1.00	1.07	14%	11%

10.2.20 Food science & technology

Table 10.20: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Food Science & Technology, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	8 680	1 026	61 092	4.90	7.04	0.93	1.05	30%	29%
Turkey	1 914	1 395	5 697	2.20	2.98	0.81	0.74	26%	49%
Brazil	1 742	1 304	7 002	2.96	4.02	0.75	0.79	26%	42%
Argentina	1 521	530	8 190	3.91	5.38	0.77	0.88	27%	35%
Mexico	1 183	1 122	5 498	3.35	4.65	0.73	0.78	28%	38%
Portugal	1 035	140	6 541	4.66	6.32	1.01	1.15	26%	29%
Egypt	965	489	3 980	3.45	4.12	0.79	0.58	16%	33%
RSA	**620**	**620**	**5 055**	**6.41**	**8.15**	**1.14**	**1.26**	**21%**	**32%**
Malaysia	619	522	2 858	3.58	4.62	0.75	0.75	23%	37%
Chile	362	210	1 550	3.03	4.28	0.87	0.79	29%	41%
Singapore	156	9	1 211	6.36	7.76	1.34	1.44	18%	34%

10.2.21 Geosciences

Table 10.21: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Geosciences, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	5 447	644	41 163	5.27	7.56	0.86	0.84	30%	30%
RSA	**2 532**	**2 532**	**23 777**	**6.81**	**9.39**	**0.92**	**0.91**	**27%**	**25%**
Brazil	2 482	1 858	15 880	4.61	6.40	0.87	0.76	28%	37%
Turkey	1 818	1 325	11 396	4.74	6.27	1.09	0.93	24%	43%
Mexico	1 808	1 715	10 909	4.28	6.03	0.75	0.72	29%	36%
Argentina	1 379	480	8 590	4.76	6.23	0.85	0.77	24%	35%
Egypt	846	429	3 278	2.85	3.87	0.67	0.38	26%	49%
Chile	731	424	5 135	5.30	7.02	0.94	0.89	25%	35%
Portugal	723	98	3 717	3.76	5.14	0.78	0.67	27%	36%
Singapore	407	22	1 425	2.41	3.50	0.74	0.57	31%	46%
Malaysia	169	142	827	4.11	4.89	0.89	0.66	16%	38%

10.2.22 Information technology

Table 10.22: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Information Technology, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	12 806	1 513	37 142	1.88	2.90	0.84	0.81	35%	63%
Singapore	6 872	378	20 461	2.20	2.98	0.85	0.86	26%	54%
Brazil	4 343	3 251	11 421	1.82	2.63	0.77	0.74	31%	61%
Turkey	2 856	2 082	6 694	1.47	2.34	0.64	0.65	37%	64%
Portugal	2 549	345	5 989	1.67	2.35	0.79	0.73	29%	62%
Mexico	1 954	1 854	4 787	1.67	2.45	0.77	0.79	32%	65%
RSA	**1 195**	**1 195**	**3 288**	**2.03**	**2.75**	**0.62**	**0.57**	**26%**	**56%**
Egypt	965	489	2 246	1.59	2.33	0.54	0.46	32%	60%
Argentina	876	305	2 511	1.74	2.87	0.57	0.55	39%	53%
Chile	780	452	2 421	2.21	3.10	0.86	0.93	29%	57%
Malaysia	517	436	666	0.96	1.29	0.59	0.56	25%	67%

10.2.23 Marine & freshwater biology

Table 10.23: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Marine & Freshwater Biology, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	4 973	588	40 696	5.67	8.18	0.88	0.83	31%	27%
Mexico	1 799	1 707	7 686	2.83	4.27	0.71	0.52	34%	40%
RSA	**1 578**	**1 578**	**14 157**	**6.79**	**8.97**	**0.84**	**0.76**	**24%**	**19%**
Brazil	1 422	1 064	6 174	3.02	4.34	0.65	0.53	30%	36%
Portugal	1 037	140	5 891	3.86	5.68	0.89	0.79	32%	37%
Argentina	935	326	4 824	3.61	5.16	0.78	0.59	30%	37%
Chile	916	531	6 632	5.19	7.24	0.81	0.80	28%	28%
Turkey	322	235	1 373	2.94	4.26	0.85	0.69	31%	46%
Singapore	317	17	2 153	5.23	6.79	0.92	0.78	23%	33%
Malaysia	208	175	1 239	4.81	5.96	0.75	0.67	19%	28%
Egypt	175	89	758	3.43	4.33	0.58	0.44	21%	38%

10.2.24 Mathematics

Table 10.24: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Mathematics, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	13 145	1 553	51 111	2.36	3.89	0.98	0.84	39%	52%
Brazil	4 821	3 609	16 502	2.14	3.42	0.81	0.77	38%	54%
Mexico	2 372	2 250	6 011	1.51	2.53	0.67	0.54	40%	58%
Turkey	2 258	1 646	4 078	0.92	1.81	0.66	0.44	49%	68%
Singapore	2 221	122	8 409	2.28	3.79	0.91	0.88	40%	49%
Portugal	2 039	276	6 460	2.04	3.17	0.89	0.80	36%	54%
Egypt	1 775	900	3 902	1.19	2.20	0.67	0.43	46%	66%
RSA	**1 670**	**1 670**	**5 445**	**2.05**	**3.26**	**0.89**	**0.72**	**37%**	**56%**
Argentina	1 454	507	4 999	2.20	3.44	0.83	0.62	36%	52%
Chile	1 223	709	4 541	2.35	3.71	0.91	0.92	37%	52%
Malaysia	294	248	475	0.95	1.62	0.66	0.35	41%	66%

10.2.25 Microbiology

Table 10.25: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Microbiology, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	8 964	1 059	103 062	8.82	11.50	0.86	0.87	23%	22%
Brazil	3 328	2 491	24 019	5.20	7.22	0.85	0.51	28%	34%
Argentina	1 410	491	11 488	5.87	8.15	0.74	0.60	28%	28%
Mexico	1 261	1 196	13 699	8.07	10.86	0.74	0.75	26%	24%
RSA	**1 151**	**1 151**	**14 719**	**10.25**	**12.79**	**0.89**	**0.91**	**20%**	**19%**
Portugal	1 064	144	12 237	8.04	11.50	0.90	0.88	30%	21%
Turkey	739	539	4 130	4.64	5.59	0.93	0.74	17%	40%
Egypt	574	291	3 348	4.90	5.83	0.84	0.39	16%	30%
Singapore	413	23	4 059	7.58	9.83	0.88	0.94	23%	24%
Chile	367	213	3 367	6.77	9.17	0.67	0.65	26%	23%
Malaysia	242	204	1 845	6.11	7.62	0.77	0.62	20%	25%

10.2.26 Ornithology

Table 10.26: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Ornithology, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	733	87	4 198	3.69	5.73	0.77	0.76	36%	32%
RSA	**489**	**489**	**1 990**	**2.91**	**4.07**	**0.94**	**0.55**	**28%**	**42%**
Argentina	241	84	824	2.24	3.42	0.81	0.69	35%	49%
Brazil	139	104	401	2.32	2.88	0.64	0.60	20%	50%
Mexico	139	132	499	2.60	3.59	0.67	0.55	28%	45%
Chile	82	48	240	1.99	2.93	0.76	0.53	32%	45%
Portugal	71	10	268	2.38	3.77	0.67	0.64	37%	45%
Singapore	7	0	21	3.00	3.00	0.45	0.52	0%	29%
Turkey	3	2	1	0.00	0.33	0.00	0.00	100%	100%
Malaysia	2	2	0	0.00	0.00	0.00	0.00	0.00	100%

10.2.27 Nuclear physics and nuclear science & technology

Table 10.27: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Nuclear Physics and Nuclear Science & Technology, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	4 041	478	28 345	3.81	7.01	1.00	0.79	46%	41%
Brazil	3 663	2 742	16 758	2.40	4.57	0.66	0.45	48%	47%
Turkey	1 434	1 045	5 060	1.78	3.53	0.91	0.50	50%	52%
Egypt	1 417	719	2 996	1.19	2.11	0.51	0.23	44%	59%
Portugal	1 405	190	8 727	3.24	6.21	0.96	0.75	48%	44%
Mexico	1 403	1 331	5 737	2.29	4.09	0.74	0.45	44%	48%
Argentina	1 263	440	6 129	2.70	4.85	0.61	0.48	44%	41%
RSA	**1 072**	**1 072**	**5 932**	**3.22**	**5.53**	**0.73**	**0.55**	**42%**	**39%**
Singapore	212	12	965	2.42	4.55	0.87	0.57	47%	42%
Malaysia	174	147	481	1.86	2.76	0.80	0.36	33%	45%
Chile	164	95	774	3.18	4.72	0.90	0.61	33%	48%

10.2.28 Condensed matter physics

Table 10.28: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Condensed Matter Physics, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	9 406	1 112	79 592	5.47	8.46	0.82	0.87	35%	33%
Brazil	6 007	4 496	36 958	3.82	6.15	0.63	0.64	38%	42%
Argentina	2 368	825	16 373	4.50	6.91	0.61	0.69	35%	37%
Mexico	2 096	1 989	11 878	3.68	5.67	0.68	0.66	35%	41%
Singapore	1 774	98	7 959	3.07	4.49	0.80	0.66	32%	41%
Turkey	1 563	1 139	7 429	2.76	4.75	0.66	0.59	42%	50%
Portugal	1 467	199	12 506	6.18	8.52	1.16	1.19	27%	42%
Egypt	1 355	687	4 814	2.20	3.55	0.67	0.36	38%	51%
RSA	**844**	**844**	**5 335**	**4.13**	**6.32**	**0.67**	**0.58**	**35%**	**41%**
Chile	431	250	2 228	3.20	5.17	0.49	0.50	38%	45%
Malaysia	205	173	737	2.41	3.60	0.68	0.53	33%	56%

10.2.29 Physics (excl Condensed matter & Nuclear)

Table 10.29: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Physics (excl Condensed Matter & Nuclear), 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	27 794	3 285	302 533	7.28	10.88	0.90	1.04	33%	31%
Brazil	17 494	13 094	121 709	4.26	6.96	0.65	0.65	39%	41%
Mexico	9 041	8 578	55 051	3.96	6.09	0.70	0.58	35%	45%
Argentina	5 978	2 083	47 190	5.14	7.89	0.68	0.71	35%	37%
Portugal	5 462	739	48 888	5.52	8.95	0.86	0.89	38%	35%
Singapore	5 416	298	24 794	2.98	4.58	0.73	0.75	35%	44%
Turkey	4 146	3 022	21 176	3.07	5.11	0.71	0.57	40%	52%
Egypt	3 214	1 630	12 816	2.38	3.99	0.70	0.36	40%	51%
RSA	**2 552**	**2 552**	**17 637**	**4.44**	**6.91**	**0.65**	**0.58**	**36%**	**37%**
Chile	1 725	999	14 199	5.72	8.23	0.77	0.86	31%	41%
Malaysia	531	448	1 654	1.87	3.11	0.52	0.35	40%	54%

10.2.30 Plant sciences

Table 10.30: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Plant Sciences, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	8 695	1 028	77 644	6.41	8.93	0.87	0.74	28%	24%
Brazil	3 670	2 747	21 424	4.15	5.84	0.83	0.53	29%	31%
RSA	**3 507**	**3 507**	**20 447**	**4.11**	**5.83**	**0.93**	**0.45**	**30%**	**36%**
Argentina	2 595	904	17 372	4.78	6.69	0.81	0.59	29%	33%
Mexico	2 580	2 448	17 532	5.08	6.80	0.81	0.63	25%	31%
Turkey	1 376	1 003	6 126	3.05	4.45	0.98	0.48	31%	48%
Egypt	992	503	4 563	3.63	4.60	0.77	0.36	21%	27%
Portugal	988	134	8 362	6.57	8.46	1.06	0.78	22%	28%
Chile	740	429	4 991	4.78	6.74	0.76	0.48	29%	23%
Malaysia	489	412	2 762	4.06	5.65	0.75	0.46	28%	29%
Singapore	468	26	4 816	8.41	10.29	0.96	0.90	18%	20%

10.2.31 Veterinary sciences

Table 10.31: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Veterinary Sciences, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Brazil	4 654	3 484	9 928	1.40	2.13	0.86	0.55	35%	62%
Spain	3 415	404	19 323	3.94	5.66	0.87	0.83	30%	32%
Turkey	2 609	1 902	1 978	0.44	0.76	0.74	0.26	42%	80%
RSA	**1 806**	**1 806**	**8 179**	**3.36**	**4.53**	**0.96**	**0.85**	**26%**	**35%**
Argentina	1 031	359	4 760	3.27	4.62	0.78	0.74	29%	37%
Mexico	608	577	2 587	2.90	4.25	0.70	0.78	32%	40%
Chile	591	342	1 605	1.91	2.72	0.95	0.46	30%	56%
Egypt	428	217	1 074	1.92	2.51	0.59	0.44	24%	44%
Portugal	223	30	1 089	3.71	4.88	1.06	1.08	24%	45%
Malaysia	181	153	936	4.16	5.17	0.81	0.84	20%	25%
Singapore	106	6	825	6.20	7.78	1.27	1.26	20%	25%

10.2.32 Water resources & biodiversity conservation

Table 10.32: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Water Resources & Biodiversity Conservation, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	2 688	318	16 986	4.72	6.32	0.91	0.87	25%	32%
RSA	**1 866**	**1 866**	**11 393**	**4.56**	**6.11**	**0.92**	**0.72**	**25%**	**34%**
Mexico	1 127	1 069	4 400	3.06	3.90	0.85	0.58	22%	51%
Turkey	1 116	813	4 542	2.94	4.07	0.79	0.64	28%	44%
Brazil	1 053	788	5 750	4.33	5.46	0.91	0.80	21%	35%
Chile	791	458	3 088	2.70	3.90	0.83	0.34	31%	39%
Argentina	591	206	2 504	3.01	4.24	0.81	0.51	29%	39%
Singapore	504	28	2 165	3.14	4.30	0.82	0.65	27%	39%
Portugal	499	68	2 421	3.63	4.85	0.91	0.77	25%	36%
Egypt	426	216	1 446	2.86	3.39	0.67	0.52	16%	37%
Malaysia	189	159	608	2.65	3.22	0.77	0.61	18%	45%

10.2.33 Zoology

Table 10.33: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Zoology, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	3 338	394	26 047	5.35	7.80	0.83	0.66	31%	30%
Brazil	2 512	1 880	11 254	3.04	4.48	0.90	0.52	32%	42%
RSA	**2 110**	**2 110**	**10 781**	**3.43**	**5.11**	**0.78**	**0.47**	**33%**	**34%**
Argentina	1 135	395	5 186	2.80	4.57	0.71	0.43	39%	40%
Mexico	835	792	4 340	3.42	5.20	0.84	0.55	34%	37%
Chile	460	267	2 785	3.70	6.05	0.74	0.45	39%	30%
Portugal	441	60	2 128	3.31	4.83	0.92	0.67	31%	41%
Singapore	386	21	1 530	2.26	3.96	0.97	0.41	43%	46%
Turkey	265	193	598	1.35	2.26	0.74	0.33	40%	66%
Egypt	228	116	526	1.57	2.31	0.53	0.20	32%	51%
Malaysia	164	138	648	2.63	3.95	0.81	0.40	33%	40%

10.2.34 Economics & management sciences

Table 10.34: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Economics & Management Sciences, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	3 146	372	12 161	3.32	3.87	0.91	0.95	14%	49%
Singapore	1 198	66	4 946	3.48	4.13	0.88	0.86	16%	43%
Turkey	804	586	1 926	1.91	2.40	0.82	0.58	20%	55%
RSA	**786**	**786**	**1 565**	**1.70**	**1.99**	**0.79**	**0.34**	**15%**	**52%**
Brazil	593	444	1 979	2.85	3.34	0.83	0.63	15%	48%
Portugal	522	71	2 561	4.41	4.91	1.07	1.20	10%	49%
Mexico	473	449	1 704	3.13	3.60	0.82	0.69	13%	46%
Argentina	402	140	598	1.28	1.49	0.70	0.24	14%	62%
Chile	367	213	1 684	4.00	4.59	0.79	0.98	13%	44%
Malaysia	138	116	277	1.83	2.01	0.88	0.46	9%	57%
Egypt	73	37	229	2.58	3.14	0.52	0.44	18%	37%

10.2.35 Social sciences

Table 10.35: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Social Sciences, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	8 389	991	40 961	3.66	4.88	0.83	0.62	25%	40%
RSA	**4 675**	**4 675**	**20 780**	**3.58**	**4.44**	**0.88**	**0.67**	**19%**	**41%**
Brazil	3 445	2 579	19 614	4.12	5.69	0.85	0.70	28%	42%
Turkey	2 293	1 671	6 307	2.15	2.75	0.81	0.57	22%	53%
Mexico	2 054	1 949	10 062	3.63	4.90	0.77	0.58	26%	39%
Singapore	2 019	111	7 823	3.25	3.87	0.90	0.76	16%	40%
Argentina	1 209	421	7 263	4.07	6.01	0.76	0.58	32%	40%
Portugal	1 003	136	3 837	2.70	3.83	0.74	0.56	29%	48%
Chile	687	398	2 394	2.72	3.48	0.68	0.53	22%	44%
Malaysia	470	396	1 157	2.07	2.46	0.67	0.46	16%	52%
Egypt	370	188	1 375	3.05	3.72	0.65	0.57	18%	42%

10.2.36 Humanities

Table 10.36: CWTS bibliometric indicators for South Africa and 10 benchmarking countries in Humanities, 1990-2005

Country	P	P*Weight	C+sc	CPP	CPP+sc	CPP/JCS	CPP/FCS	% Self citations (% sc)	Non cited (% Pnc)
Spain	7 488	885	7 527	0.76	1.01	0.94	0.67	25%	79%
RSA	**2 281**	**2 281**	**3 799**	**1.30**	**1.67**	**0.96**	**0.88**	**22%**	**63%**
Brazil	995	745	914	0.75	0.92	0.73	0.55	18%	77%
Mexico	955	906	900	0.79	0.94	0.85	0.61	16%	70%
Argentina	704	245	1 291	1.45	1.83	1.26	1.17	21%	75%
Turkey	631	460	869	1.03	1.38	0.68	0.50	26%	67%
Portugal	479	65	1 075	1.60	2.24	1.10	0.96	29%	68%
Singapore	466	26	752	1.39	1.61	0.92	0.73	14%	62%
Chile	449	260	433	0.68	0.96	0.97	0.70	29%	80%
Egypt	138	70	299	1.87	2.17	0.99	0.92	14%	64%
Malaysia	78	66	95	1.12	1.22	0.68	0.57	8%	67%

10.3 SUMMARY OF FINDINGS

Our discussion of the tables presented in Section 10.2 involves a summary of the statistics for South African and the 10 benchmarking countries per field in relation to four key bibliometric indicators. The indicators are:

Total weighted publication output for the period 1990-2005 (P*Weight) – Table 10.37

We have ranked South Africa and the benchmarking countries in terms of their weighted article output per field. The summary table shows the countries that occupy the **top 3** ranks per field. The ranks are displayed in the cells and the legend is as follows:

	Country occupies rank 1
	Country occupies ranks 2 & 3

Citation rate (CPP) – Table 10.38

To produce the summary table we have ranked, per field, the average number of citations to South Africa and the benchmarking countries, and indicated in the cells those countries that occupy the **top 3** ranks. The average numbers of citations received are displayed in the cells and the legend is as follows:

	Country occupies rank 1
	Country occupies ranks 2 & 3

Journal normalised citation rate (CPP/JCS) – Table 10.39

Each cell in Table 10.39 that contains a value indicates that the journal normalised citation rate of that country's output ranks among the **top 3**. Even in cases where the citation rate of a country ranks among the top 3, it does not necessarily imply good international (journal normalised) visibility or impact. Only journal normalised citation rates of 1.0 or more can be interpreted as such, as the following legend shows:

	CPP/JSC ≥ 1.0 [The mean impact of a country's articles **equals** (if 1) **or exceeds** (if > 1) the mean impact of all articles in the journals in which the country published its articles]
	CPP/JSC < 1.0 [The mean impact of a country's articles **falls below** the mean impact of all articles in the journals in which the country published its articles]

Field normalised citation rate (CPP/FCS) – Table 10.40

Similar to Table 10.39, each shaded cell in Table 10.40 indicates that the field normalised citation rate of that country ranks within the **top 3**. However, good international (field normalised) visibility or impact should not necessarily be attributed to every country ranking among the top 3. There are different degrees of international standing, as is indicated by the table's legend:

	CPP/JSC between 1.2 and 2.0 [The mean impact of a country's articles is **significantly above** the international impact standard of the field]
	CPP/JSC between 0.8 and 1.2 [The mean impact of a country's articles is **about** the mean impact of all articles in the journals in which the country published its articles]
	CPP/JSC between 0.5 and 0.8 [The mean impact of a country's articles is **significantly below** the mean impact of all articles in the journals in which the country published its articles]

Table 10.37: Relative position of South Africa (compared to benchmarking countries) in terms of weighted number of publications per top / strategic field, 1990-2005

Top / strategic field	South Africa	Argentina	Brazil	Chile	Egypt	Malaysia	Mexico	Portugal	Singapore	Spain	Turkey
Chemical engineering			2				3				1
Electrical & electronic engineering			1				3				2
Materials science			1				3				2
Mechanical engineering & mechanics			2				3				1
Metallurgy & metallurgical engineering	1		2				3				
General & internal medicine	1									3	2
Genetics & heredity	3		1				2				
Obstetrics, gynecology & pediatrics	2		3								1
Oncology	3		2								1
Pharmacology & pharmacy			1				3				2
Public, environmental & occupational health	3		1				2				
Surgery	3		2								1
Virology, infectious diseases, immunology, parasitology & tropical medicine	2		1				3				
Astronomy & astrophysics	3		1				2				
Biochemistry, molecular & cell biology			1				2			3	
Chemistry			1							2	3
Dairy & animal science	2		1				3				
Ecology & environmental sciences	1		2				3				
Entomology	3		1				2				
Food science & technology			2				3				1
Geosciences	1		2				3				
Information technology			1				3				2
Marine & freshwater biology	2		3				1				
Mathematics	3		1				2				
Microbiology	3		1				2				
Ornithology	1		3				2				
Nuclear physics and nuclear science & technology	3		1				2				
Condensed matter physics			1				2				3
Physics (excl condensed matter & nuclear)			1				2			3	

Top / strategic field	South Africa	Argentina	Brazil	Chile	Egypt	Malaysia	Mexico	Portugal	Singapore	Spain	Turkey
Plant sciences	1		2				3				
Veterinary sciences	3		1								2
Water resources & biodiversity conservation	1						2				3
Zoology	1		2				3				
Economics & management sciences	1						3				2
Social sciences	1		2				3				
Humanities	1						2				3

Table 10.38: Relative position of South Africa (compared to benchmarking countries) in terms of number of citations per paper (CPP) per top / strategic field, 1990-2005

Top / strategic field	South Africa	Argentina	Brazil	Chile	Egypt	Malaysia	Mexico	Portugal	Singapore	Spain	Turkey
Chemical engineering	3.75							3.77		5.04	
Electrical & electronic engineering			2.76					2.53		2.58	
Materials science	4.04								3.51	4.00	
Mechanical engineering & mechanics	2.54			2.55						3.38	
Metallurgy & metallurgical engineering		3.81							3.49	3.29	
General & internal medicine		8.20	8.69					13.03			
Genetics & heredity	14.86					11.54			12.82		
Obstetrics, gynecology & pediatrics	6.74			10.20	6.64						
Oncology	15.70			19.21				13.30			
Pharmacology & pharmacy	6.74							6.14		6.66	
Public, environmental & occupational health								6.55	8.08	6.51	
Surgery	5.66	8.34								5.51	
Virology, infectious diseases, immunology, parasitology & tropical medicine	8.44							7.87		8.67	
Astronomy & astrophysics	9.36			13.77						10.16	

Top / strategic field	South Africa	Argentina	Brazil	Chile	Egypt	Malaysia	Mexico	Portugal	Singapore	Spain	Turkey
Biochemistry, molecular & cell biology	8.31								12.62	10.18	
Chemistry	6.15								6.22	6.76	
Dairy & animal science		4.08						4.09		4.10	
Ecology & environmental sciences	6.48						5.70			6.43	
Entomology						4.24		2.94	5.24		
Food science & technology	6.41								6.36	4.90	
Geosciences	6.81			5.30						5.27	
Information technology	2.03			2.21					2.20		
Marine & freshwater biology	6.79								5.23	5.67	
Mathematics				2.35					2.28	2.36	
Microbiology	10.25						8.07			8.82	
Ornithology	2.91								3.00	3.69	
Nuclear physics and nuclear science & technology	3.22							3.24		3.81	
Condensed matter physics		4.50						6.18		5.47	
Physics (excl condensed matter & nuclear)				5.72				5.52		7.28	
Plant sciences								6.57	8.41	6.41	
Veterinary sciences						4.16			6.20	3.94	
Water resources & biodiversity conservation	4.56		4.33							4.72	
Zoology	3.43			3.70						5.35	
Economics & management sciences				4.00				4.41	3.48		
Social sciences		4.07	4.12							3.66	
Humanities		1.45			1.87			1.60			

Table 10.39: Relative position of South Africa (compared to benchmarking countries) in terms of journal normalised citation rate (CPP/JCS) per top / strategic field, 1990-2005

Top / strategic field	South Africa	Argentina	Brazil	Chile	Egypt	Malaysia	Mexico	Portugal	Singapore	Spain	Turkey
Chemical engineering						0.95				0.98	0.96
Electrical & electronic engineering			0.84				0.86			0.84	
Materials science						0.96		0.97	0.94		
Mechanical engineering & mechanics								0.90	0.89	0.93	
Metallurgy & metallurgical engineering					0.91	0.88			1.01		
General & internal medicine				1.17				1.30	1.10		
Genetics & heredity	0.90					1.17			1.03		
Obstetrics, gynecology & pediatrics	1.00			1.14	1.07			1.00			
Oncology	1.18			1.22				1.31			
Pharmacology & pharmacy	0.87				0.88						0.88
Public, environmental & occupational health								1.20	1.08	0.95	
Surgery		1.14	0.89						0.89	0.91	
Virology, infectious diseases, immunology, parasitology & tropical medicine	1.00							0.97	0.96		
Astronomy & astrophysics				1.17		1.17		1.11			
Biochemistry, molecular & cell biology						0.84		0.84	1.02		0.94
Chemistry	0.89								0.98	0.87	
Dairy & animal science		0.90						1.05		0.90	
Ecology & environmental sciences			0.95			0.94				0.92	
Entomology				1.01		0.97			1.00		
Food science & technology	1.14							1.01	1.34		
Geosciences	0.92			0.94							1.09
Information technology				0.86					0.85	0.84	
Marine & freshwater biology								0.89	0.92	0.88	
Mathematics				0.91					0.91	0.98	
Microbiology	0.89							0.90			0.93
Ornithology	0.94	0.81								0.77	
Nuclear physics and nuclear science & technology								0.96		1.00	0.91

Top / strategic field	South Africa	Argentina	Brazil	Chile	Egypt	Malaysia	Mexico	Portugal	Singapore	Spain	Turkey
Condensed matter physics								1.16	0.80	0.82	
Physics (excl condensed matter & nuclear)				0.77				0.86		0.90	
Plant sciences								1.06	0.96		0.98
Veterinary sciences	0.96							1.06	1.27		
Water resources & biodiversity conservation	0.92		0.91					0.91		0.91	
Zoology			0.90					0.92	0.97		
Economics & management sciences						0.88		1.07	0.88	0.91	
Social sciences	0.88		0.85						0.90		
Humanities		1.26			0.99			1.10			

Table 10.40: Relative position of South Africa (compared to benchmarking countries) in terms of field normalised citation rate (CPP/FCS) per top / strategic field, 1990-2005

Top / strategic field	South Africa	Argentina	Brazil	Chile	Egypt	Malaysia	Mexico	Portugal	Singapore	Spain	Turkey
Chemical engineering								0.95	1.04	1.19	
Electrical & electronic engineering		0.82	0.82	0.85			0.82			0.83	
Materials science						0.96		0.87	0.94		
Mechanical engineering & mechanics								0.90	0.89	0.93	
Metallurgy & metallurgical engineering		1.04							1.25	0.99	
General & internal medicine			0.88					1.27	0.86		
Genetics & heredity	0.89					0.88			1.00		
Obstetrics, gynecology & pediatrics	0.80			1.14	0.89					0.80	
Oncology	0.99			1.45				1.14			
Pharmacology & pharmacy								0.76	0.69	0.71	
Public, environmental & occupational health								1.04	1.00	0.84	
Surgery		1.00	0.66						0.78	0.66	
Virology, infectious diseases, immunology, parasitology & tropical medicine	0.82							0.76		0.76	

Top / strategic field	South Africa	Argentina	Brazil	Chile	Egypt	Malaysia	Mexico	Portugal	Singapore	Spain	Turkey
Astronomy & astrophysics				1.32				1.15		0.96	
Biochemistry, molecular & cell biology								0.67	1.03	0.66	
Chemistry								0.80	1.09	0.92	
Dairy & animal science		0.90						1.05		0.90	
Ecology & environmental sciences		0.82						0.83		0.90	
Entomology				1.03		1.04			1.07		
Food science & technology	1.26							1.15	1.44		
Geosciences	0.91			0.89							0.93
Information technology				0.93					0.86	0.81	
Marine & freshwater biology								0.79	0.78	0.83	
Mathematics				0.92					0.88	0.84	
Microbiology	0.91							0.88	0.94		
Ornithology		0.69						0.64		0.76	
Nuclear physics and nuclear science & technology				0.61				0.75		0.79	
Condensed matter physics		0.69						1.19		0.87	
Physics (excl condensed matter & nuclear)				0.86				0.89		1.04	
Plant sciences								0.78	0.90	0.74	
Veterinary sciences	0.85							1.08	1.26		
Water resources & biodiversity conservation			0.80					0.77		0.87	
Zoology							0.55	0.67		0.66	
Economics & management sciences				0.98				1.20		0.95	
Social sciences	0.67		0.70						0.76		
Humanities		1.17			0.92			0.96			

According to Table 10.37, South African institutions occupy the top 3 ranks in 11 of the 36 fields, when we compare the total weighted article output of South Africa to that of the benchmarking countries. With the exception of General & Internal Medicine, Economics & Managements Sciences, Social Sciences, and Humanities, all top ranking fields reflect research activities into the country's natural resource base.

Table 10.38 reveals that the average number of citations per paper is highest in the fields of Oncology, Genetics & Heredity, and Microbiology. South African ranks among the top 3 countries in 22 of the 36 fields, and in 8 of these 22 fields it occupies the first rank. However, if one normalises the average number of citations per paper

by taking into account variations in the journals in which the country publishes, it appears that South Africa has a journal normalised citation rate of good international standing (Table 10.39) in only four fields. South Africa ranks among the top 3 countries in these fields, with journal normalised citation rates greater than 1 (see the blue shaded cells in Table 10.39). The fields are as follows:

- Oncology
- Food Science & Technology
- Obstetrics, Gynecology & Pediatrics
- Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine

The last, and most important, set of results is the one that throws light on the relative position of South Africa to the benchmarking countries in terms of the field normalised citation rate (Table 10.40). The latter relates the performance of a country to the international (western world dominated) impact standard of the field. The performance of South Africa is significantly above the international impact standard in only ONE field, namely in Food Science & Technology.

There are seven more fields in which South Africa's performance is on a par with the international average and where the country also occupies one of the top three ranks (compared to the benchmarking countries). The fields are:

- Oncology
- Geosciences
- Microbiology
- Genetics & Heredity
- Veterinary Sciences
- Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine
- Obstetrics, Gynecology & Pediatrics

CHAPTER 11
PROFILE OF KEY INSTITUTIONS

11.1 INTRODUCTION

This chapter looks at the field normalised citation rates of ALL South African institutions that have been identified as being productive in 25 of the 36 strategic fields. For each institution we report the field normalised citation rate (cf Section 3.6) and the following legend should be consulted to interpret the results:

	CPP/JSC >2.0 [The mean impact of an organisation's articles is **significantly far above** the international impact standard of the field]
	CPP/JSC between 1.2 and 2.0 [The mean impact of an organisation's articles is **significantly above** the international impact standard of the field]
	CPP/JSC between 0.8 and 1.2 [The mean impact of an organisation's articles is **about** the international impact standard of the field]
	CPP/JSC between 0.5 and 0.8 [The mean impact of an organisation's articles is **significantly below** the international impact standard of the field]
	CPP/JSC < 0.5 [The mean impact of an organisation's articles is **significantly far below** the international impact standard of the field]

Apart from the field normalised citation rate, we also report the number of ISI articles by the selected institutions for the period 1990-2005 in a particular field.

11.2 SUMMARY OF FINDINGS

The field normalised citation rates are summarised in Table 11.1.

Table 11.1: Number of articles (P) and field normalised citation rate (CPP/FCS) of South African institutions per top / strategic field, 1990-2005

Top / strategic field	Organisation	P	CPP/FCS
Engineering & Applied Technologies			
Chemical Engineering	UCT	143	1.14
	SU	208	0.74
	UKZN	127	0.67
Materials Science	CSIR	136	2.22
	SU	148	0.88
	UCT	164	0.86
	WITS	384	0.78
	UP	212	0.46
	NMMU	117	0.42
Health Sciences			
General & Internal Medicine	HOSP G SCHUUR	595	1.03
	SU	771	0.67
	NHLS	368	0.64
	UCT	1 651	0.63
	WITS	1 248	0.60
	MRC	653	0.54
	UP	357	0.50
	UKZN	674	0.42
	UL	246	0.32
Genetics & Heredity	WITS	182	1.09
	UCT	220	0.82
	SU	167	0.71
Obstetrics, Gynecology & Pediatrics	SU	278	0.91
	UCT	313	0.89
	WITS	272	0.74
	UKZN	261	0.66
Pharmacology & Pharmacy	WITS	201	0.86
	UKZN	213	0.60
	NWU	185	0.54
	UP	201	0.50
Public, Environmental & Occupational Health	MRC	288	1.14
	UCT	209	0.73
	WITS	323	0.63
	NHLS	146	0.53

Top / strategic field	Organisation	P	CPP/FCS
Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine	NHLS	229	1.30
	MRC	293	0.90
	UKZN	306	0.84
	WITS	491	0.82
	UCT	412	0.80
	SU	200	0.69
	UP	231	0.50
Astronomy & Astrophysics	UCT	410	0.87
	SAAO	628	0.81
	NWU	200	0.72
Biochemistry, Molecular & Cell Biology	WITS	443	0.63
	UCT	595	0.62
	UFS	259	0.61
	UP	281	0.50
	SU	471	0.49
	UKZN	316	0.39
Chemistry	UCT	582	0.88
	SU	244	0.88
	WITS	715	0.82
	UP	610	0.63
	UKZN	469	0.63
	UFS	259	0.61
	UJ	169	0.60
	RHODES	334	0.57
	UFS	285	0.56

Table 11.1 (Continued)

Top / strategic field	Organisation	P	CPP/FCS
Natural & Agricultural Sciences			
Dairy & Animal Science	ARC	150	0.65
	UFS	105	0.52
	UP	140	0.47
	SU	123	0.38
Ecology & Environmental Sciences	UCT	755	1.01
	WITS	269	0.93
	UKZN	396	0.64
	UP	506	0.57
	SU	248	0.52
Entomology	WITS	90	1.02
	RHODES	110	0.73
	UP	176	0.68
	UKZN	59	0.67
	SU	50	0.62
	UCT	107	0.60
	NFI	48	0.14
Geosciences	UCT	482	1.27
	UJ	163	1.15
	WITS	533	0.96
	CGS	176	0.82
	UKZN	237	0.71
	UP	194	0.70
	SU	114	0.39
Information Technology	UCT	117	0.71
	UP	279	0.64
	WITS	143	0.52
	UJ	133	0.41
Marine & Freshwater Biology	M&CM	293	0.97
	UCT	371	0.92
	RHODES	206	0.88
Microbiology	SU	208	1.02
	WITS	219	0.97
	UCT	147	0.70
Nuclear Physics & Nuclear Science & Technology	UCT	144	0.93
	iTHEMBA	272	0.57

Top / strategic field	Organisation	P	CPP/FCS
	WITS	311	0.37
Ornithology	UCT	223	0.74
Physics (Excl Condensed Matter & Nuclear)	UCT	409	0.83
	WITS	544	0.53
	SU	134	0.52
	UKZN	417	0.45
	UNISA	145	0.44
	UP	260	0.41
	UJ	161	0.34
Plant Sciences	UCT	347	0.69
	ARC	146	0.48
	UKZN	791	0.47
	WITS	163	0.41
	SU	275	0.36
	UFS	271	0.34
	UP	368	0.30
	SANBI	532	0.29
Veterinary Sciences	ARC	169	1.21
	ARC (Ond Vet Inst)	309	0.90
	UP	801	0.85
	UL	171	0.65
Water Resources & Biodiversity Conservation	UCT	295	1.11
	UKZN	227	0.69
	UP	241	0.59
Zoology	NFI	53	0.71
	UCT	291	0.60
	WITS	247	0.59
	RHODES	120	0.54
	UKZN	275	0.53
	SU	154	0.48
	UP	413	0.43

The analyses reveal that the performance of South African institutions is on a par with the international impact standard in the following fields. The fields and institutions are:

- University of Cape Town – Materials Science; Obstetrics, Gynecology & Pediatrics; Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine; and Astronomy & Astrophysics

- Stellenbosch University – Materials Science
- University of the Witwatersrand – Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine; Chemistry; Ecology and Environmental Sciences; and Geosciences
- University of Kwazulu Natal – Virology, Infectious Diseases, Immunology, Parasitology & Tropical Medicine
- Rhodes University – Marine & Freshwater Biology
- South African Astronomical Observatory – Astronomy & Astrophysics
- Council for Geosciences – Geosciences

In five fields none of the most productive South African institutions has a field normalised citation rate that reflects good international standing. In other words, the citation rates of the institutions in these five fields are all below 0.8. The fields are:

- Biochemistry, Molecular & Cell Biology
- Dairy & Animal Sciences
- Information Technology
- Plant Sciences
- Zoology

Lastly, there are some instances where one would have expected a field normalised citation rate that is at least on a par with the international impact standard of the field. An example is Nuclear Physics and Nuclear S&T where a good international standing for iThemba LABS is to be expected. However, its citation rate is significantly below the international impact standard of that field. Similarly, in the field of General & Internal Medicine (with the exception of Groote Schuur Hospital), none of the major health school universities has a field normalised citation rate that equals the international average for that field.

APPENDICES

Appendix Table 1 – Total output by scientific field and strategic field (1990-2004)

Total output	Scientific field	Strategic field	Total output
10430	Agricultural sciences	Dairy & animal science	873
		Food science & technology	875
		Plant sciences	4109
		Veterinary sciences	1814
8978	Biological sciences	Entomology	1032
		Marine & freshwater biology	1876
		Microbiology	961
		Ornithology	785
		Zoology	1698
4258	Chemical sciences	Chemistry	3908
8784	Earth sciences	Ecology & environmental sciences	3191
		Geosciences	3022
		Water resources & biodiversity conservation	2523
2803	Mathematical sciences & ICCT	Information technology	1359
		Mathematics	1570
5183	Physical sciences	Astronomy & astrophysics	1103
		Condensed matter physics	782
		Nuclear physics and nuclear science & technology	963
		Physics (excl condensed matter & nuclear)	2292
2803	Multidisciplinary sciences	--	--
8960	Engineering & applied technologies	Chemical engineering	901
		Electrical & electronic engineering	1011
		Materials science	1579
		Mechanical engineering & mechanics	1707
		Metallurgy & metallurgical engineering	1010
7712	Basic health	Biochemistry, molecular & cell biology	2325
		Genetics & heredity	740

Appendix Table 1 (Continued)

Total output	Scientific field	Strategic field	Total output
15408	Clinical health	General & internal medicine	6687
		Obstetrics, gynecology & pediatrics	1205
		Oncology	608
		Pharmacology & pharmacy	1222
		Surgery	1856
		Virology, infectious diseases, immunology, parasitology & tropical medicine	2474
3247	Public / community health	Public, environmental & occupational health	1709
3125	Economic & management sciences	Economic & management sciences	3125
3212	Education	Social sciences	18317
2104	Psychology		
5347	Sociology & related studies		
12599	Other social sciences		
4478	Language & linguistics	Humanities	22237
6165	Law		
6315	Religion		
5666	Other humanities & arts		

Appendix Table 2 – Total output by scientific field and strategic field (1990- 2004)

Article output						Scientific field	Strategic field	Article output					
Total	2002-2004	1999-2001	1996-1998	1993-1995	1990-1992			1990-1992	1993-1995	1996-1998	1999-2001	2002-2004	Total
10430	2023	2174	2029	1981	2223	Agricultural sciences	Dairy & animal science	203	147	136	206	181	873
							Food science & technology	189	168	151	174	193	875
							Plant sciences	807	817	841	847	797	4109
							Veterinary sciences	351	349	364	388	362	1814
8978	2080	2069	1683	1652	1494	Biological sciences	Entomology	139	166	190	268	269	1032
							Marine & freshwater biology	402	346	424	358	346	1876
							Microbiology	120	147	174	264	256	961
							Ornithology	148	189	87	212	149	785
							Zoology	348	332	297	332	389	1698
4258	1003	921	814	800	720	Chemical sciences	Chemistry	688	732	773	824	891	3908
8784	2044	1868	1712	1589	1571	Earth sciences	Ecology & environmental sciences	509	539	566	719	858	3191
							Geosciences	544	575	611	660	632	3022
							Water resources & biodiversity conservation	380	422	466	580	675	2523
2803	665	695	526	489	428	Mathematical sciences & ICCT	Information technology	206	240	235	342	336	1359
							Mathematics	232	275	276	407	380	1570

Appendix Table 2 (Continued)

Article output						Scientific field	Strategic field	Article output					
Total	2002-2004	1999-2001	1996-1998	1993-1995	1990-1992			1990-1992	1993-1995	1996-1998	1999-2001	2002-2004	Total
5183	1053	1131	1033	1120	846	Physical sciences	Astronomy & astrophysics	164	253	226	232	228	1103
							Condensed matter physics	125	162	144	209	142	782
							Nuclear physics and nuclear science & technology	169	207	175	233	179	963
							Physics (excl condensed matter & nuclear)	391	488	448	524	441	2292
2803	421	617	633	560	572	Multidisciplinary sciences	--	--	--	--	--	--	--
8960	2128	1960	1837	1718	1317	Engineering & applied technologies	Chemical engineering	107	167	200	211	216	901
							Electrical & electronic engineering	176	197	206	193	239	1011
							Materials science	220	278	303	405	373	1579
							Mechanical engineering & mechanics	226	348	448	343	342	1707
							Metallurgy & metallurgical engineering	173	170	187	239	241	1010
7712	1645	1846	1534	1405	1282	Basic health	Biochemistry, molecular & cell biology	344	436	424	544	577	2325
							Genetics & heredity	108	140	153	170	169	740

Appendix Table 2 (Continued)

Article output						Scientific field	Strategic field	Article output					
Total	2002-2004	1999-2001	1996-1998	1993-1995	1990-1992			1990-1992	1993-1995	1996-1998	1999-2001	2002-2004	Total
15408	3102	3710	3015	2785	2796	Clinical health	General & internal medicine	1354	1155	1334	1649	1195	6687
							Obstetrics, gynecology & pediatrics	161	220	215	303	306	1205
							Oncology	111	129	123	139	106	608
							Pharmacology & pharmacy	171	207	256	321	267	1222
							Surgery	439	434	373	372	238	1856
							Virology, infectious diseases, immunology, parasitology & tropical medicine	322	347	488	638	679	2474
3247	662	868	636	435	646	Public / community health	Public, environmental & occupational health	322	323	301	346	417	1709
3125	795	625	621	600	484	Economic & management sciences	Economic & management sciences	484	600	621	625	795	3125
3212	818	763	558	544	529	Education	Social sciences	3417	3599	3679	3682	3940	18317
2104	479	411	498	345	371	Psychology							
5347	1249	983	1026	1148	941	Sociology & related studies							
12599	2612	2576	2521	2591	2299	Other social sciences							

Appendix Table 2 (Continued)

Article output						Scientific field	Strategic field	Article output					
Total	2002-2004	1999-2001	1996-1998	1993-1995	1990-1992			1990-1992	1993-1995	1996-1998	1999-2001	2002-2004	Total
4478	877	897	955	907	842	Language & linguistics	Humanities	4457	4697	4474	4377	4232	22237
6165	937	1236	1266	1410	1316	Law							
6315	1432	1235	1229	1317	1102	Religion							
5666	1050	1097	1108	1157	1254	Other humanities & arts							