SOUTH AFRICAN NATIONAL SURVEY OF RESEARCH AND EXPERIMENTAL DEVELOPMENT

MAIN ANALYSIS REPORT 2015/16

science & technology
Department: Science and Technology
REPUBLIC OF SOUTH AFRICA

HSRC
Human Sciences Research Council

STATS SA
STATISTICS SOUTH AFRICA

FOREWORD

Any modern economy requires adequate levels of investment in research and development (R&D) and innovation. The National Survey of Research and Experimental Development (R&D Survey) is conducted annually to update the series of official statistics on South Africa's performance on key indicators of inputs to R&D – measuring the size, growth and composition of R&D expenditure and the human resources devoted to R&D.

The survey is overseen by the Department of Science and Technology (DST) as a partner within the South African National Statistics System (NSS). R&D statistics are key to informing policy implementation by government and are also of use to the private sector, the international community, media, and researchers.

The Statistics Act (No. 6 of 1999) mandates the Statistician General (SG) to coordinate statistical production in the country, even beyond the confines of Statistics South Africa (Stats SA). Accordingly, each R&D survey is subject to a quality assessment prior to its publication, in terms of the South African Statistical Quality Assessment Framework (SASQAF), to ensure that the survey remains credible and true to its purpose.

The Clearance Committee that conducted the quality assessment noted that the 2015/16 R&D Survey was conducted following good practices, and met most of the set quality requirements. The questionnaire response rate was 73.1%, 1.9 points below the set standard of 75%. The collection rate was 80.8%, which is above the standard of 75%. As in the previous two rounds of the survey, greater focus has been given to expanding the universe of R&D performers, particularly in the business sector and the not-for-profit sector. This led to a higher than targeted out-of-scope rate, i.e. proportion of sampled units that did not perform in-house R&D in the reference year. Intermittent R&D performing units cause this tendency. Also, as in several other economies, R&D in South Africa is concentrated in a few larger R&D performing units across institutional sectors, requiring the survey to purposefully cover such units. Important changes are noted in the higher education sector, with new public institutions established and private higher education institutions growing their research capacity.

The initial phase of incorporating the revisions to the 2015 Frascati Manual (*i.e. Guidelines for Collecting and Reporting Data on Research and Experimental Development*) has started. Minor refinements will be introduced in the 2016/17 round of the R&D Survey questionnaire. Further research and consultations are being undertaken to consider enhancements, both to account for expanded uses of the R&D data in South Africa, and to maintain international comparability.

Given my assessment of the recommendations of the Clearance Committee, I endorse the 2015/16 R&D Survey results and encourage its use by stakeholders.

Risenga Maluleke
STATISTICIAN-GENERAL, REPUBLIC OF SOUTH AFRICA

PREFACE

International experience has highlighted the crucial link between the levels of investment in R&D and economic growth. Over the past two decades, the economic success of some of the newly industrialised countries, such as China, Singapore, South Korea, Ireland and Tunisia, is partly attributed to their rapid improvements in R&D. For these countries, their openness to international trade, investment and skills mobility, have made their increased R&D activity more beneficial in growing their economies, improving their standard of living, and in making major strides in international competitiveness.

The South African government regards investment in R&D as an integral part of its agenda for socio-economic development. Our efforts over the years in building a base for research, development, and innovation have led to led scientific discoveries and major advances that have positioned South Africa favourably in global innovation.

Advances in the development of hydrogen and fuel cell technology not only serves as a source of alternative forms of cleaner energy, but also adds to the portfolio of interventions to promote beneficiation of natural resources by using the catalytic capability of platinum, which South Africa has in abundance. As a result of this, a fuel cell manufacturing capacity is being established in South Africa.

The successful work of the Technology Innovation Agency has led to the establishment of many technology-based start-up companies, stemming from university-based research and the intellectual property developed. This represents serious inroads into this global multidisciplinary and high-technology industry, where South Africa already possesses specific resource advantages for its growing pharmaceutical sector.

New enterprises, including cooperatives and community-based initiatives, have been established arising from technology demonstration activities in the sectors of aquaculture, information and communication technologies, bio-prospecting and indigenous knowledge. Such initiatives have demonstrated the tangible impact in improving livelihood and creating employment opportunities in outlying communities such as Hondeklip Bay, Giyani and elsewhere.

The research in the human and social sciences, largely done by the Human Sciences Research Council (HSRC), the Africa Institute of South Africa (AISA), the higher education sector, the non-governmental organisations and other private sector bodies, is a strength in government policy formulation.

There have been major breakthroughs in the areas of health research and innovation through various initiatives focusing on the prevention and treatment of HIV/AIDS, tuberculosis, malaria and others as well as the development of new or improved drugs and modes of treatment.

South Africa's successful bid to host the Square Kilometre Array (SKA) offers huge potential for major scientific developments in Africa. Already supported by 19 countries involving 55 scientific institutions, this project puts South Africa at the centre of global science and research in this area, and the development of local high-tech input industries.

To sustain these developments, the government has established various initiatives for human-capital development, in the forms of Centres of Excellence, Research Chairs as well as special bursaries to train and build skills capabilities in all these areas. Technology infrastructure investments are being rolled out and cooperation arrangements are being established with the private sector and international partners.

These achievements have laid an ideal foundation for further developing the science base and ensuring that research work addresses the key policy concerns of the country. In the midst of the challenges in the areas of energy, health, food, education, climate change and others, science and research continues to play a significant role in generating sustainable solutions that lead to an improved quality of life for all.

The R&D survey for 2015/16 shows South Africa's gross expenditure on research and experimental development (GERD) was up R2.992 billion to R32.337 billion. It gives me great pleasure to note that this is the second year in a row that there has been an increase in research intensity, that is, research as a percentage of GDP, up 0.03% to 0.80%.

Naledi Pandor
MINISTER OF SCIENCE AND TECHNOLOGY

ACKNOWLEDGEMENTS

The South African National Survey of Research and Experimental Development (R&D Survey) is conducted annually by CeSTII on behalf of the DST. The CeSTII team extend their appreciation to Risenge Maluleke (Statistician-General), Dr Pali Lehohla (the outgoing Statistician-General), Dr Phil Mjwara (Director-General of the DST), Prof. Crain Soudien (CEO of the HSRC), Dr Leickness Simbayi (Deputy CEO: Research of the HSRC) and Dr Glenda Kruss (Deputy Executive Director, CeSTII) for their support of the R&D Survey.

The continuous support and contributions of Imraan Patel, Godfrey Mashamba, Tshidi Mamogobo, Kgomotso Matlapeng and Nangamso Mnwana of the DST are greatly appreciated.

Technical inputs and advice by the DST and Statistics South Africa teams, as well as from the Clearance Committee for Science, Technology and Innovation Statistical Reports, are appreciated.

Interactions with the OECD Working Party of National Experts on Science and Technology Indicators (NESTI) continue to be invaluable in maintaining the quality and standard of the South African R&D surveys and analysis of the results. We are also most grateful for and acknowledge the co-operation of the survey's respondents.

The CeSTII team responsible for producing this report included: Neo Molotja, Natalie Vlotman, Saahier Parker, Mario Clayford, Natasha Saunders, Janine Senekal, Jerry Mathekga, Theo Sass, Sinovuyo Takatshana, Nhlanhla Malaza, Thembinkosi Zulu, Ndiyakholwa Ngqulu, Yasser Buchana, Hlamulo Makelane, Firdous Khan, Sanelisiwe Ngcobo, Precious Mudavanhu, Lwando Kondlo, Loyiso Maciko, Nazeem Mustapha, Lindiwe Binda, Moses Sithole, Gerard Ralphs, Maria Maluleke, Zinziswa Hlakula and Gina Mshengu.

ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
BERD	Business Expenditure on R&D
BRICS	Brazil, the Russian Federation, India, China and South Africa
CEO	Chief Executive Officer
CeSTII	Centre for Science, Technology and Innovation Indicators
DACST	Department of Arts, Culture, Science and Technology
DST	Department of Science and Technology
FTE	Full-time Equivalent
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
HERD	Higher Education Expenditure on R&D
HIV	Human Immunodeficiency Virus
HSRC	Human Sciences Research Council
ICT	Information, Computer and Communication Technology
NESTI	National Experts on Science and Technology Indicators
NPO	Not-for-profit Organisation
NSI	National System of Innovation
OECD	Organisation for Economic Co-operation and Development
PPP	Purchasing Power Parity
QMP	Quality Management Plan
R	Rand (South African currency)
R&D	Research and Experimental Development
SA	South Africa
SASQAF	South African Statistical Quality Assessment Framework
SIC	Standard Industrial Classification
Stats SA	Statistics South Africa
STI	Science, Technology and Innovation
SVC	Statistical Value Chain
TB	Tuberculosis
UIS	UNESCO Institute for Statistics
UNESCO	United Nations Educational, Scientific and Cultural Organization
US/USA	United States of America

DEFINITION OF TERMS

Applied research is original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.

Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.

Biotechnology is an application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services.

Capital expenditure is the annual gross expenditure on fixed assets used repeatedly or continuously in the performance of R&D programmes for more than one year. Such expenditure is reported in full in the period in which it took place and is not registered as an element of depreciation. Capital expenditure includes expenditure on land, buildings, instruments and equipment.

Current expenditure is composed of labour costs of R&D personnel and other current costs used in R&D. Services and items (including equipment) used and consumed within one year are current expenditures. Annual fees or rents for the use of fixed assets should be included in current expenditures.

Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems or services, or to improving substantially those already produced or installed.

Full-time equivalent (FTE) refers to the number of hours (person-years of effort) spent on R&D activities.

FTE per 1 000 in total employment is the number of professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, as well as in the management of these projects during a given year expressed as a proportion of 1,000 employed people. It is calculated by number of researchers during a given year divided by the total employed people and multiplied by 1 000.

Gross domestic product (GDP) is the total market value of all final goods and services produced in a country in a given year, equal to total consumer, investment and government spending, plus the value of exports, minus the value of imports.

Gross expenditure on research and experimental development (GERD) covers all expenditures for R&D performed on national territory in a given year. It thus includes domestically performed R&D that is financed from abroad but excludes R&D funds paid abroad, notably to international agencies.

Headcount refers to the actual number of people directly involved in or supporting R&D (i.e. the total number of R&D personnel).

HERD refers to higher education expenditure on research and experimental development.

In-house or intramural R&D refers to R&D performed by the unit or entity itself (i.e. by the personnel of the unit or entity). This is R&D performed within the borders of South Africa, even if funded by foreign sources.

Labour costs comprise annual wages and salaries and all associated costs or fringe benefits, such as bonus payments, holiday pay, contributions to pension funds and other social security payments, and payroll taxes. The labour costs of persons providing indirect services that are not included in the personnel data (such as security and maintenance personnel or the staff of central libraries, computer departments or head offices) are excluded from labour costs and included in other current expenditure.

New materials refers to the technology and R&D activities of high-technology companies particularly in the aerospace, construction, electronic, biomedical, renewable energy, environmental remediation, food and packaging, manufacturing and motor car industries. New materials include multi-functional materials, advanced materials, nano-materials, nano-composites and nanotechnology.

Other current expenditure comprises non-capital purchases of materials, supplies and equipment to support R&D performed by the reporting unit in a given year

Other support staff includes skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects.

Outsourced R&D refers to R&D done by another entity on behalf of the reporting unit and paid for by the reporting unit.

Research and experimental development (R&D) comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, and in the management of the projects concerned.

R&D intensity refers to gross expenditure on R&D as a percentage of GDP.

R&D personnel includes all persons employed directly on R&D activities, as well as those providing direct services, such as R&D managers, administrators, technicians and clerical staff.

R&D-performing sectors comprise the government, higher education, business and not-for-profit sectors.

Standard Industrial Classifications (SIC) are codes used by Statistics South Africa for all economic activities of industries.

Socio-economic objectives (SEO) are classification codes providing an indication of the main beneficiaries of R&D activities.

Technicians and equivalent staff are persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life sciences, or social sciences, humanities and the arts.

Total employment is the total employment in the economy. This statistic is obtained from the Statistics South Africa Labour Force Survey series P0211 (Stats SA, 2015b), where employed persons are those aged 15–64 years who, during the reference week, did any work for at least one hour, or had a job or business but were not at work (temporarily absent).

Year-on-year changes are calculated as follows:
(current year's figure - previous year's figure) / previous year's figure × 100%.

EXECUTIVE SUMMARY

The South African National Survey of Research and Experimental Development (R&D Survey) generates key data on human resources and expenditure on R&D. These data are used to develop statistical indicators on the level of investment and the structure of sectors performing R&D. Over time, this trend information provides evidence for setting and monitoring science, technology and innovation policy priorities and targets.

South Africa has undertaken R&D surveys since the 1960s. The Centre for Science, Technology and Innovation Indicators (CeSTII) at the Human Sciences Research Council (HSRC) has undertaken this task since 2001, on behalf of the Department of Science and Technology. This report presents the results of the 2015/16 R&D Survey, which is the fourteenth produced by CeSTII.

Total R&D expenditure in South Africa increased to R32.337 billion in 2015/16.

The gross domestic expenditure on research and experimental development (GERD) increased to R32.337 billion in 2015/16. In nominal terms, this represented an increase of R2.992 billion from the R29.345 billion recorded in 2014/15. At constant 2010 Rand value, GERD amounted to R24.458 billion in 2015/16, which was a year-on-year increase of R1.154 billion from R23.304 billion in 2014/15.

GERD as a percentage of GDP increased from 0.77% to 0.80%.

GERD as a percentage of GDP, or R&D intensity, was 0.80% in 2015/16, which is an improvement of 0.03 percentage points from 0.77% recorded in 2014/15. GERD as a percentage of GDP had remained at 0.73% for three consecutive years, since 2011/12. GDP declined from 1.7% in 2014 to 1.3% in 2015. Therefore, any improvement in R&D intensity must be interpreted in the context of declining economic growth in the period.

GERD increased for all survey sectors.

In nominal terms, GERD grew in all sectors covered by the survey. The business sector was the largest performer of R&D in South Africa in 2015/16, with business expenditure on R&D (BERD) amounting to R13.815 billion. The second largest performer of R&D, and the largest contributor to the increase in GERD, was the higher education sector. Higher education expenditure on R&D (HERD) increased from R8.378 billion in 2014/15 to R9.877 billion in 2015/16. Expenditure on R&D by science councils grew from R5.005 billion in 2014/15 to R5.741 billion in 2015/16. Government expenditure on R&D (GOVERD) increased from R1.893 billion in 2014/15 to R2.013 billion in 2015/16, while the not-for-profit organisation sector recorded an increase in R&D expenditure, from R779 million in 2014/15 to R891 million in 2015/16. In real terms, GERD increased in all sectors, with the exception of the business sector, which registered a decrease of 1.0%.

The business and government sectors are the largest funders of R&D in South Africa.

Government and business enterprises have consistently funded the largest proportion of GERD in South Africa. Funding from the business sector is the second highest after government funding, but its share decreased from 40.8% in 2014/15 to 38.9% in 2015/16. Funding of R&D from government increased slightly, from 43.9% of total funding in 2014/15 to 44.6% in 2015/16. Foreign funding shifted upward, from 12.2% in 2014/15 to 13.0% in 2015/16. The proportion of GERD from other national sources increased marginally from 3.1% in 2014/15 to 3.5% in 2015/16.

Applied research makes up the largest proportion of R&D in SA.

Nationally, the largest proportion of R&D expenditure was allocated for applied research in 2015/16, accounting for 47.5% of GERD. This was followed by experimental development at 27.1% and basic research at 25.4%. Most applied research and experimental development is done within the business sector, followed by the government and science councils sectors combined, for each of these two types of research. The majority of basic research is performed by the higher education sector.

The highest proportion of GERD is within the medical and health sciences.

The largest share of GERD continued to be within the medical and health sciences field at 19.8%, followed by the social sciences and humanities at 18.7%.

R&D expenditure in the financial, intermediation, real estate and business services industry has dominated the composition of BERD since 2011/12.

The financial, intermediation, real estate and business services industry accounted for R5.910 billion (42.8%) of total BERD, and 18.3% of GERD. The manufacturing industry accounted for R4.442 billion (32.2%) of BERD. The mining and quarrying industry decreased from R1.340 billion (10.1%) in 2014/15 to R1.221 billion (8.8%) of total BERD in 2015/16. The electricity, gas and water supply industry recorded a decline of 0.9%, reporting a total R&D expenditure of R0.439 billion in 2015/16. It is worth noting that there has been a marked shift in the composition of BERD: R&D in services is increasing its percentage contribution, while the percentage contribution of R&D in manufacturing is decreasing. These changes are a reflection of the evolving structure of the R&D system in South Africa.

R&D personnel headcounts and FTEs grew in 2015/16.

The 2015/16 R&D Survey recorded 74 931 R&D personnel headcounts, an increase of 2 531 from 2014/15. The majority of R&D personnel were employed in the higher education and business sectors, although total R&D personnel in the business sector decreased. Minor increases in headcounts are observed between 2014/15 and 2015/16 within the not-for-profit, science council and government sectors. The 2015/16 survey recorded a 6.7% increase in FTEs for the

total R&D personnel from 2014/15. The increases in R&D personnel headcounts and FTEs were due to an increase in the number of researchers, mainly postgraduate students. The indicator of R&D personnel FTEs per thousand in total employment (which includes researchers, technicians and other personnel) increased to 2.6 in 2015/16. This indicator has remained around the 2.4 mark for all recorded years in the post-democratic era.

There are increases in R&D investments globally.

Research and experimental development trends around the globe indicate that there is renewed interest in investing in R&D after the 2008-2010 economic crises. Within the BRICS[1] countries, China has shown the highest growth in R&D investments, and South Africa's investment in R&D is growing in nominal and real terms. The economies of China, South Korea, India and Brazil, too, have expanded their proportions of global R&D expenditure. Although the share of global expenditure is not as significant when compared to the other BRICS countries, South Africa is also improving its investment in R&D.

[1] Data for Brazil sourced from the UNESCO Institute for Statistics is for 2014.

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INTRODUCTION

This report provides analysis and commentary on the results of the 2015/16 South African National Survey of Research and Experimental Development (R&D Survey). It is a companion piece to the *Statistical Report*, which presents detailed data tables for 2015/16 in the context of trend data for the past ten years.

The Survey covers the main institutional sectors that perform R&D in South Africa, namely the business, not-for-profit, government, science council and higher education sectors. This approach is followed in order to satisfy national data needs and, at the same time, maintain consistency with the international sector categorisation for measuring R&D. The Organisation for Economic Co-operation and Development (OECD) recommends standards in *The Measurement of Scientific and Technological Activities: Proposed Standard Practice for Surveys on Research and Experimental Development*, commonly known as the Frascati Manual (OECD, 2002).

This report is organised into seven main sections:

- Section 1 of this report provides a contextual overview of the Survey, showing that the need for measurement is increasing, as well as a high-level summary of key indicators.
- Section 2 focuses on indicators relevant for tracking progress towards the policy target of 1.5% of GERD as a percentage of R&D.
- Section 3 considers the major sources and flows of funding across institutional sectors, and compares local and foreign flows.
- Section 4 disaggregates trends in R&D expenditure: for each institutional sector, the type of research conducted, the main focal research fields, accounting categories, and standard industrial codes are analysed. Trends in the R&D conducted to address socio-economic objectives in health, related to HIV/AIDS, malaria and tuberculosis, and biotechnology are outlined. Finally, Section 4 highlights the regional concentration of R&D expenditure.
- Section 5 describes the people employed in R&D occupations (such as researchers, technicians and support staff), assessing trends in headcounts, full-time equivalents (FTEs) and qualification levels. An important policy issue explored in this section is the rapid growth of the post-graduate researcher component.
- Section 6 compares South African R&D performance with selected countries.
- Section 7 concludes with a summary of key trends and policy issues arising from the data.

The last part of the report contains a description of the survey methodology, particularly measurement and classification issues; relevant information on dissemination and enquiries; and a user satisfaction survey.

1. MEASURING STI: THE NEED FOR INDICATORS IS ON THE INCREASE

Globally, the idea that the world is facing a 'fourth industrial revolution' driven by the digitalisation of the economy, big data and artificial intelligence, is gaining support. The rapid changes in technology bring disruption to traditional ways of doing things, to the competitive patterns of entire industries, and creates uncertainty but also great potential. Advanced countries are embracing the benefits of new technologies for all sectors of their economies, having long realised that R&D and innovation are key to economic growth.

For middle-income economies like South Africa, the challenge is to design policies, strategies and plans to maximise an appropriate selection of innovations, technologies and research areas that will embrace the digital potential for wider social benefit. The draft White Paper on Science, Technology and Innovation (STI), which is currently under review, echoes the sentiment that STI are key to development. The White Paper provides an opportunity to orient the national system of innovation (NSI) to take into account the needs and requirements of all actors in the system, addressing poverty, inequality and employment in an inclusive manner. Proposed new policy initiatives such as the establishment of a Sovereign Innovation Fund, expansion of sector innovation funds, and finalisation of an innovation for inclusive development strategy will, when fully established and implemented, enable the resourcing of the NSI to this effect. In this context, the measurement of R&D potential and performance becomes even more significant as a tool to inform policy change.

The STI profiles of most countries provide indicators of their path to economic growth, or the lack of progress in 'catching up'. In recent decades, measuring the level and status of national STI activity has become central to understanding countries' potential to contribute to economic growth and inclusive development. Measures derived from a national R&D survey can provide an indication of the effectiveness of the financial and human resources allocated, highlight areas of under-investment, and identify possible misalignments.

Ten years ago the Department of Science and Technology set a GERD/GDP target of 1.5% to be attained in South Africa by 2018/19. This has been elusive over the years, although arguably it is not unattainable. A key trend evident over time is the fluctuation and decline in both R&D investment and spending by firms in the business sector. There is equally room for improvement in the R&D performance of the public sector. Of course, since the 2008/09 trigger of a global recession, the South African economy, too, has shown sluggish growth. In the 2015/16 year under review, this trend is exacerbated by political turbulence, threats of downgrading by rating agencies, and the adverse effects of climate change. Together, these could have a negative impact

on overall R&D investments. R&D performance could also reflect the consequences of the #FeesMustFall campaign, which, from the perspective of R&D performance, has disrupted activities in the higher education sector since 2015.

1.1 Key indicators

South Africa's key R&Dindicators for 2015/16 are presented in Table 1, in comparison with the indicators for 2013/14 and 2014/15. These high-level results suggest that, despite the poor conditions, in 2015/16 GERD increased in nominal terms, the GERD/GDP ratio inched up to 0.80%, and the R&D personnel complement grew. The remaining sections of this report will provide a more nuanced analysis of the data, to contribute to STI policy debate on the potential for embarking on a transformative and inclusive developmental path.

Table 1: Key R&D indicators, 2015/16 with comparative figures for 2014/15 and 2013/14

KEY INDICATOR	VALUE		
	2013/14	2014/15	2015/16
Gross domestic expenditure on R&D (GERD) (R million)	25 661	29 345	32 337
Gross domestic product (GDP) at current prices (R million)	3 534 326	3 796 462	4 049 760
GERD as a percentage of GDP (%)	0.73	0.77	0.80
Civil GERD as a percentage of GDP (%)[2]	0.69	0.72	0.75
Basic research (Rand million)	6 102	7 133	8 210
Total R&D personnel (FTE*)	37 956.5	38 465.0	41 054.5
Total researchers (FTE*)	23 346.0	23 571.9	26 159.4
Total researchers (FTE*) per 1 000 in total employment	1.6	1.5	1.7
Total R&D personnel (FTE*) per 1 000 in total employment	2.5	2.5	2.6
Total researchers (headcount)	45 935	48 479	51 877
Female researchers (headcount) as a percentage of total researchers (%)	44.0	44.3	44.4

Data note	* FTE = Full-time equivalent
Data sources	South African National Survey of Research and Experimental Development, 2013/14 to 2015/16 GDP values: Statistics South Africa, GDP, Quarter 4 2015, P0441 Series (Stats SA, 2015a) Total employment value: Stats SA, Labour Force Survey, Quarter 1, 2015. P0211 Series (Stats SA, 2015b)

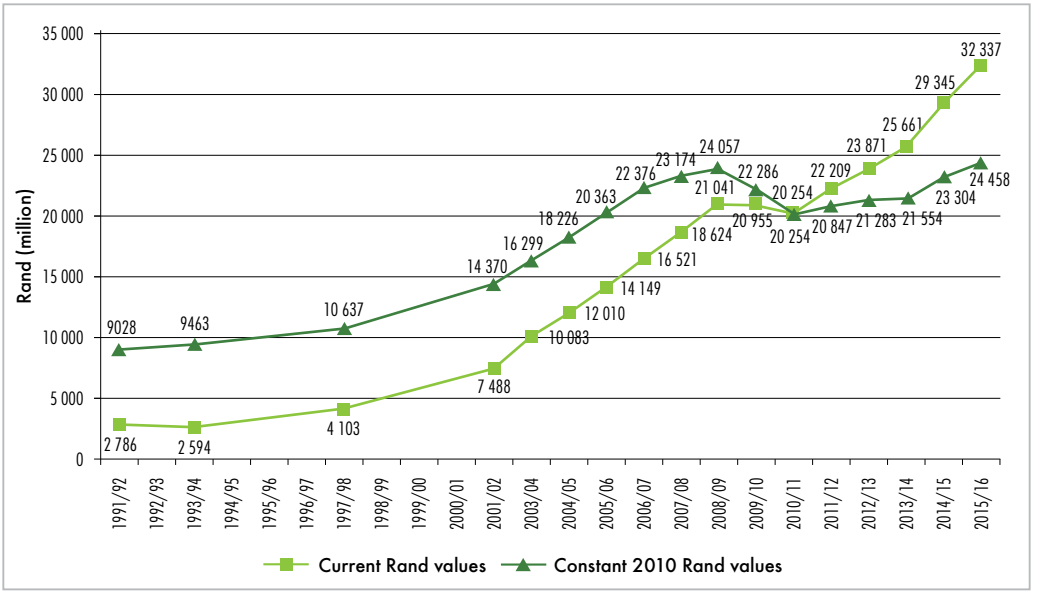
[2] Civil GERD is GERD minus defence GERD.

2. R&D EXPENDITURE

2.1 Gross domestic expenditure on R&D

The gross expenditure on research and experimental development (GERD) amounted to R 32.337 billion in 2015/16. In nominal terms, this represented an increase of R2.992 billion from the R29.345 billion recorded in 2014/15. At constant 2010 Rand value, GERD amounted to R24.458 billion in 2015/16, which was an increase of R1.154 billion from R23.304 billion in 2014/15.

Figure 1: GERD in current and constant 2010 Rand value (R million), South Africa, 1991/92 to 2015/16

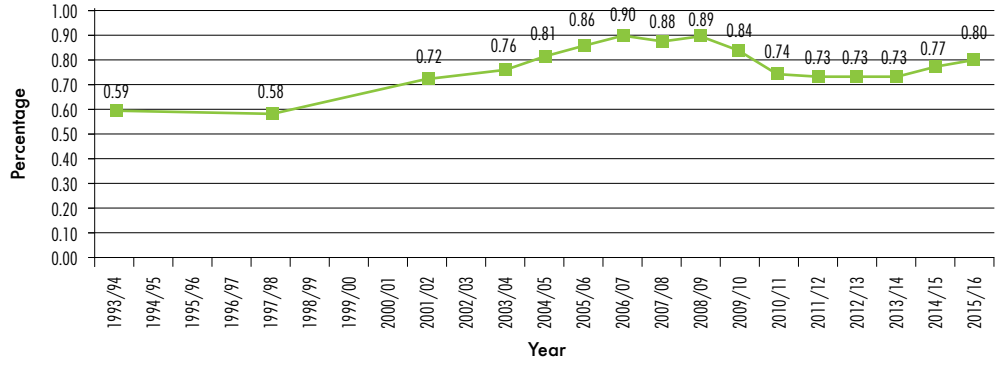


Data note	GDP deflator values derived from Stats SA (2015a) were used to calculate constant 2010 Rand values for R&D expenditure.
Data sources	Revised GDP (current values): Statistics South Africa, GDP, Quarter 4 2015, P0441 Series (Stats SA, 2015a). R&D expenditure: National Survey of Research and Experimental Development, 2001/02 to 2015/16. R&D expenditure for the period prior to 2001/02 was sourced from archived data (DNE, 1993; DACST, 1996; DACST, 2000).

2.2 GERD as a percentage of GDP

GERD as a percentage of GDP, a measure of R&D intensity, was 0.80% in 2015/16. This indicator increased, by 0.03 percentage points from 0.77% in 2014/15, after remaining at 0.73% for three consecutive years since 2011/12. Figure 2 shows that GERD as a percentage of GDP in South Africa increased steadily from 0.58% in 1997/98 and peaked at 0.90% in 2006/07. The GERD/GDP level is yet to surpass the level it reached in 2006/07. The rate of increase in R&D expenditure in nominal Rand value in the periods 2014/15 and 2015/16 has been consistent.

Figure 2: GERD as a percentage of GDP, South Africa, 1993/94 to 2015/16



Definition	GERD expressed as a percentage of GDP indicates the intensity of R&D in an economy.
Data sources	Statistics South Africa, GDP, Quarter 4, 2015, P0441 Series (Stats SA, 2015a) R&D expenditure: National Survey of Research and Experimental Development, 2001/02 to 2014/15. R&D expenditure for the period prior to 2001/02 was sourced from archived data (DNE, 1993; DACST, 1996; DACST, 2000). R&D intensities prior to GDP revision: National Survey of Research and Experimental Development, 2015/16

2.3 GERD by institutional sector

The business sector was the largest performer of R&D in South Africa in 2015/16, with business expenditure on R&D (BERD) amounting to R13.815 billion. Business expenditure on R&D at constant prices amounted to R10.449 billion, which is equivalent to 42.7% of GERD. Although there were decreases in the level of R&D investment by business enterprises between 2008/09 and 2012/13, this sector has remained the largest R&D performer throughout the history of the South African R&D Survey.

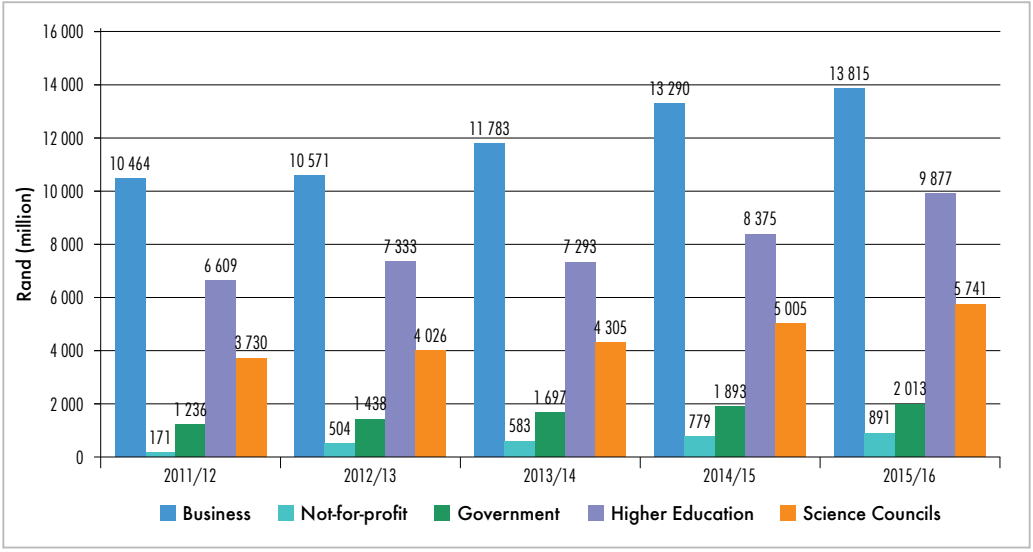
The second largest performer of R&D was the higher education sector. Higher education expenditureon R&D (HERD) increased from R 8.378 billion in 2014/15 to R9.877 billion in 2015/16. At constant 2010 Rand value, this represented a 30.5% increase in R&D expenditure from R6.653 billion in 2014/15 to R7.470 billion in 2015/16.

Expenditure on R&D by science councils grew from R5.005 billion in 2014/15 to R5.741 billion in 2015/16, and accounted for 17.8% of total GERD. At constant 2010 Rand value, this represented a 9.5% increase, from R3.974 billion in 2014/15 to R4.342 billion in 2015/16.

Government expenditure on R&D (GOVERD) constituted 6.2% of GERD and increased in current Rand value from R1.893 billion in 2014/15 to R2.013 billion in 2015/16. At constant 2010 Rand value, this represented an increase of 1.3% from R1.503 billion in 2014/15 to R1.523 billion in 2015/16.

Not-for-profit organisations recorded an increase in R&D expenditure from R779 million in 2014/15 to R891 million in 2015/16. At constant 2010 Rand value, this represented a 9.0% increase from R618 million in 2014/15 to R674 million in 2015/16.

Figure 3: R&D expenditure by sector (R million), South Africa, 2011/12 to 2015/16



Definition	The Frascati Manual (OECD, 2002) defines the R&D-performing sectors as the government, higher education, business and not-for-profit sectors. For these statistics, GERD has been broken down by sector of performance as recorded in the R&D Survey.
Data source	National Survey of Research and Experimental Development, 2011/12 to 2015/16

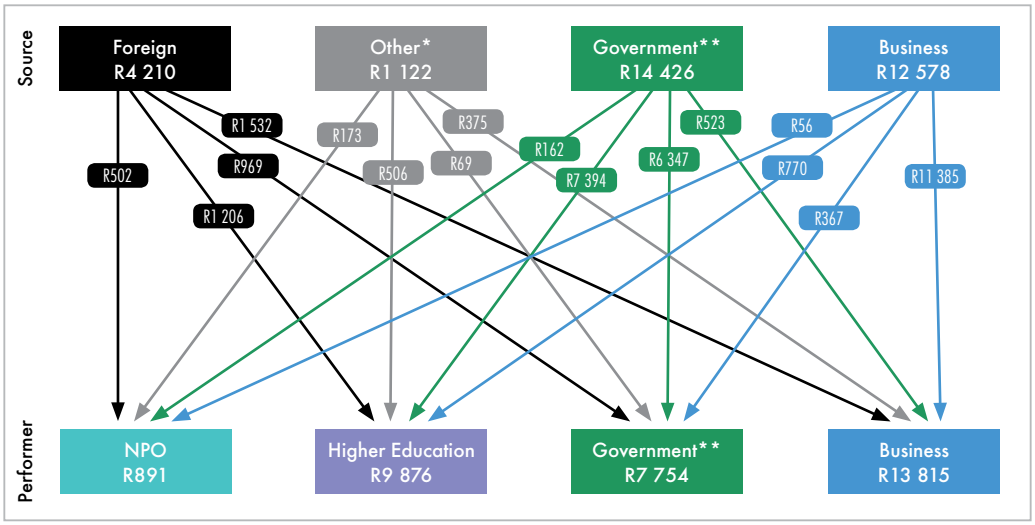
3. FUNDING FOR R&D

3.1 Major flows of R&D funding

Government funded the largest proportion of R&D in South Africa in 2015/16. Government funding increased by 12.1% from R12.873 billion in 2014/15 to R14.426 billion in 2015/16, representing 44.6% of total R&D funding. Higher education institutions received 51.3% (R7.394 billion) and government institutions received 44.0% (R6.347 billion) of the total government R&D funding. The business and not-for-profit sectors were the smallest recipients of R&D funding from government, receiving 3.6% (R523 million) and 1.1% (R162 million) respectively.

The business sector was the second-largest funder of R&D, contributing 38.9% (R12.578 billion) towards total R&D funding. The business sector funded 90.5% (R11.385 billion) of BERD from its own sources. The remainder of the R&D funding by the business sector was allocated mainly to the higher education and government sectors (including science councils), at R770 and R367 million respectively. The third-largest source of funding for R&D in 2015/16 was from abroad. This amounted to 13.0% (R4.210 billion) in 2015/16, an increase of 18.1% from R3.566 billion in 2014/15.

Figure 4: Major flows of funding, (R million), South Africa, 2015/16



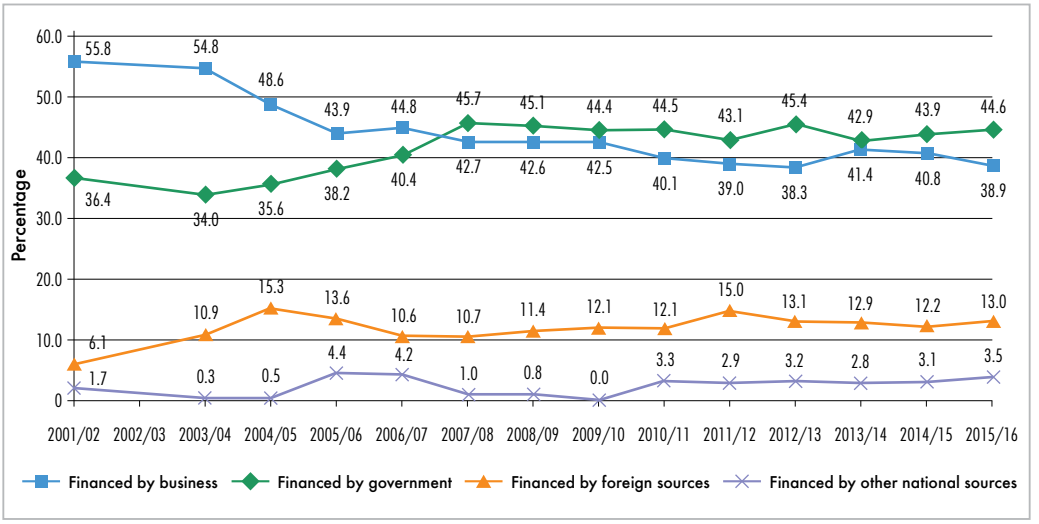
Data note	*Other national sources include contributions from higher education, not-for-profit organisations and individual donations. **Government includes science councils. Differences in values may be due to rounding.
Data source	National Survey of Research and Experimental Development, 2015/16

3.2 GERD by sources of funds

Government and business enterprises have consistently funded the largest proportion of GERD in South Africa. However, the proportion of R&D funding by government, foreign sources, and other national sources increased in 2015/16, while the proportion of funds from business sources decreased.

Funding of R&D from government increased from 43.9% of total funding in 2014/15 to 44.6% in 2015/16. Foreign funding increased from 12.2% in 2014/15 to 13.0% in 2015/16. The proportion of GERD from other national sources increased marginally from 3.1% in 2014/15 to 3.5% in 2015/16. The only decrease was reported in business-funded R&D, which decreased from 40.8% in 2014/15 to 38.9% in 2015/16.

Figure 5: GERD by source of funds (percentage), South Africa, 2001/02 to 2015/16



Data note	*Other national sources include contributions from higher education, not-for-profit organisations and individual donations. **Government includes science councils.
Data source	National Survey of Research and Experimental Development, 2001/02 to 2015/16

3.3 Business-funded R&D

The business sector continued to fund its own research almost exclusively in 2015/16. This proportion of funding has increased steadily since 2010/11, though the sector's total contribution to funding GERD has been decreasing since 2013/14.

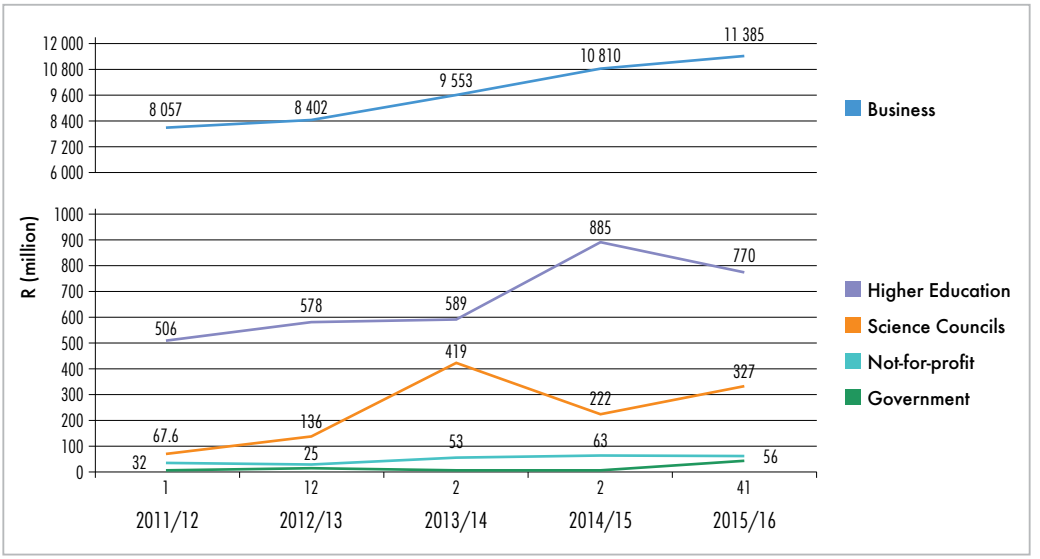
Business funding of R&D for the higher education sector decreased by 13.0% from R885 million in 2014/15 to R770 million in 2015/16. Higher education remained the second-largest recipient of funding from the business sector. Business funding of R&D in the government sector showed a significant increase in investment, from R290 thousand in 2014/15 to R41 million in 2015/16. Similarly, funding of R&D from business sources to the science councils showed a 46.6% increase from R223 million in 2014/15 to R327 million in 2015/16. The not-for-profit sector showed a decrease of R&D funding from the business sector from R63 million in 2014/15 to R56 million in 2015/16.

Table 2: Business-funded R&D by sector of performance (R million), South Africa, 2011/12 to 2015/16

SECTOR	2011/12	2012/13	2013/14	2014/15	2015/16
Business	8 056 545	8 402 340	9 552 717	10 810 428	11 384 709
Not-for-profit	32 081	24 894	53 359	63 084	55 584
Government	1 355	11 552	1 759	290	41 109
Science councils	67 614	135 729	419 469	222 892	326 647
Higher education	505 510	577 527	588 598	885 280	770 448
Total (current Rand value)	**8 663 105**	**9 152 042**	**10 615 902**	**11 981 974**	**12 578 497**
Total (constant 2010 Rand value)	**8 131 909**	**8 159 802**	**8 916 961**	**9 515 357**	**9 513 948**

Data note	GDP deflator values derived from the Stats SA (2015a) and were used to calculate constant 2010 Rand values for R&D expenditure. Revised GDP (current values): Statistics South Africa, GDP, Quarter 4 2015, P0441 Series (Stats SA, 2015a)
Data source	National Survey of Research and Experimental Development, 2011/12 to 2015/16

Figure 6: Business-funded R&D by sector of performance (R million), South Africa, 2011/12 to 2015/16



Data source National Survey of Research and Experimental Development, 2011/12 to 2015/16

3.4 Government funding of local R&D

Government funding of R&D has grown steadily since 2010/11 to date. Higher education institutions and science councils were the largest recipients of government funding between 2011/12 and 2015/16. Government funding of higher education increased by 22.8% from R6.021 billion in 2014/15 to R7.394 billion in 2015/16, while funding of R&D for science councils increased by 14.0%, from R4.319 billion in 2014/15 to R4.922 billion in 2015/16. Government funding of R&D for the not-for-profit sector increased by 23.7%, from R131 million in 2014/15 to R162 million in 2015/16. Government funding of R&D to the government sector decreased by 16.7% from R1.712 billion in 2014/15 to R1.426 billion in 2015/16, while the business sector also received less R&D funding from government, decreasing from R690 million to R523 million in the same period.

Table 3: Government-funded R&D (R'000), South Africa, 2010/11 to 2014/15

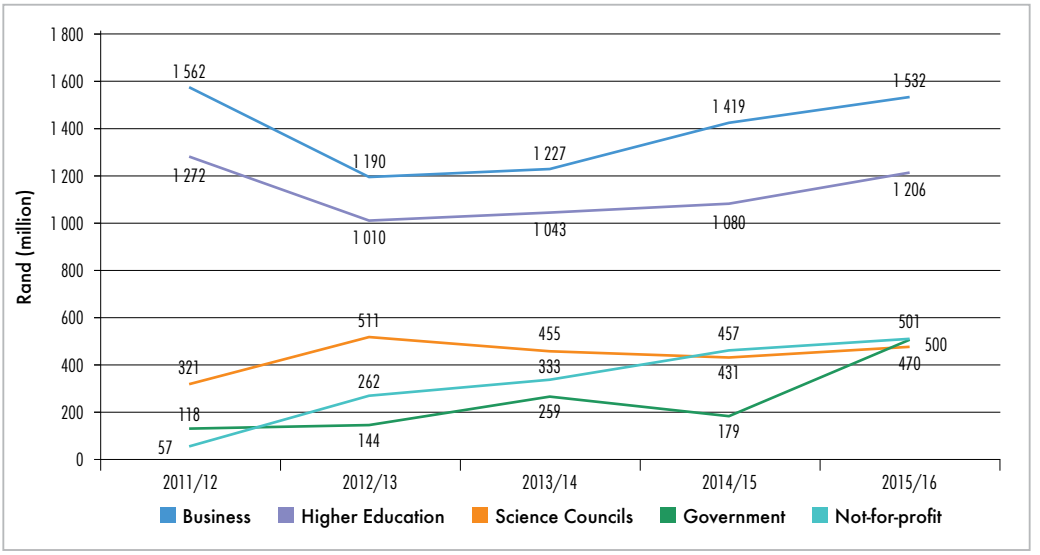
SECTOR	2011/12	2012/13	2013/14	2014/15	2015/16
Business	499 298	683 669	685 670	690 396	522 631
Not-for-profit	40 992	114 461	103 148	131 288	161 682
Government	1 112 307	1 269 337	1 436 141	1 711 809	1 425 598
Science councils	3 310 894	3 368 555	3 412 790	4 319 393	4 922 222
Higher education	4 598 426	5 395 871	5 369 334	6 020 572	7 393 857
Total (current Rand value)	**9 561 917**	**10 831 893**	**11 007 083**	**12 873 458**	**14 425 990**
Total (constant 2010 Rand value)	**8 975 608**	**9 657 528**	**9 245 538**	**10 223 319**	**10 911 329**

Data note	GDP deflator values derived from the Stats SA (2015a) and were used to calculate constant 2010 Rand values for R&D expenditure.
Data sources	Revised GDP (current values): Statistics South Africa, GDP, Quarter 4, 2015, P0441 Series (Stats SA, 2015a) R&D expenditure: National Survey of Research and Experimental Development, 2011/12 to 2015/16

3.5 Foreign funding of local R&D

R&D funding from abroad shows fluctuations across the institutional sectors over the years, but increased across all sectors in the 2015/16 survey reference period. The largest share of foreign funding was received by the business (36.4%) and higher education (28.7%) sectors. Foreign funding of R&D to the business sector increased from R1.419 billion in 2014/15 to R1.532 billion in 2015/16, and increased from R1.080 billion to R1.206 billion in the higher education sector. Foreign funding of R&D for the government sector increased significantly, from R179 million in 2014/15 to R500 million in 2015/16. Not-for-profit organisations' share of funding increased marginally, growing by 9.6% from R457 million in 2014/15 to R501 million in 2015/16, while the science councils increased similarly by 9.0% from R431 million to R470 million.

Figure 7: Foreign-funded R&D by sector of performance (R million), South Africa, 2011/12 to 2015/16



Data note	Foreign sources include all funding from foreign sources from all sectors.
Data source	National Survey of Research and Experimental Development, 2011/12 to 2015/16

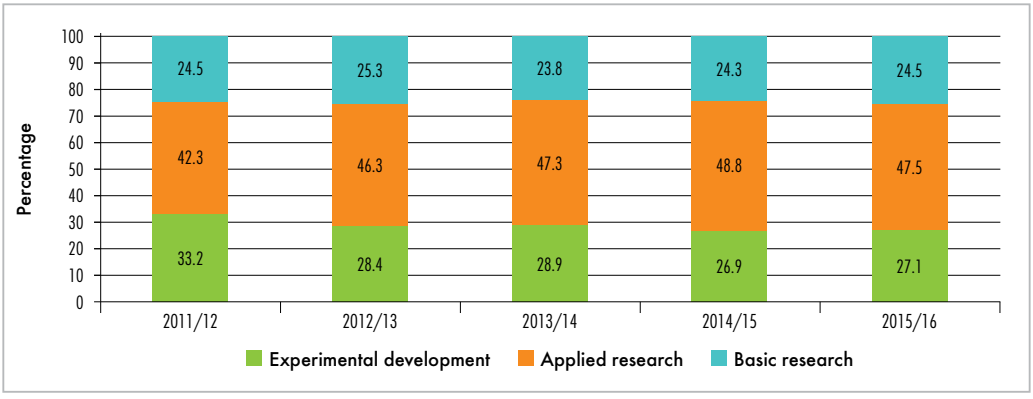
4. DISAGGREGATION OF R&D EXPENDITURE

4.1 GERD by type of research

In the 2015/16 reporting period, applied research continued to attract the largest proportion of R&D expenditure. The proportion of domestic R&D expenditure devoted to applied research accounted for 47.5% in 2015/16, a slight decline from the value recorded in 2014/15 (48.8%). As a result, the proportional share of expenditure accounted for in the basic research (25.4%) and experimental development (27.1%) types of research increased from the reported levels in the 2014/15 reference period.

Despite the proportional decrease in applied research expenditure, this category of R&D continues to account for the largest share of research activity in South Africa. Between the period 2011/12 and 2015/16, applied R&D expenditure increased by 5.2%, reaching its highest level in 2014/15.

Figure 8: GERD by type of research (percentage), South Africa, 2011/12 to 2015/16



Data source National Survey of Research and Experimental Development, 2011/12 to 2015/16

4.2 GERD by type of research and institutional sector of performance

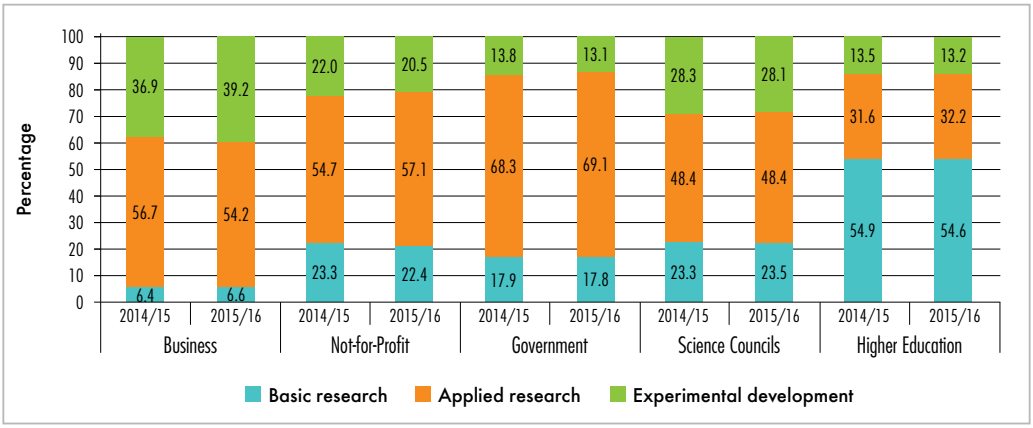
The business sector mirrors the national data trends, demonstrating similar patterns of R&D by type of research expenditure. Notwithstanding the 2.5% decrease since the 2014/15 measurement, applied research contributed the largest share to BERD, with 54.2% of expenditure attributed to this R&D category in 2015/16. Despite remaining relatively stable, an increased proportional share of BERD was reported in the 2015/16 reference period for both experimental development and basic research.

The not-for-profit sector revealed a proportional increase in applied research spend, from 54.7% in 2014/15 to 57.1% in 2015/16. Basic research and experimental development in 2015/16 experienced a decline in proportional R&D spend for the NPO sector during this reference period.

R&D expenditure within the government sector did not demonstrate significant change from levels recorded in the 2014/15 survey results. There were minor declines in proportional expenditure on basic research and experimental development in 2015/16, though applied research expenditure did record a marginal increase, from 68.3% in 2014/15 to 69.1% in 2015/16. Similarly, in the science council sector, the trends in R&D expenditure by type of research remained relatively unchanged, with the major share of expenditure spent on applied research (48.4%), when compared to basic research (23.5%) and experimental development (28.1%) in 2015/16.

The higher education sector continued to allocate the greatest share of expenditure to basic research (54.6%). This is significantly higher than any other institutional sector within the survey series. It displayed a minor year-on-year increase of 0.6% between 2014/15 and 2015/16. The proportion of expenditure on applied research (32.2%) and experimental development (13.2%) remained comparatively similar to levels recorded in the 2014/15 reference period.

Figure 9: GERD by type of research and sector of performance (percentage), South Africa, 2014/15 to 2015/16



Data source National Survey of Research and Experimental Development, 2014/15 to 2015/16

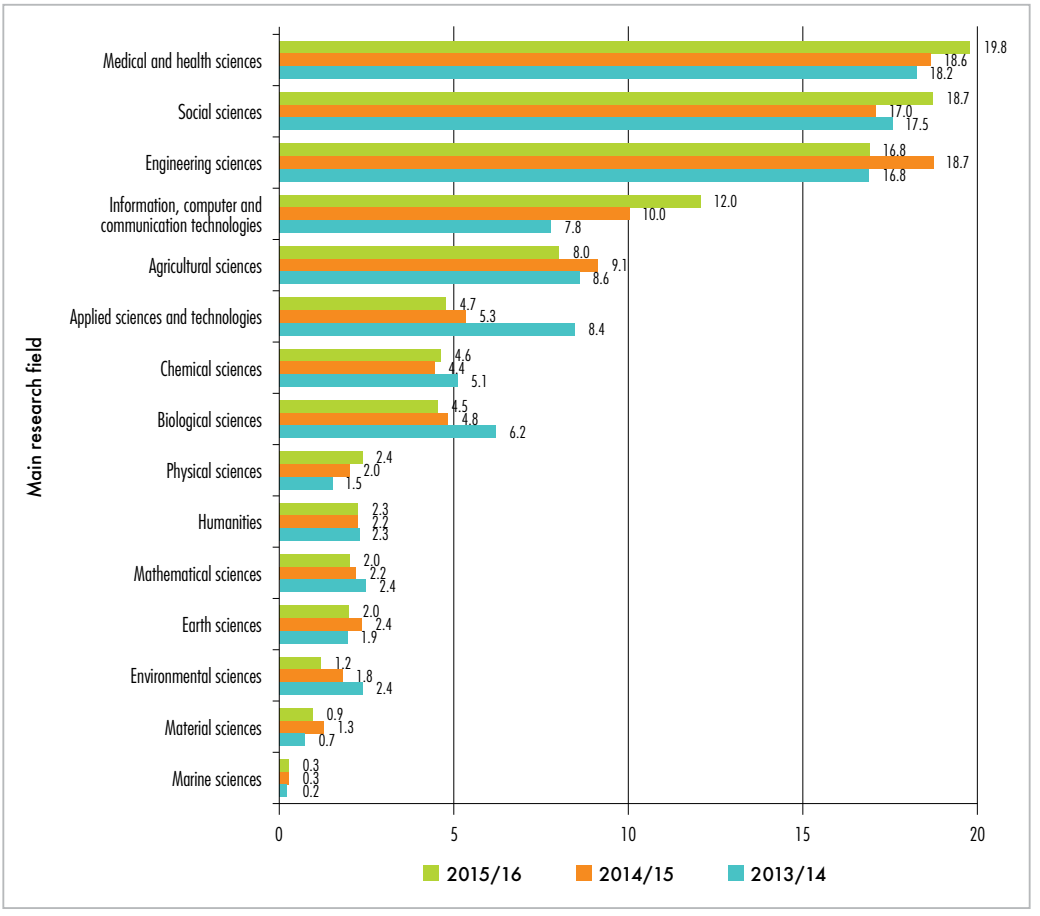
4.3 GERD by major research field

In the 2015/16 reference period, the key research fields to which the highest proportion of R&D funding was allocated remained consistent with the 2014/15 results, despite minor within-category expenditure fluctuations. The largest share of GERD continued to be spent within the medical and health sciences field (19.8%). This indicates a 1.2% increase on the level recorded in 2014/15 and a 2.6% increase over the five-year period since 2011/12.

The social sciences category attracted the next highest proportion of GERD (18.7%) in the 2015/16 reference period. This represents a 1.7% year-on-year increase in expenditure within the social sciences and a five-year trend analysis shows a 6.1% increase. Expenditure within the Information, computer and communication technologies field reflected a year-on-year increase of 2.0%, while the physical sciences recorded an increase of 0.4%.

Some research fields reflected a year-on-year decline in proportional R&D expenditure. The engineering sciences research field recorded a slight decrease in expenditure during the 2015/16 reporting period. The year-on-year decline was 1.9%, while analysis of the five-year data since 2011/12 indicates a decline of 0.2%. Similarly, the mathematical, biological, material, earth, environmental, agricultural, engineering and applied sciences all recorded minor decreases in proportional expenditure, between 0.2% and 1.1%.

Figure 10: GERD by research field (percentage), South Africa, 2013/14 to 2015/16



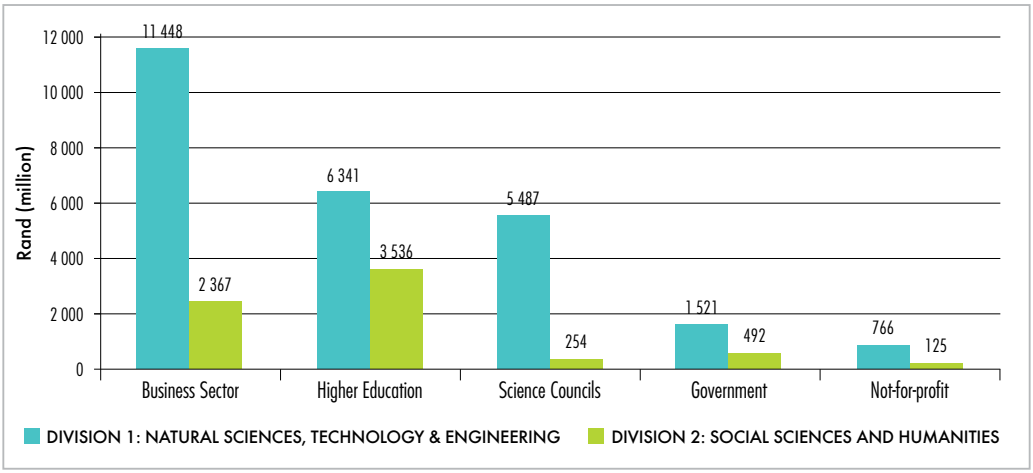
Data note	GERD according to research fields as measured in the R&D survey.
Data source	National Survey of Research and Experimental Development, 2013/14 to 2015/16

4.4 GERD by division of research field and institutional sector of performance

The largest share of GERD falls within Division 1 (79.1%), while Division 2 attracted 21.0% of total national R&D expenditure for 2015/16.

During the 2015/16 reference period, the business sector accounted for the largest share of GERD within Division 1 (35.4%); followed by higher education (19.6%); the science councils (17.0%); government (4.7%) and the NPO sector (2.4%). Within Division 2, higher education spent a higher proportional value on social sciences and humanities research (10.9%). This was followed by the business sector (7.3%), government (1.5%), science councils (0.8%) and the NPO sector (0.4%).

Figure 11: R&D expenditure by research field (R million), South Africa, 2015/16



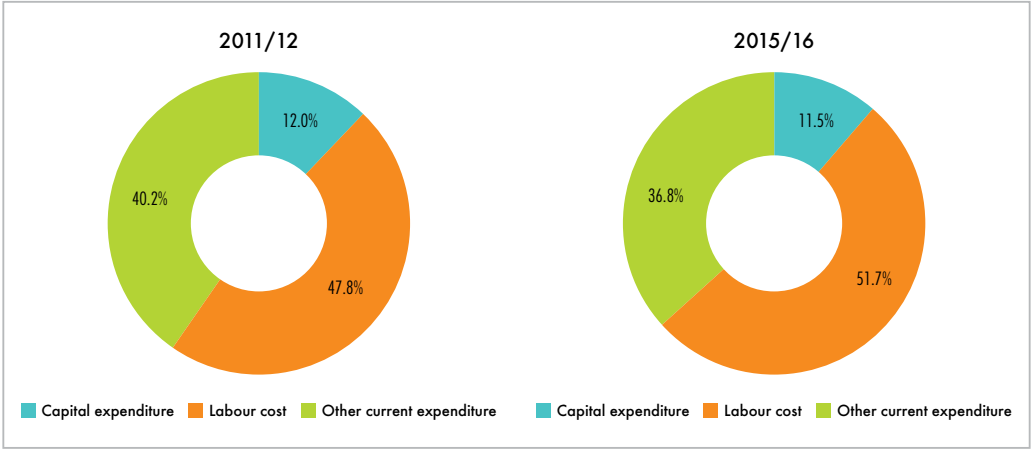
Data note	Research field codes are used to classify research expenditure into two divisions according to defined scientific disciplines: Division 1 (Natural sciences, technology and engineering) and Division 2 (Social sciences and humanities).
Data source	National Survey of Research and Experimental Development, 2015/16

4.5 R&D expenditure by accounting category

The trends in R&D expenditure by accounting categories have been changing over the past five reference periods. Since 2011/12, the portion of R&D expenditure allocated to capital expenditure and other current expenditure has been decreasing.

In 2011/12, South Africa reported 40.2% of R&D expenditure devoted to 'other' current expenditure, while in the most recent 2015/16 survey period, this value decreased to 36.8%. Capital expenditure, which records investment in infrastructure and equipment, has seen a 0.5% decline during the period 2011/12 to 2015/16.

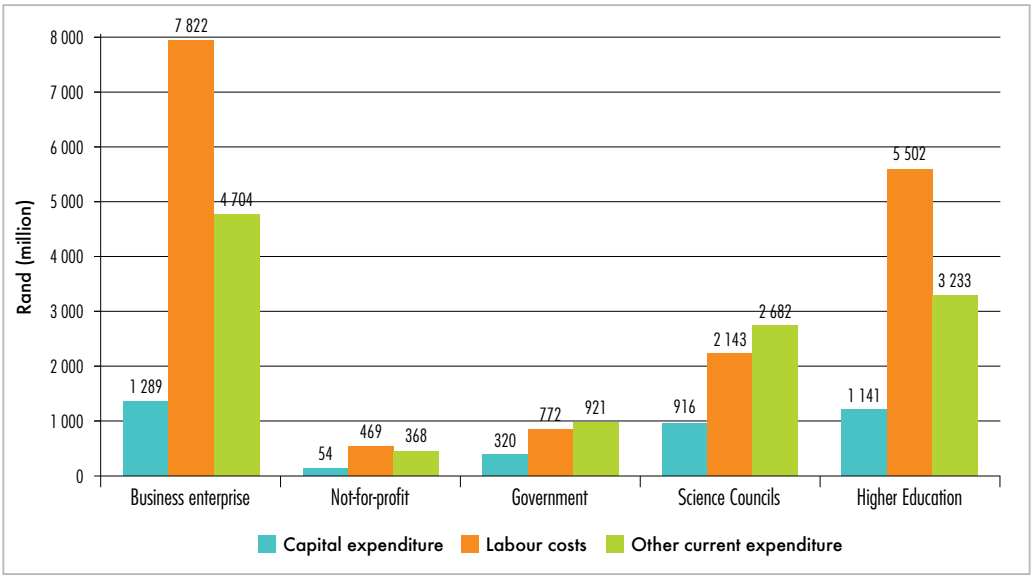
Figure 12: R&D expenditure by accounting category (percentage), South Africa, 2011/12 and 2015/16



Definition	Other current expenditure comprises non-capital purchases of materials, supplies and equipment to support R&D performed by the statistical unit in a given year.
Data source	National Survey of Research and Experimental Development, 2011/12 and 2015/16

The largest proportion of R&D expenditure, at a national aggregate level, was allocated to labour costs. This category includes costs associated with knowledge-generating staff, as well as those university students investing a significant time allocation in research activities. The proportion of costs within this accounting category has been increasing at a higher rate than capital and other current expenditure. In 2011/12, the proportional cost associated with labour was 47.8%, while in the most recent reference period this value reached 51.7%, an increase of 3.9% across the five-year period. Within this 51.7%, 45.7% of costs are attributed to staff, while 6.0% of R&D expenditure was devoted to supporting students at tertiary institutions.

Figure 13: R&D expenditure by accounting category (R million), South Africa, 2015/16



Data source National Survey of Research and Experimental Development, 2015/16

4.6 Business sector R&D expenditure by Standard Industrial Classification

The business sector records R&D expenditure within standard industrial classification (SIC) codes, allowing a more detailed examination of R&D activity within this sector. The largest contributing economic sector to GERD in South Africa continues to be the financial, intermediation, real estate and business services industry (80 000 code group) (Figure 14, Table 4). In the 2015/16 reference period, this industrial sector accounted for 42.8% of BERD and 18.28% of GERD. In the 2015/16 period, businesses in the financial intermediation, real estate and business services sector spent R 5.910 billion on R&D. This represents a 2.5% increase on the value recorded in the 2014/15 survey, amounting to a year-on-year nominal increase of R560 million.

The next largest economic sector was the manufacturing sector (30 000 code group), accounting for 32.2% of BERD. In nominal terms, this amounted to R4.440 billion, 1.7% lower than the value recorded in the 2014/15 reference period. The largest decline was revealed in the 35 000 code group (manufacture of broadcast and precision equipment), where expenditure decreased by 0.8%; while the 33 000 code group, manufacture of chemical products (including pharmaceuticals), recorded a decrease of 0.8% between 2014/15 and 2015/16 (Figure 15).

Mining and quarrying (20 000 code group) continued to be the third largest area of R&D by SIC group, attracting R1.220 billion in the 2015/16 period. This amounts to 8.8% of total BERD, down 1.2% from the previous value in 2014/15. The electricity, gas and water supply sector (40 000 code group) recorded a decline of 0.9%, reporting a total R&D expenditure of R 0.439 billion, compared to R0.548 billion in the preceding reference period. The wholesale and retail trade sector recorded a second successive annual decline in R&D expenditure during 2015/16, indicating a decline of R42 million less R&D than in 2014/15.

The transport, storage and communication SIC group (70 000 code group) recorded the largest increase in R&D expenditure during the 2015/16 period, amounting to a 1.7% year-on-year increase.

Figure 14: Business R&D expenditure by SIC category (as a percentage of GERD), South Africa, 2014/15 and 2015/16

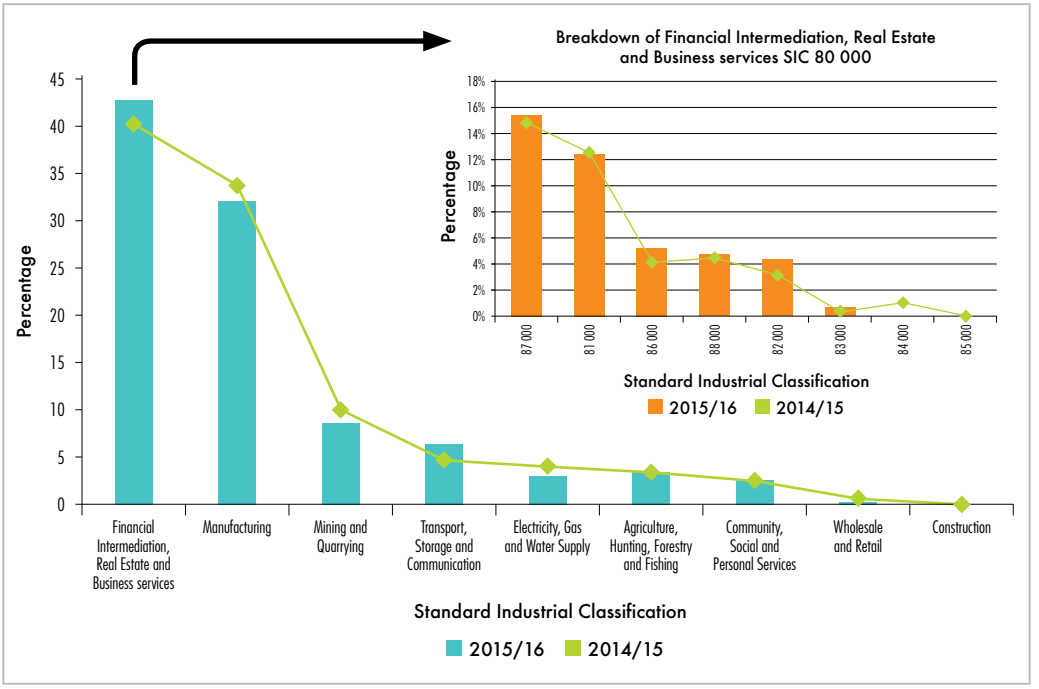


Table 4: Standard Industrial Classification (SIC) categories in the 80000 group

81000	Financial Intermediation, except Insurance and Pension Funding
82000	Insurance and Pension Funding, except Compulsory Social Security
83000	Activities Auxiliary to Financial Intermediation
84000	Real Estate Activities
85000	Renting of Machinery and Equipment, and of Personal and Household Goods
86000	Computer and Related Activities
87000	Research and Development
88000	Other Business Activities; N.E.C

Definition	Industry classification is based on Statistics South Africa's five-digit Standard Industrial Classification (SIC) codes, which are used to classify businesses according to economic activities.
Data source	National Survey of Research and Experimental Development, 2014/15 and 2015/16

Figure 15: Business R&D expenditure by SIC manufacturing category, South Africa, 2014/15 and 2015/16

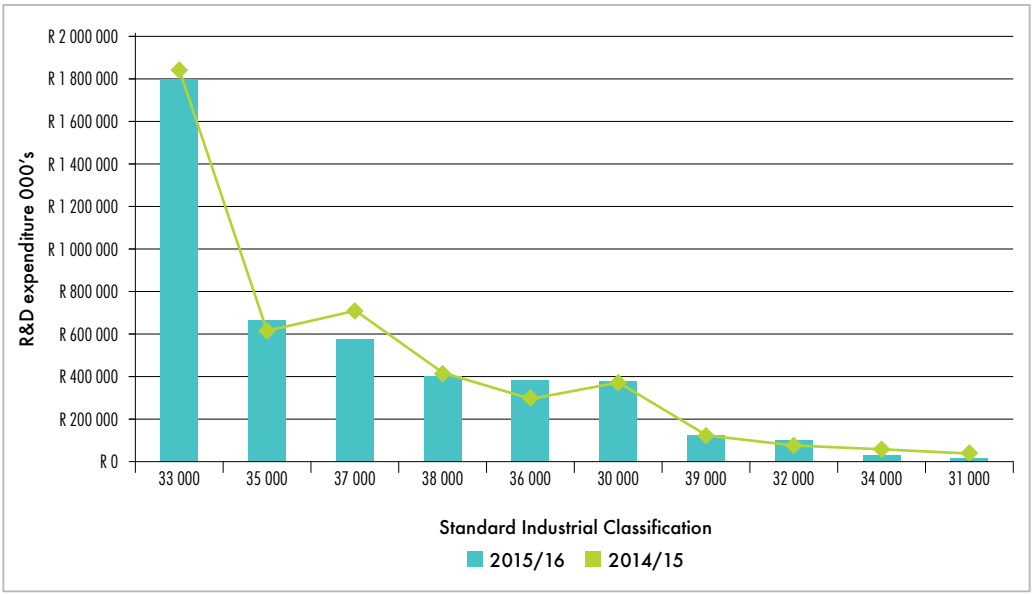


Table 5: Standard Industrial Classification (SIC) codes in the 30000 group

30000	Manufacture of Food Products, Beverages and Tobacco Products
31000	Manufacture of Textiles, Clothing and Leather Goods
32000	Manufacture of Wood Products, except Furniture, Paper Products, Publishing & Printing Material
33000	Manufacture of Refined Petroleum, Nuclear Fuel, Chemical Products (incl. Pharmaceuticals, Rubber and Plastic)
34000	Manufacture of Non-Metallic Mineral Products
35000	Manufacture of Basic & Fabricated Metal Products, Machinery & Equipment, Office, Accounting and Computing
36000	Manufacture of Electrical Machinery and Apparatus
37000	Manufacture of Communication Equipment & Apparatus, Medical, Precision and Optical Instruments
38000	Manufacture of Transport Equipment
39000	Manufacture of Furniture, Recycling, Manufacturing not elsewhere classified

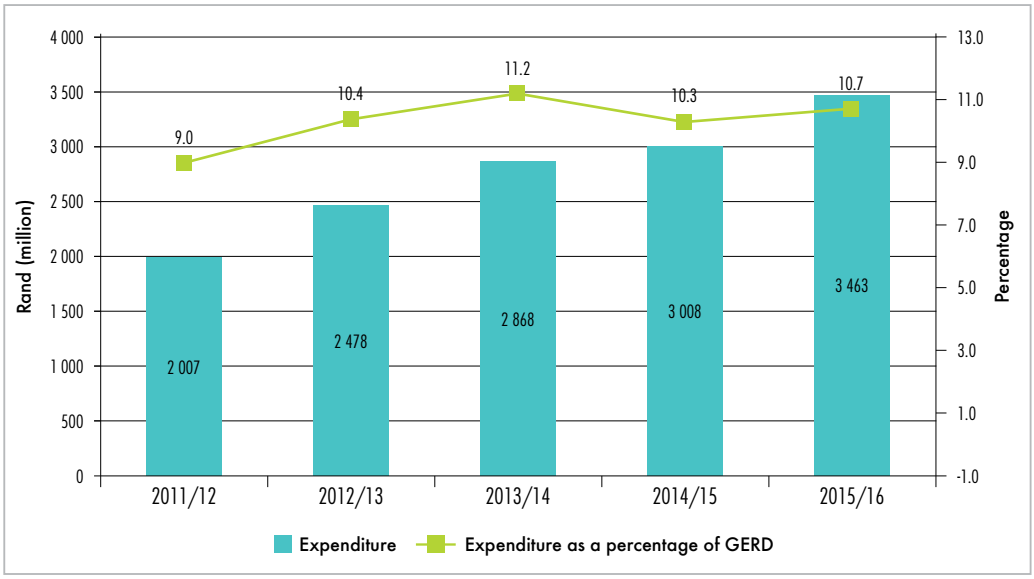
Definition	Industry classification is based on Statistics South Africa's five-digit Standard Industrial Classification (SIC) codes, which are used to classify businesses according to their economic activities.
Data source	National Survey of Research and Experimental Development, 2014/15 and 2015/16

4.7 R&D related to HIV/AIDS, malaria and tuberculosis and Biotechnology

4.7.1 R&D on tuberculosis, HIV/AIDS and malaria

Health and medical research are key areas of R&D addressing social challenges in contemporary South Africa. Domestic research within this domain has produced globally recognised solutions, reflected in the increasing level of investment. R&D investment in priority areas of health research, including TB, HIV/AIDS and malaria, amounted to R3.463 billion in the 2015/16 reference period. This increased by R0.454 billion compared to the levels recorded in the 2014/15 survey. The growing investment in health-related areas of R&D is a consistent trend since 2011/12, increasing by 72.6% across the five-year period from R2.007 billion to R3.463 in 2015/16.

Figure 16: R&D expenditure on TB, HIV/AIDS and malaria (R million and as a percentage of GERD), South Africa, 2011/12 to 2015/16

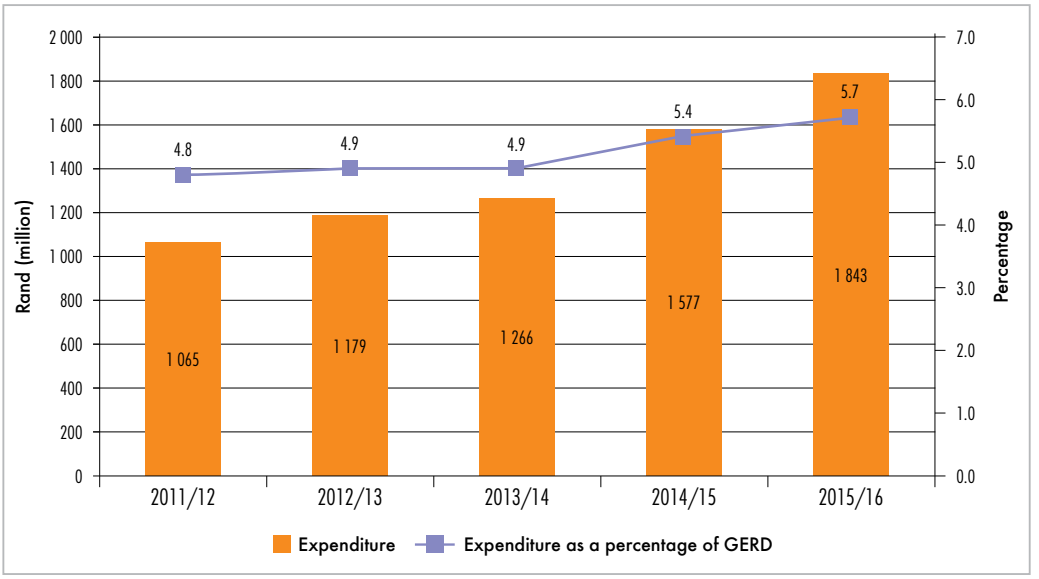


Data source National Survey of Research and Experimental Development, 2011/12 to 2015/16

4.7.2 Biotechnology-related R&D

The multidisciplinary area of biotechnology attracted R1.843 billion in R&D investment during the reference period 2015/16. This amounted to 5.7% of GERD, a nominal value increase of 16.9% between 2014/15 and 2015/16. Across the five-year period (2011/12 to 2015/16), R&D investment in biotechnology increased from R1.065 billion to R1.843 billion, an increase of just over 73%, indicating steady growth within this sub-sector of the developing knowledge economy.

Figure 17: R&D expenditure on biotechnology (R million and as a percentage of GERD), South Africa, 2011/12 to 2015/16



Data source National Survey of Research and Experimental Development, 2011/12 to 2015/16

4.8 Geographic dimensions of R&D

4.8.1 R&D expenditure by province

In South Africa, R&D activities have historically been concentrated in the three strongest provinces, namely Gauteng, the Western Cape and KwaZulu-Natal. This pattern has remained relatively consistent in 2015/16, with some growth in proportional expenditure within the Western Cape.

The Gauteng province accounted for 45.4% (R14.666 billion) of GERD, followed by the Western Cape recording 22.0% (R7.125 billion), and Kwazulu-Natal at 10.3% (R3.335 billion) of total GERD. The Eastern Cape, Free State and the Northern Cape showed increased proportional R&D expenditure between 2014/15 and 2015/16. The largest decrease in R&D expenditure was found in the North West province, which dropped by 13.8%, year-on-year, or R0.193 billion less than in 2015/16.

Table 6: R&D expenditure by province (R'000 and percentage), South Africa, 2014/15 and 2015/16

PROVINCE	2014/15		2015/16	
	R'000	%	R'000	%
Eastern Cape	1 734 410,5	5,9	2 142 918,7	6,6
Free State	1 456,460,6	5,0	1 778 469,4	5,5
Gauteng	13 686 733,7	46,6	14 666 110,9	45,4
KwaZulu-Natal	3 187 480,9	10,9	3 335 141,1	10,3
Limpopo	628 607,0	2,1	627 124,6	1,9
Mpumalanga	859 200,5	2,9	791 248,2	2,4
North-West	1 402 742,0	4,8	1 209 434,3	3,7
Northern Cape	575 584,2	2,0	660 963,2	2,0
Western Cape	5 813 757,9	19,8	7 125 269,1	22,0
Total	29 344 977,3	100	32 336 679,5	100

Data source National Survey of Research and Experimental Development, 2014/15 and 2015/16

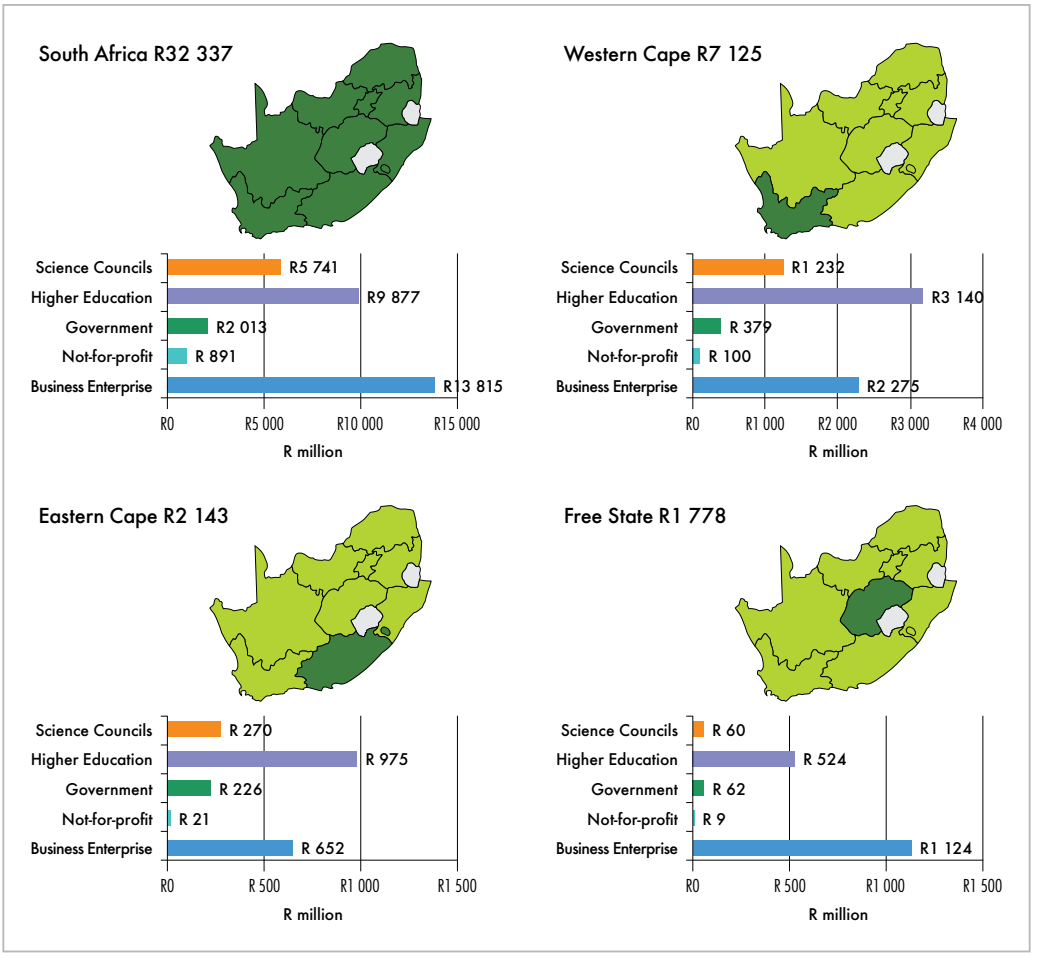
4.8.2 Proportions of R&D expenditure by province and sector of performance

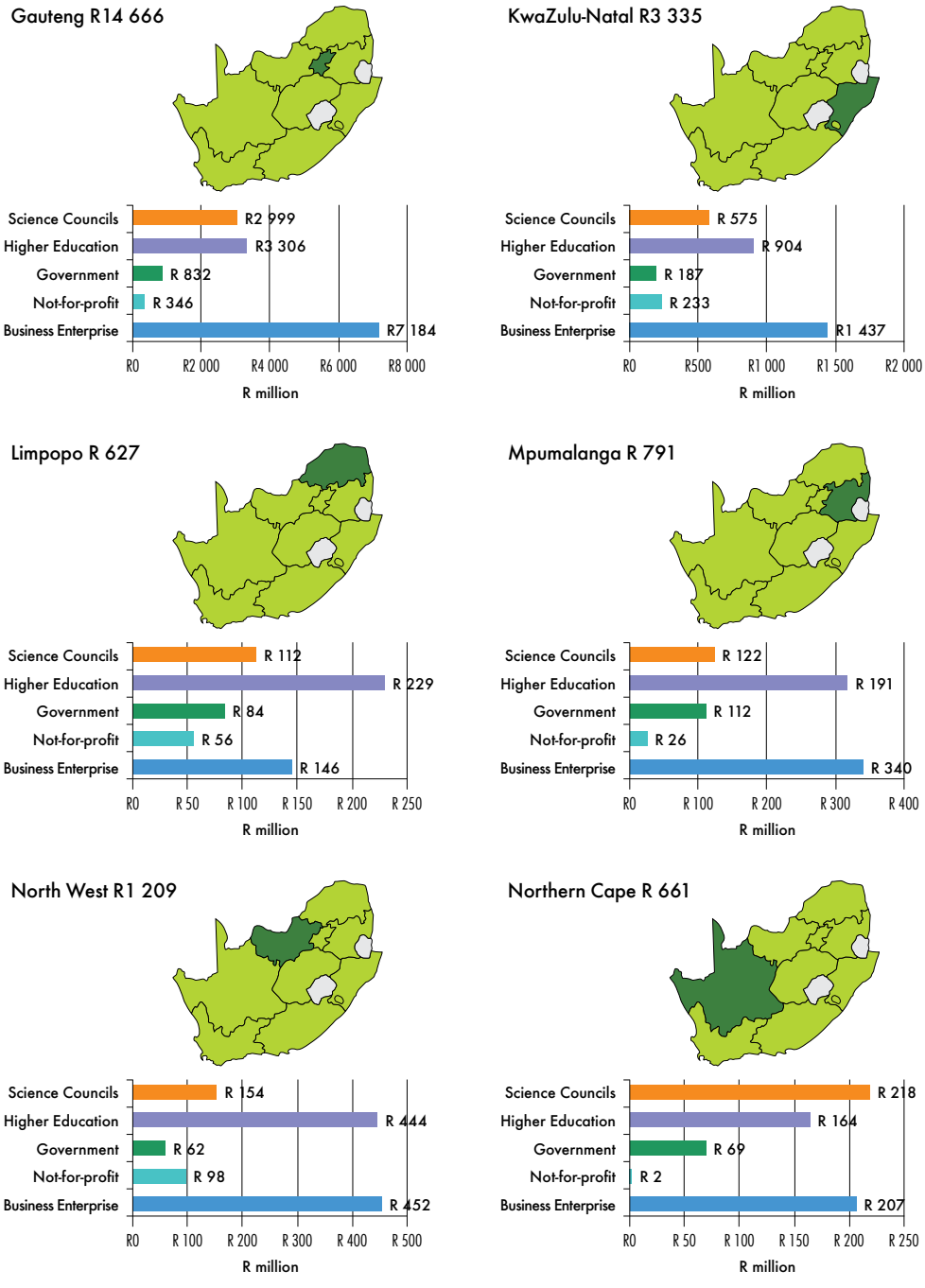
R&D expenditure by province and sector of performance is shown in Figure 18 and Table 7. HERD increased in all provinces followed by GOVERD, which similarly increased in all provinces. Exceptions to this are in the Eastern Cape and the Western Cape data. R&D expenditure within

the science council sector increased in six of the nine provinces, with a decline in Limpopo, Mpumalanga and the Northern Cape. R&D expenditure in the NPO sector increased in Gauteng, Kwa-Zulu Natal, Limpopo, the Northern Cape and Western Cape. BERD increased in three provinces only, namely, the Eastern Cape, Free State and the Western Cape.

Table 8 shows the provincial R&D expenditures by institutional sector of performance during the 2011/12 survey cycle. Five years later the trends are still largely the same, although with a few fluctuations and improvements in performance.

Figure 18: R&D expenditure by province and sector of performance (R million), South Africa, 2015/16





Data source National Survey of Research and Experimental Development R&D, 2015/16

Table 7: R&D expenditure by province and sector of performance (R'000 and percentage), South Africa, 2015/16

PROVINCE	BUSINESS ENTERPRISE		NOT-FOR-PROFIT		GOVERNMENT		SCIENCE COUNCILS		HIGHER EDUCATION		TOTAL	
	R 000	%	R 000	%	R 000	%	R 000	%	R 000	%	R 000	%
Eastern Cape	651 533	4.7	21 026	2.4	225 603	11.2	269 658	4.7	975 099	9.9	**2 142 919**	**6.6**
Free State	1 124 042	8.1	8 890	1.0	61 802	3.1	59 953	1.0	523 782	5.3	**1 778 469**	**5.5**
Gauteng	7 183 557	52.0	345 937	38.8	832 397	41.4	2 998 643	52.2	3 305 576	33.5	**14 666 111**	**45.4**
KwaZulu-Natal	1 436 737	10.4	232 636	26.1	187 088	9.3	575 016	10.0	903 664	9.1	**3 335 141**	**10.3**
Limpopo	145 736	1.1	56 143	6.3	84 232	4.2	111 649	1.9	229 364	2.3	**627 125**	**1.9**
Mpumalanga	339 985	2.5	25 944	2.9	112 173	5.6	122 432	2.1	190 716	1.9	**791 248**	**2.4**
North-West	451 891	3.3	97 918	11.0	61 815	3.1	153 676	2.7	444 135	4.5	**1 209 434**	**3.7**
Northern Cape	206 786	1.5	2 200	0.2	69 174	3.4	218 317	3.8	164 487	1.7	**660 963**	**2.0**
Western Cape	2 274 728	16.5	100 449	11.3	378 737	18.8	1 231 555	21.5	3 139 800	31.8	**7 125 269**	**22.0**
Total	**13 814 995**	**100**	**891 142**	**100**	**2 013 021**	**100**	**5 740 897**	**100**	**9 876 623**	**100**	**32 336 679**	**100.0**

Table 8: R&D expenditure by province and sector of performance (R'000 and percentage), South Africa, 2011/12

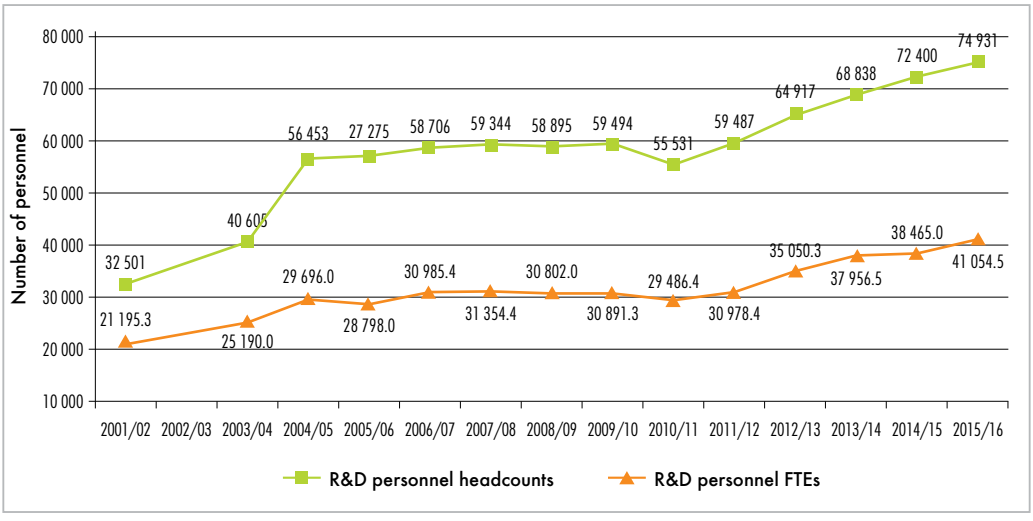
PROVINCE	BUSINESS ENTERPRISE		NOT-FOR-PROFIT		GOVERNMENT		SCIENCE COUNCILS		HIGHER EDUCATION		TOTAL	
	R 000	%	R 000	%	R 000	%	R 000	%	R 000	%	R 000	%
Eastern Cape	354 553	3,4	9 493	5,6	127 415	10,3	178 594	4,8	608 815	9,2	**1 278 870**	**5,8**
Free State	1 308 833	12,5	5 096	3,0	44 200	3,6	37 138	1,0	323 335	4,9	**1 718 602**	**7,7**
Gauteng	5 558 409	53,1	69 321	40,6	447 635	36,2	2 287 762	61,3	2 028 145	30,7	**10 391 272**	**46,8**
KwaZulu-Natal	1 160 507	11,1	33 740	19,8	126 857	10,3	292 246	7,8	902 386	13,7	**2 515 736**	**11,3**
Limpopo	62 728	0,6	7 449	4,4	65 017	5,3	99 104	2,7	349 559	5,3	**583 857**	**2,6**
Mpumalanga	157 158	1,5	16 027	9,4	78 335	6,3	100 476	2,7	170 966	2,6	**522 963**	**2,4**
North-West	45 267	0,4	1 889	1,1	63 556	5,1	81 998	2,2	148 425	2,2	**341 136**	**1,5**
Northern Cape	302 164	2,9	6 353	3,7	44 618	3,6	104 139	2,8	275 088	4,2	**732 363**	**3,3**
Western Cape	1 514 404	14,5	21 236	12,4	238 035	19,3	548 223	14,7	1 802 496	27,3	**4 124 394**	**18,6**
Total	**10 464 022**	**100**	**170 605**	**100**	**1 235 669**	**100**	**3 729 680**	**100**	**6 609 216**	**100**	**22 209 192**	**100**

5. PEOPLE IN R&D

5.1 R&D personnel

South Africa's R&D personnel headcounts have been increasing steadily. This is reflected in marginal annual increases in headcounts and full-time equivalents (FTEs) between 2005/06 and 2010/11 (with the exception of 2008/09); and more robust growth between 2010/11 and 2015/16. The 2015/16 R&D Survey recorded a 3.5% growth in R&D personnel headcounts, to 74 931, an increase of 2 531 from 2014/15. The growth of R&D personnel is mostly influenced by increases in the number of researchers, particularly at the level of postgraduate students. An area of interest requiring further investigation would be the assessment of how well these students are being absorbed by the system.

Figure 19: R&D personnel (headcount and FTEs), South Africa, 2001/02 to 2015/16



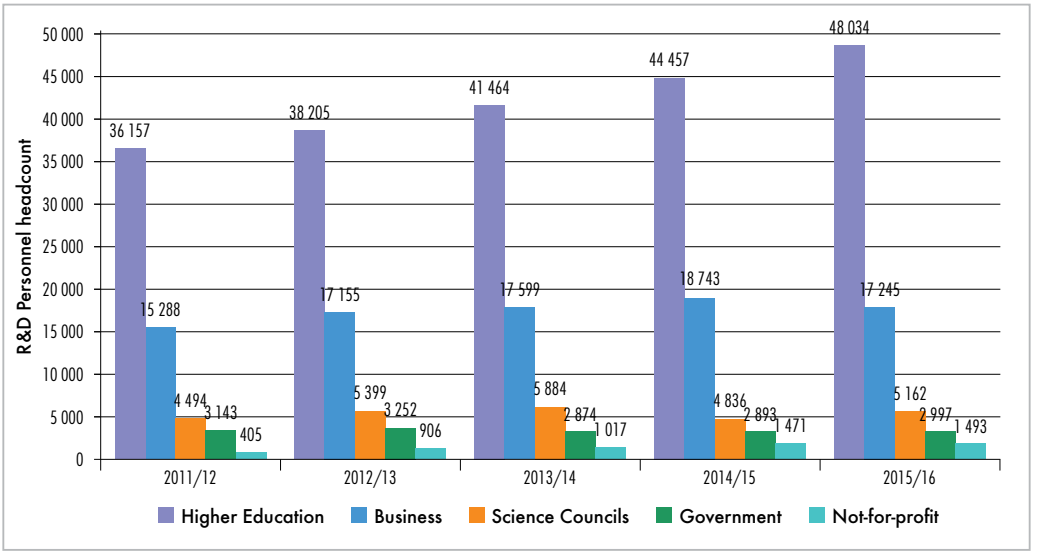
Data note	Following OECD practice, doctoral students and post-doctoral fellows are counted as researchers.
Data source	National Survey of Research and Experimental Development, 2001/02 to 2015/16

5.1.1 R&D personnel headcount by sector of performance

In the 2015/16 R&D Survey, the majority of R&D personnel were employed in the higher education and business sectors, which recorded headcounts of 48 034 and 17 245 respectively. Increases in R&D personnel were recorded across all sectors, except the business sector. The business sector reported a lower R&D personnel headcount of 17 245 in 2015/16 compared to the 18 743 in 2014/15. Closer analysis of the data suggests the reduction in headcount could be attributed to organic unit-level fluctuations in R&D investment, mergers and/or changes to firm-level reporting.

Minor increases in headcounts were observed within the not-for-profit, science councils and government sectors between 2014/15 and 2015/16. The growth of R&D personnel was mostly influenced by increases in the number of researchers, particularly at the level of postgraduate students, within the higher education sector. It should be noted that the higher education sector had improvements in the survey quality, such as improved responses and decreased imputations, with subsequent adjustments to previously undercounted values.

Figure 20: R&D personnel by sector (headcount), South Africa, 2011/12 to 2015/16



Data note	Higher education R&D personnel include post-doctoral fellows and doctoral students under the 'researcher' category.
Data source	National Survey of Research and Experimental Development, 2011/12 to 2015/16

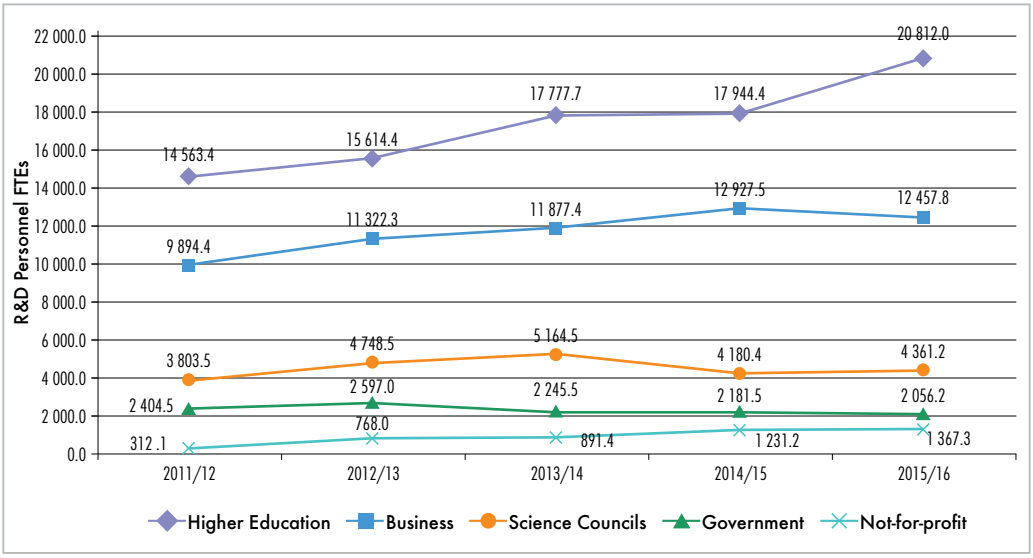
5.1.2 R&D personnel full-time equivalents (FTEs) by sector of performance

The 2015/16 survey recorded a 6.7% increase in FTEs for the total R&D personnel between 2014/15 and 2015/16, representing an improvement against the 1.3% recorded increase between 2013/14 and 2014/15. The R&D personnel FTEs per thousand in total employment indicator remained fairly static over the five-year period, increasing by 0.1 in each of previous three surveys: from 2.4 in 2012/13 to 2.5 in 2013/14, and 2.5 in 2014/15 to 2.6 in 2015/16.

In the 2015/16 reference period, the government, science councils and not-for-profit sectors showed minimal changes in their overall R&D personnel FTE, with government displaying a slight decrease. The highest numbers of FTEs were in the higher education sector (20 812.0). The business sector reported a loss of 469.7 FTEs in R&D personnel between 2014/15 (12 927.5) and 2015/16 (12 457.8); contrary to an increase in FTEs in the preceding four years.

It is encouraging to note the increases observed in headcounts and FTEs in R&D personnel. However, survey data reveals that only 54.8% of time was spent on research (calculated as FTEs as a % of headcounts) in 2015/16 and 53.1% in 2014/15.

Figure 21: R&D personnel by sector (FTEs), South Africa, 2011/12 to 2015/16

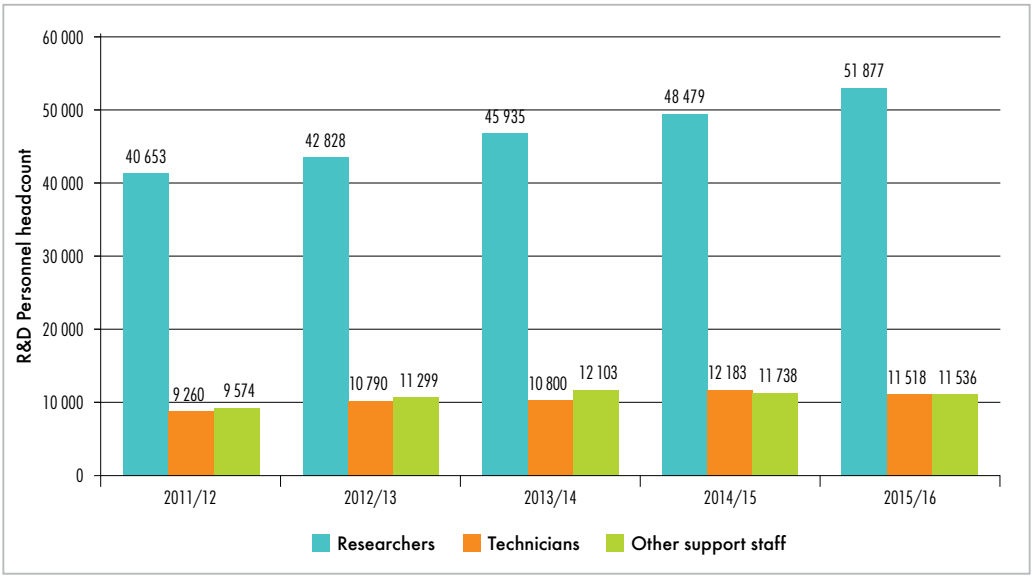


Data note	Following OECD practice, doctoral students and post-doctoral fellows are counted as researchers.
Data source	National Survey of Research and Experimental Development, 2011/12 to 2015/16

5.1.3 R&D personnel by occupation

Of the total R&D personnel, researchers made up the highest proportion, accounting for 69.2%, followed by technicians at 15.4%, and other support staff directly supporting R&D at 15.4%. The headcount of researchers increased by 7.0% from 48 479 in 2014/15 to 51 877 in 2015/16. The headcount of technicians increased between 2011/12 and 2014/15 but declined from 12 183 in 2014/15 to 11 518 in 2015/16. The headcount of other support staff directly supporting R&D decreased from 11 738 to 11 536 in the last two survey periods.

Figure 22: R&D personnel by occupation (headcount), South Africa, 2011/12 to 2015/16



Data note	Higher education R&D personnel include post-doctoral fellows and doctoral students under the 'researcher' category.
Data source	National Survey of Research and Experimental Development, 2011/12 to 2015/16

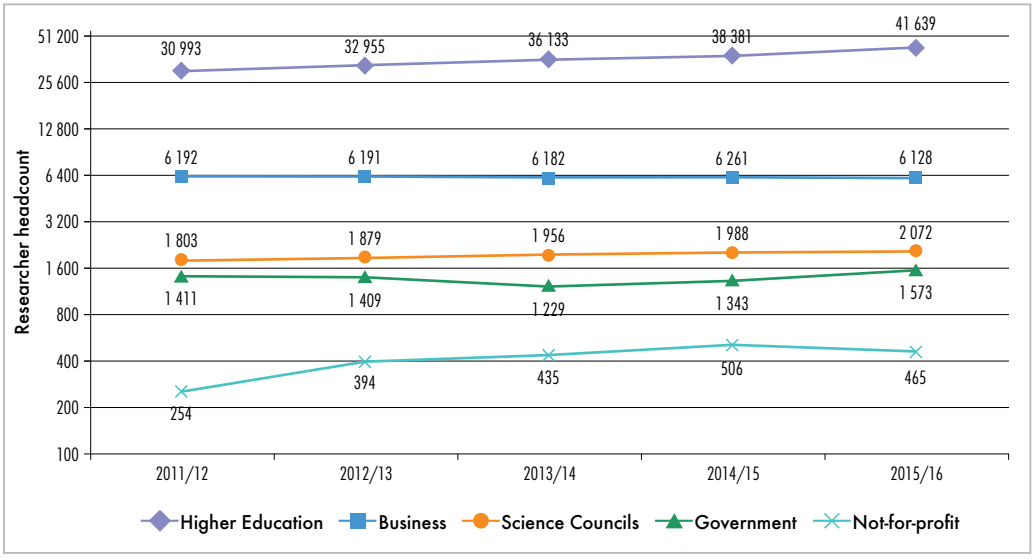
5.2 Researchers

5.2.1 Researcher headcount by sector of performance

The highest concentration of researchers was found in the higher education sector, with a headcount of 41 639 in 2015/16, which reflects an increase of 8.5% between 2014/15 and 2015/16. Researcher headcounts in the not-for-profit sector showed a decline in 2015/16 in comparison to the considerable increases observed between 2011/12 and 2014/15. The changes in the not-for-profit sector have been influenced by a combination of factors, including reduction in the number of researchers, changes to their employment status (contracts of less than six months), as well as known R&D performers becoming inactive due to lack of funding, which adversely affected their ability to continue with R&D activities.

The headcount of researchers in the science councils and business sectors remained fairly constant, indicating minimal change between 2011/12 and 2015/16, while headcounts in the government sector grew by 17.1% from 2014/15 to 2015/16, as a result of some research institutes reporting increases in their number of researchers.

Figure 23: Researchers by sector (headcount), South Africa, 2011/12 to 2015/16



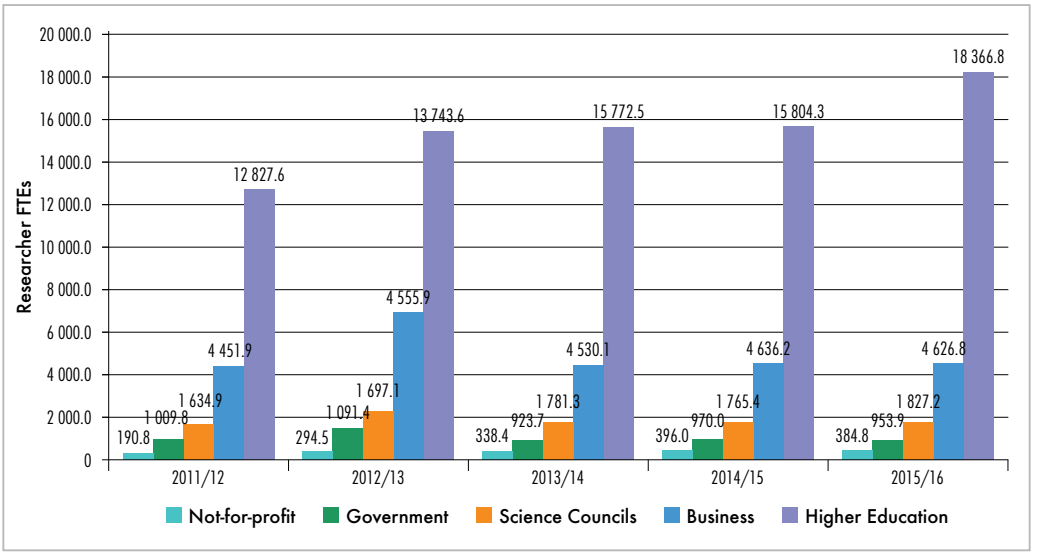
Data note	Higher education R&D personnel include post-doctoral fellows and doctoral students under the 'researcher' category.
Data source	National Survey of Research and Experimental Development, 2011/12 to 2015/16

5.2.2 Researcher full-time equivalent (FTEs) by sector of performance

In the higher education sector, the number of researcher FTEs shows a steady increase over the five year period, from 12 827.6 in 2011/12 to 18 366.8 in 2015/16. These increases are largely driven by the increases in the postgraduate students in the sector, as reported above. Science council researcher FTEs increased from 1 765.4 (2014/15) to 1 827.2 (2015/16). The government sector researcher headcounts increased by 17.1% in 2015/16, while researcher FTEs remained similar despite a small decrease from 970.0 to 953.9 in the same period. This is not unusual as government sector personnel are typically not exclusively devoted to research only and this can be observed in their time spent on research.

Researcher FTEs in the business and not-for-profit sectors showed minor reductions from 2014/15 to 2015/16, following similar trends to those observed for the corresponding researcher headcounts in these sectors.

Figure 24: Researchers by sector (FTEs), South Africa, 2011/12 to 2015/16

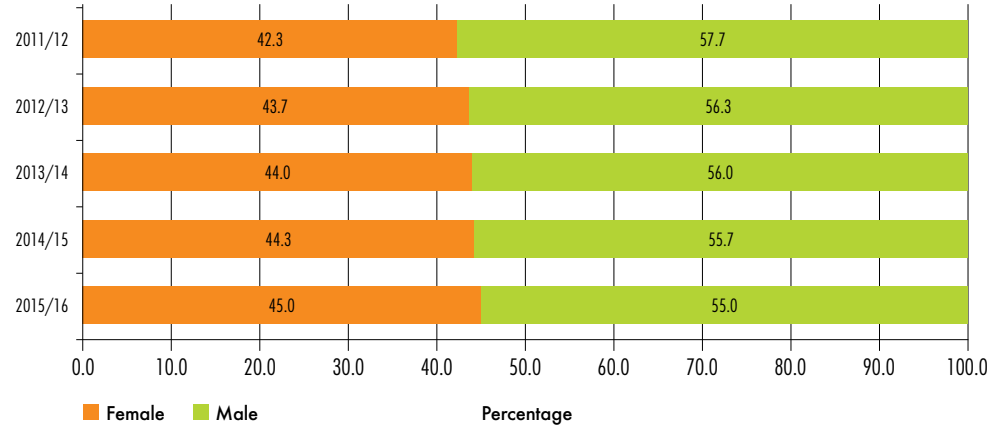


Data note	Higher education researchers include post-doctoral fellows and doctoral students under the 'researcher' category.
Data source	National Survey of Research and Experimental Development, 2011/12 to 2015/16

5.2.3 Researcher headcount by gender

Women accounted for almost half of the total number of researchers, where their share peaked at 45.0 % in 2015/16. There has been a steady annual increase in the percentage of female researchers, from 42.3% in 2011/12 to 45.0% in 2015/16.

Figure 25: Researchers by gender (percentage), South Africa, 2011/12 to 2015/16



Data note	Higher education R&D personnel include post-doctoral fellows and doctoral students under the 'researcher' category.
Data source	National Survey of Research and Experimental Development, 2011/12 to 2015/16

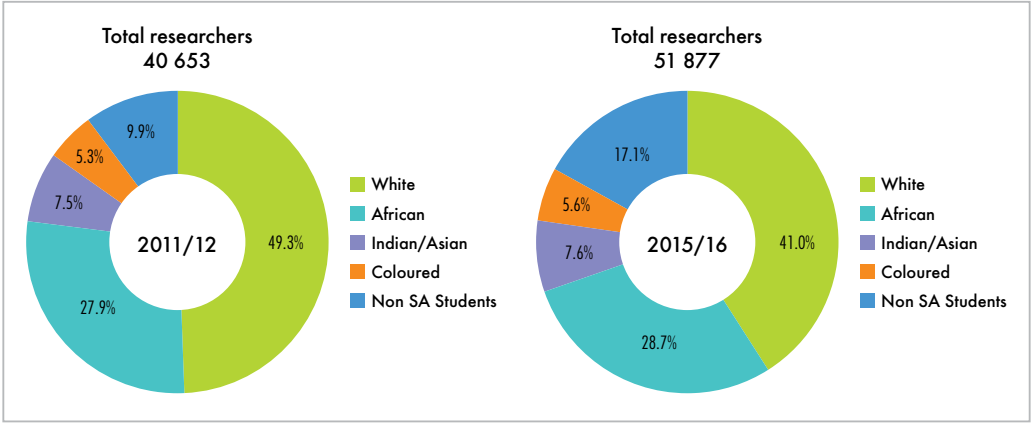
5.2.4 Researchers by population group

The majority of researchers in South Africa continue to be drawn from the White population group. Researchers from the other population groups (Africans, Coloureds and Indians/Asians), collectively, increased from 40.7% in 2011/12 to 41.9% in 2015/16.

The proportion of African researchers was 28.7% in 2015/16, similar to the 27.9% reported in 2011/12. The percentage of Coloured and Indian/Asian researchers also remained largely unchanged over the last five years, accounting for 5.6% and 7.6% respectively in 2015/16. The percentage of White researchers decreased from 49.3% in 2011/12 to 41.0% in 2015/16.

The proportions of the various population groups differ somewhat from previous survey data. This is because, prior to the 2011/12 survey, non-South African students (post-doctoral fellows and doctoral students) were included in the count for each population group. The data now allows for disaggregation, enabling further analysis of trends over time. Significantly, the non-South African student proportion increased from 9.9% in 2011/12 to 17.1% in 2015/16.

Figure 26: Researchers by population group (percentage), South Africa, 2011/12 to 2015/16



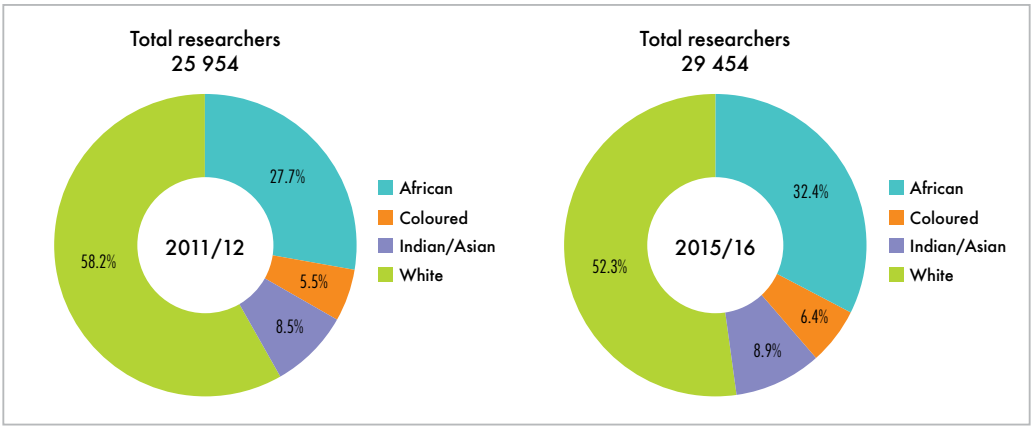
Data note	Higher education researchers include post-doctoral fellows and doctoral students under the 'researcher' category.
Definition	The population is classified according to the following race groups: African, Coloured, Indian/Asian and White.
Data source	National Survey of Research and Experimental Development, 2011/12 and 2015/16

5.2.5 Researchers (excluding doctoral students and post-doctoral fellows) by population group

Data on R&D personnel helps to gauge the extent of a country's R&D activity. An analysis of R&D personnel, excluding doctoral students and post-doctoral fellows from the population of researchers, provides a reflection of the trends within the R&D-active workforce. The total number of researchers in 2011/12 was 25 954, which grew by 2.5% from the 28 723 reported in 2014/15 to 29 454 in 2015/16. This is a slower growth rate in comparison to the 7.0% growth rate of researchers including postgraduate students, over the same period.

The disaggregation of the data also illuminates the shifts in the breakdown of researchers by population group over time. The proportion of African researchers increased, from 27.7% in 2011/12 to 32.4% in 2015/16. Coloured researchers increased from 5.5% to 6.4%, and Indian/Asian researchers remained almost unchanged from 8.5% to 8.9%. The percentage of White researchers decreased from 58.2% to 52.3%, over the same period.

Figure 27: Researchers (excluding doctoral students and post-doctoral fellows) by population group (percentage), South Africa, 2011/12 to 2015/16



Data note	For this section only the Higher education researchers do not include post-doctoral fellows and doctoral students under the 'researcher' category.
Definition	The population is classified according to the following race groups: African, Coloured, Indian/Asian and White.
Data source	National Survey of Research and Experimental Development, 2011/12 and 2015/16

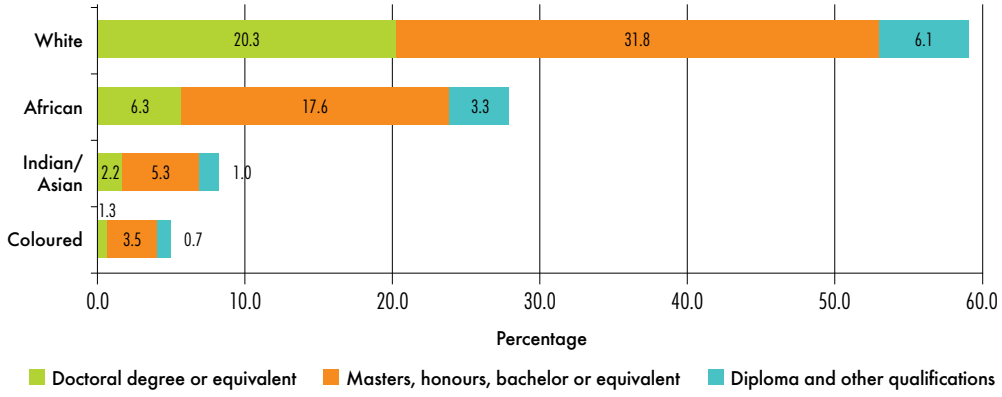
5.2.6 Researchers (excluding doctoral students and post-doctoral fellows) by qualification and population group

African researchers with a doctoral degree increased from 6.3% of this group in 2011/12, to 8.8% in 2015/16. Similar to previous years, in 2015/16, the majority of doctoral qualifications were found within the White population group (21.1%). Within all the population groups, the majority of South African researchers held a masters, honours, bachelor or equivalent degree qualification between 2011/12 and 2015/16.

Figure 28: Researchers (excluding doctoral students and post-doctoral fellows) by qualification and population group (percentage), South Africa, 2015/16

Data note	For this section only the higher education researchers do not include post-doctoral fellows and doctoral students under the 'researcher' category.
Definition	The population is classified according to the following race groups: African, Coloured, Indian/ Asian and White.
Data source	National Survey of Research and Experimental Development, 2011/12 and 2015/16

Figure 29: Researchers (excluding doctoral students and post-doctoral fellows) by qualification and population group (percentage), South Africa, 2011/12



Data note	For this section only the higher education researchers do not include post-doctoral fellows and doctoral students under the 'researcher' category.
Definition	The population is classified according to the following race groups: African, Coloured, Indian/ Asian and White.
Data source	National Survey of Research and Experimental Development, 2011/12 and 2015/16

5.3 Higher education R&D personnel

5.3.1 Higher education R&D personnel: FTEs as a percentage of headcount

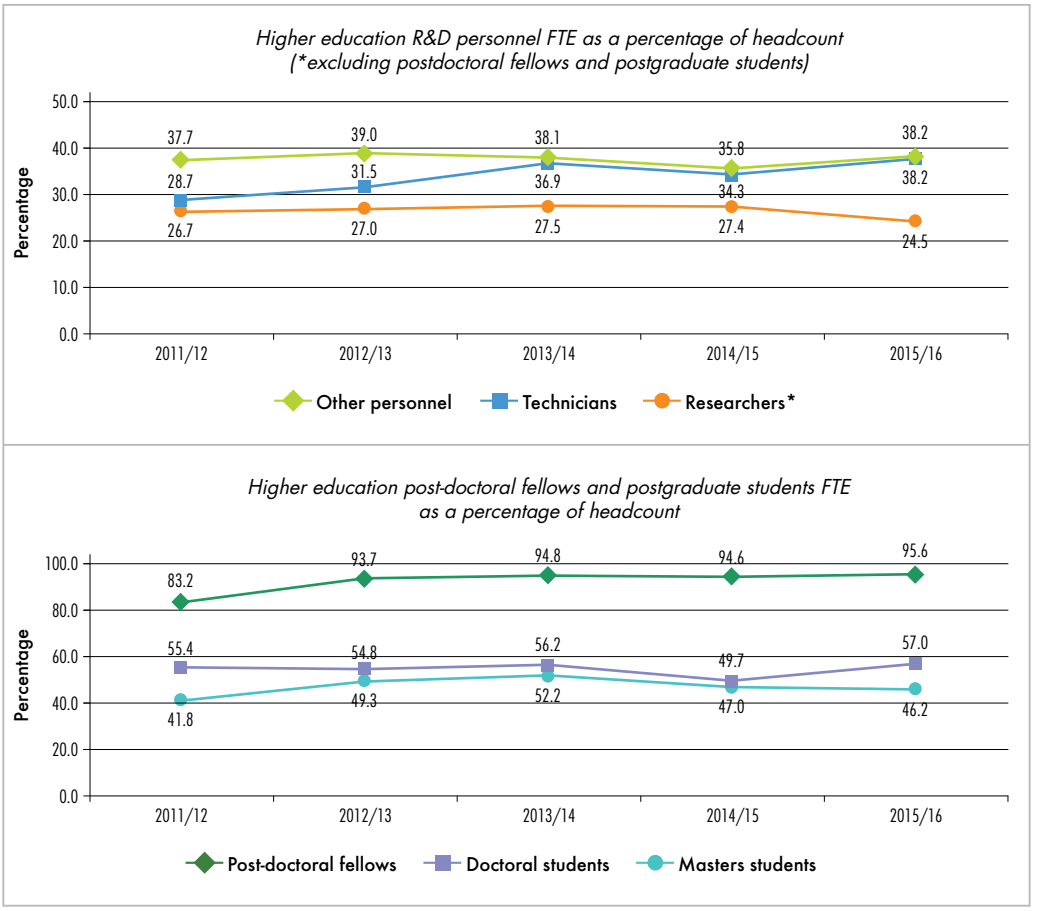
The 2015/16 R&D Survey data reflected increases in headcounts and FTEs in both the R&D personnel and researcher categories. Higher education researchers (excluding post-doctoral fellows and postgraduate students) increased from 18 212 in 2013/14 to 18 625 in 2014/15, and then to 19 217 in 2015/16. It is important to note the smaller margins of the increase of researchers in the higher education sector, in comparison with the rate of growth observed in postgraduate student numbers. Higher education researchers grew by 3.2%, and post-doctoral fellows and postgraduate students combined grew by 13.5% between 2014/15 and 2015/16. This is significant considering the role researchers play in providing training and supervision to postgraduates, in addition to their own research mandates.

Higher education researchers (excluding post-doctoral fellows and postgraduate students) spent 26.7% of their time on research in 2011/12, and this percentage increased to 27.4% in 2014/15 but showed a decline to 24.5% in 2015/16. The #FeesMustFall campaign brought about severe disruptions to the higher education sector in 2015/16. These occurrences could have been

a contributing factor to the observed declines in time spent on research, though no definitive conclusions can be drawn.

Doctoral students spent 55.4% of their time on research activities in 2011/12 and 57.0% in 2015/16, while masters students spent 41.8% of their time on research in 2011/12 and 46.2% in 2015/16. Post-doctoral fellows spent most of their time performing research, as indicated by the high ratio of FTEs as a percentage of headcounts. Their time spent on research was 83.2% in 2011/12, but this percentage improved to 94.6% in 2014/15 and to 95.6% in 2015/16.

Figure 30: Higher education R&D personnel and students time spent on research (FTEs as a percentage of headcount), South Africa, 2011/12 to 2015/16

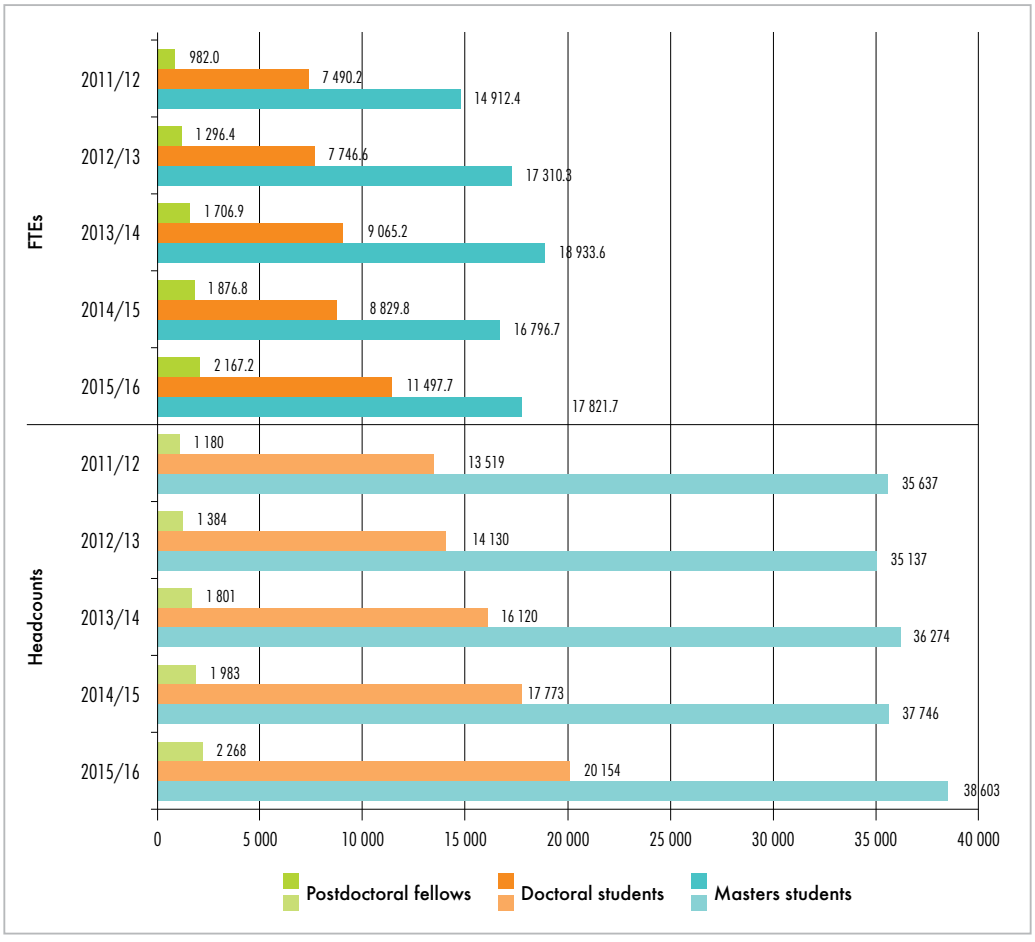


Data note	FTEs as a percentage of headcount.
Data source	National Survey of Research and Experimental Development, 2011/12 to 2015/16

5.3.2 Post-doctoral fellow and post-graduate student headcount and full-time equivalents (FTEs)

Headcounts and FTEs of post-doctoral fellows, doctoral and masters students within the higher education sector contributed consistently to the growth of the total R&D personnel. This was evident in the growth in the numbers reported for postgraduate students between 2011/12 and 2015/16. Post-doctoral fellows and postgraduate student numbers grew by 13.5% from 2014/15 to 2015/16. The headcount of doctoral students was 13 519 in 2011/12 and reached 20 154 in 2015/16; while masters students increased from 35 637 in 2011/12 to 38 603 in 2015/16.

Figure 31: Higher education post-doctoral fellows and postgraduate students (headcount and FTEs), South Africa, 2011/12 to 2015/16

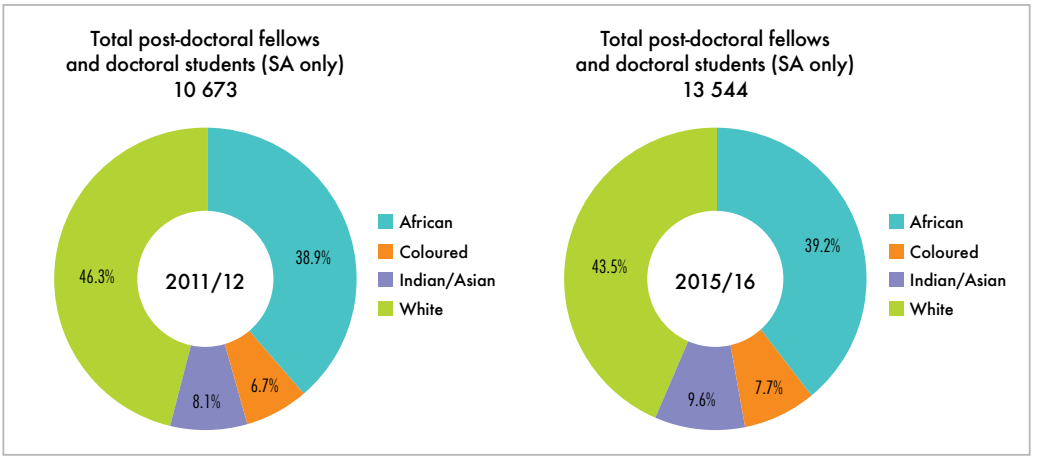


Data note	Masters students are not counted as R&D personnel according to the Frascati Manual.
Data source	National Survey of Research and Experimental Development, 2011/12 to 2015/16

5.3.3 Post-doctoral fellows and doctoral students by population group

The total share of South African post-doctoral fellows and doctoral students in 2011/12 comprised of 46.3% White, 38.9% African, 8.1% Indian/Asian and 6.7% Coloured. The figures for 2015/16 revealed marginal changes; the proportion of White students declined to 43.5%, while the other population groups increased slightly: African to 39.2%, Indian/Asian to 9.6% and Coloured to 7.7%.

Figure 32: Higher education post-doctoral fellows and doctoral students by population group (percentage), South Africa, 2011/12 and 2015/16



Data note	The 2011/12 and 2015/16 surveys distinguished between South African and non-South African nationals for post-doctoral fellows, doctoral and masters students.
Definition	The population is classified according to the following race groups: African, Coloured, Indian/Asian and White.
Data source	National Survey of Research and Experimental Development, 2011/12 and 2015/16

5.3.4 Profile of South African and non-South African postgraduate students

From 2011/12 onwards, the R&D Survey captured data on doctoral students and post-doctoral fellows according to race, gender and whether they were South African nationals. Indicators of the number of postgraduate students provide an indication of the extent to which a country may have researchers with the highest level of formal education in the future. A total of 22 422 post-doctoral fellows and doctoral students (headcount) were reported for 2015/16; of these, approximately 60.4% were South African and 39.6% were non-South African. The proportion of non-South African post-doctoral fellows and doctoral students increased from 27.4% in 2011/12 to 39.6% in 2015/16.

Analysis of this group by qualification level showed that the majority of masters (82.8%) and doctoral students (63.1%) were South African nationals in 2015/16; however, among post-doctoral fellows, the majority (62.8%) were non-South African nationals. Marked increases in the numbers of foreign post-doctoral fellows, doctoral students and masters students were evident from 2013/14 up to 2015/16. The number of South African post-doctoral fellows, doctoral and masters students also increased between 2014/15 and 2015/16.

Figure 33: Higher education post-doctoral fellows and doctoral students by nationality (headcount), South Africa, 2011/12 to 2015/16

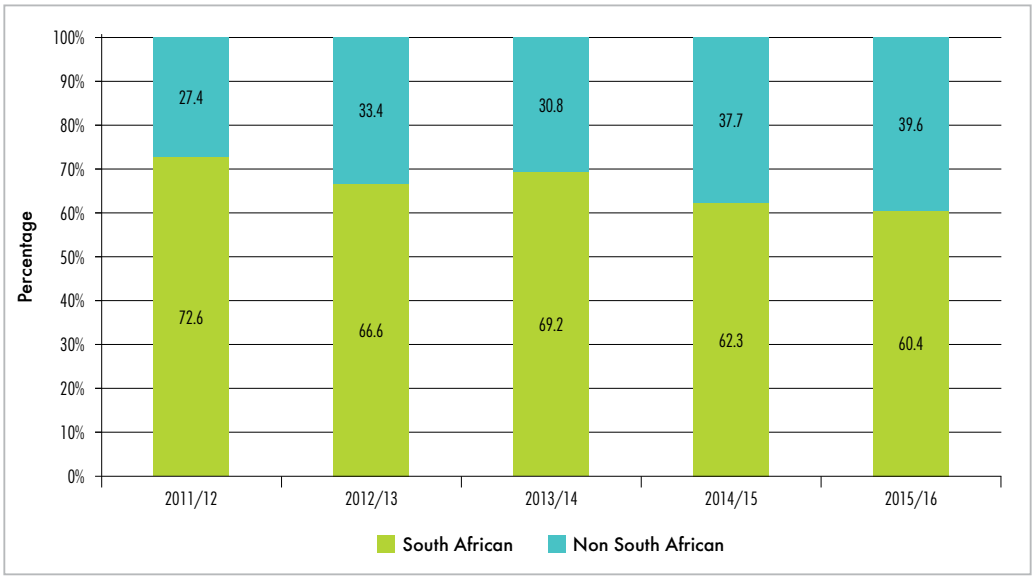
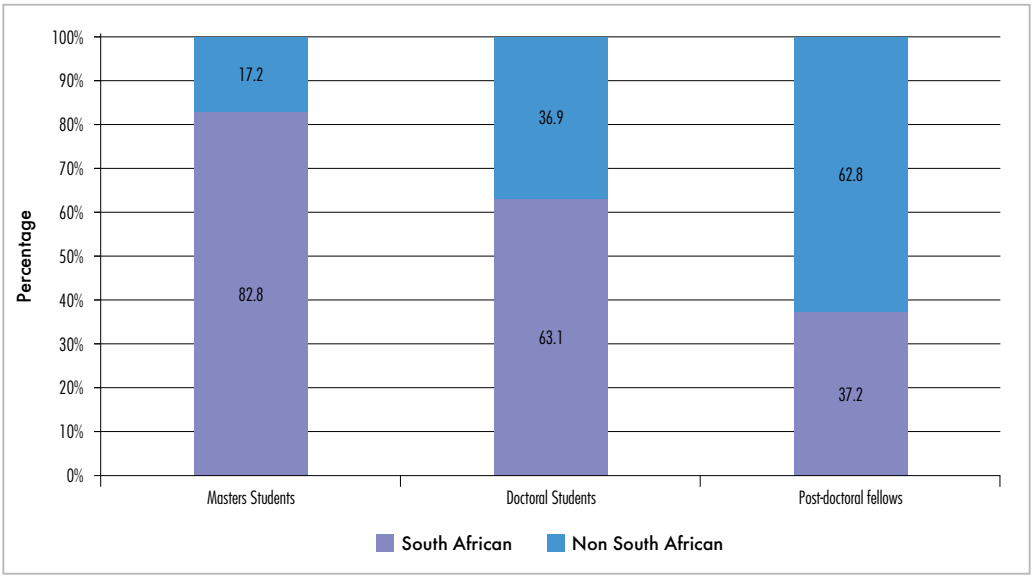


Figure 34: Higher education postgraduates by qualification (headcount), South Africa, 2015/16



Data note	The 2015/16 survey distinguished between South African and non-South African nationals.
Data source	National Survey of Research and Experimental Development, 2011/12 to 2015/16

Table 9: Higher education postgraduates by qualification (headcount), 2011/12 to 2015/16

QUALIFICATION	HEADCOUNT		
2011/12	**SOUTH AFRICAN**	**NON-SOUTH AFRICAN**	**TOTAL**
Post-doctoral fellows	538	642	1 180
Doctoral students	10 135	3 384	13 519
Masters students	29 131	6 506	35 637
Total	**39 804**	**10 532**	**50 336**
2012/13			
Post-doctoral fellows	511	873	1 384
Doctoral students	9 822	4 308	14 130
Masters students	29 364	5 773	35 137
Total	**39 697**	**10 954**	**50 651**
2013/14			
Post-doctoral fellows	616	1 185	1 801
Doctoral students	11 778	4 342	16 120
Masters students	31 424	4 850	36 274
Total	**43 818**	**10 377**	**54 195**
2014/15			
Post-doctoral fellows	657	1 326	1 983
Doctoral students	11 644	6 129	17 773
Masters students	29 598	6 148	35 746
Total	**41 899**	**13 603**	**55 502**
2015/16			
Post-doctoral fellows	843	1 425	2 268
Doctoral students	12 711	7 443	20 154
Masters students	31 951	6 652	38 603
Total	**45 505**	**15 520**	**61 025**

Data note	The 2011/12 - 2015/16 surveys captured postgraduate students according to race, gender; distinguished between South African and non-South African nationals for post-doctoral fellows, doctoral and masters students.
Data source	National Survey of Research and Experimental Development, 2015/16

6. INTERNATIONAL COMPARISONS

6.1 Gross domestic expenditure on R&D

Countries are encouraged to increase expenditure on R&D and research capacity development, amongst other mechanisms, through the targets set to achieve Sustainable Development Goal 9, in an effort to ensure sustainable industrialisation and innovation (Montoya & Chalaud, 2016). This section compares the R&D performance of South Africa to that of selected global counterparts. The comparison takes cognisance of the fact that there are differences in economic structures at country level, and of the availability of current and up-to-date data. In terms of country selection, this meant a combination of African countries that had datasets for the survey period, newly industrialised countries, the BRICS countries and selected top R&D-performing countries and regions.

6.1.1 GERD for the selected countries

There has not been a notable increase in R&D expenditure among low and middle income economies (UNESCO UIS, 2017). Using the total R&D amount spent as a measurement unit, China, Japan and South Korea feature in the "top five". The United States and Germany are the other two top spenders. It is worth noting that the business sector is the main driver in terms of R&D in these research-intensive economies.

Table 10 shows an increase in GERD for the top five, measured in terms of US dollar purchasing power parity (PPP$). This trend is also observed among the majority of the remaining selected countries, except for Italy and Finland, which reflected decreases in GERD. South Africa's GERD increased from $5.526 billion in 2013/14 to $5.879 billion in 2015/16.

Table 10: GERD for selected countries (million current PPP$), 2012/13 to 2015/16 or latest available year

COUNTRY		2013/14		2014/15		2015/16
Argentina		5 340		5 030		5 577
Mexico		10 293	e, p	11 582	e, p	11 563
Turkey		13 834		15 324		16 604
United States	d	457 612	d	479 358	d, p	502 893
China		334 135		370 116		408 828
Japan	b	164 656		170 512		170 003
Germany		102 905		109 802		114 778
France		58 353		59 529	p	60 818
Russian Federation		36 607		36 829		38 136
Italy		28 459	e	30 324	p	30 102
India		*		*		50 269
Spain		19 282		19 341		19 734
Poland		8 186		9 187		10 239
Finland		7 383		7 185		6 712
Brazil		39 704		38 448		*
South Africa		5 022		5 526		5879
Chile		1 533	b	1 522	p	1 604

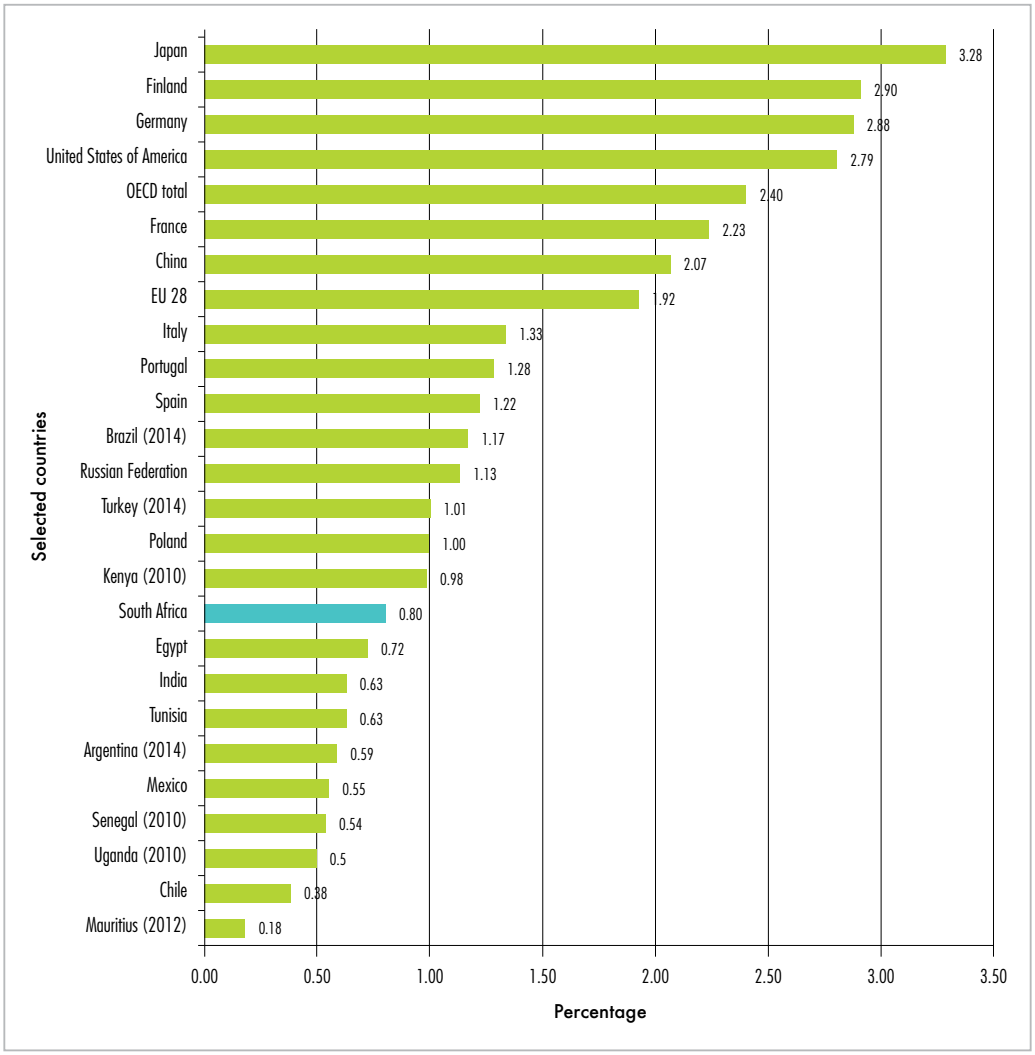
Data note	b) Break in series with previous year for which data are available e) National estimate or projection d) Definition differs p) Provisional *Data not available
Data source	South Africa: National Survey of Research and Development, 2015/16; Argentina, Chile, China, Finland, France, Germany, Italy, Japan, Mexico, Poland, Russian Federation, Spain, Turkey, United States: OECD, 2016 Brazil, Egypt, India: UNESCO UIS, 2017

6.1.2 GERD as a percentage of GDP

During the 2015/16 financial year, South Africa spent 0.80% of its GDP on R&D. Egypt observed a similar trend: an increase of 0.05% in terms of GERD as a percentage of GDP (0.72%). This brings the two countries slightly closer to the continental aspiration of committing 1% of GERD as a percentage of GDP (Montoya & Chalaud, 2016). Of the BRICS countries, South Africa, China and Russia reported R&D intensity increases to 0.80%, 2.077% and 1.13% respectively. Brazil's GERD as a percentage of GDP was stagnant at 1.21%, while India's decreased to 0.63%.

European Union countries set a more ambitious target of 3% of GERD as a percentage of GDP by 2020 (Montoya & Chalaud, 2016). In the 2015/16 financial year, only Finland managed to reach this goal, reporting 3.17% GERD as a percentage of GDP. There is evidence of variation in terms of R&D capacity among EU countries. For example, Italy, Spain, Turkey and Poland reported GERD intensities below the EU average of 1.92%, while Germany (2.88%) and Finland (2.90%) surpassed the GERD intensity threshold of 2.50%.

Figure 35: GERD as a percentage of GDP, selected countries, 2015/16 or latest available year



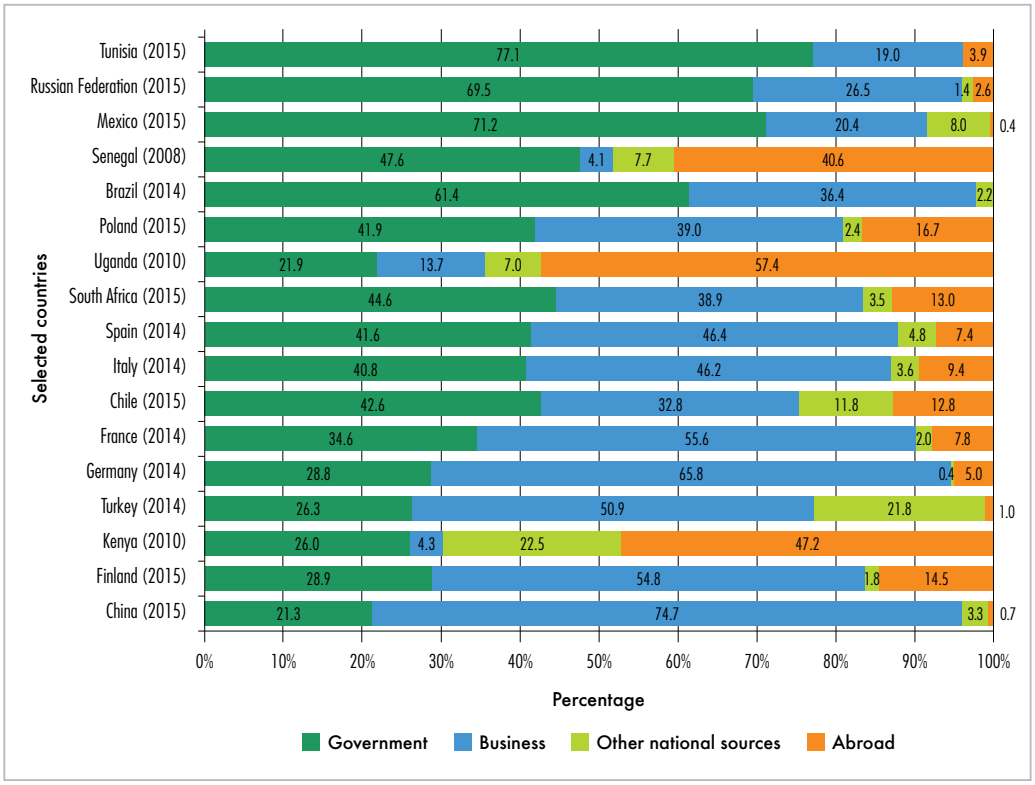
Data note	Reported data are for the 2015/16 financial year or the latest available year as indicated in brackets. Calculations are based on current national currencies.
Data source	Country data: South Africa: National Survey of Research and Experimental Development, 2015/16; Argentina, Chile, China, EU 28, Finland, France, Germany, Italy, Japan, Mexico, Poland, Russian Federation, Spain, Turkey, United States: OECD, 2016; Brazil, Egypt, India, Tunisia: UNESCO UIS, 2017

6.1.3 GERD by source of funds

Levels of R&D funding differ between countries, as do the sources of funding for the various R&D-performing sectors. Government funding is usually predominant in low and middle income countries, and the not-for-profit sector also plays a major role in funding R&D. Business is typically most active in funding R&D in research-intensive countries.

South Africa falls between these two patterns, as Figure 36 illustrates. In 2015/16, 44.6% of R&D funding came from government and 38.9% from the business sector. South Africa began, in the 2013/14 survey cycle, to follow the model of funding more typical of developing countries. This is not by design, but probably because of the decline in funding of R&D by the business sector. Argentina, Egypt, the Russian Federation, Mauritius, Brazil, Poland, Spain, Tunisia, and Italy also reported that more than 40% of their R&D funding came from the government sector. The countries that received the largest share of R&D funding from the business sector were China (74.7%), Germany (65.8%), Finland (54.8%), Turkey (50.9%) and France (55.7%).

Figure 36: GERD by source of funds in selected countries (percentage), 2015/16 or latest available year



Data note	Data are for 2015/16 or the latest available year as indicated in brackets. Other national sources include the not-for-profit and higher education sectors.
Data source	Country data: South Africa: National Survey of Research and Experimental Development, 2015/16; Argentina, Mexico: OECD, 2016; Brazil, Spain, Italy, Poland, Russian Federation, China, Germany, Finland, France: UNESCO UIS, 2017

6.2 R&D personnel

6.2.1 Researcher full-time equivalents (FTEs) per thousands in total employment

South Africa's figure of 1.7 researcher FTEs per thousand employed in 2015/16 was comparable with China. China measures particularly low on this indicator, despite having the largest overall number of researchers of the BRICS countries, given its very large population. In the Russian Federation, researchers per thousand employed (6.2) was much higher in comparison to any of the other BRICS countries. Sweden reported 13.6 and Japan 10.0 researchers per thousand employed, while Finland reported 15.0.

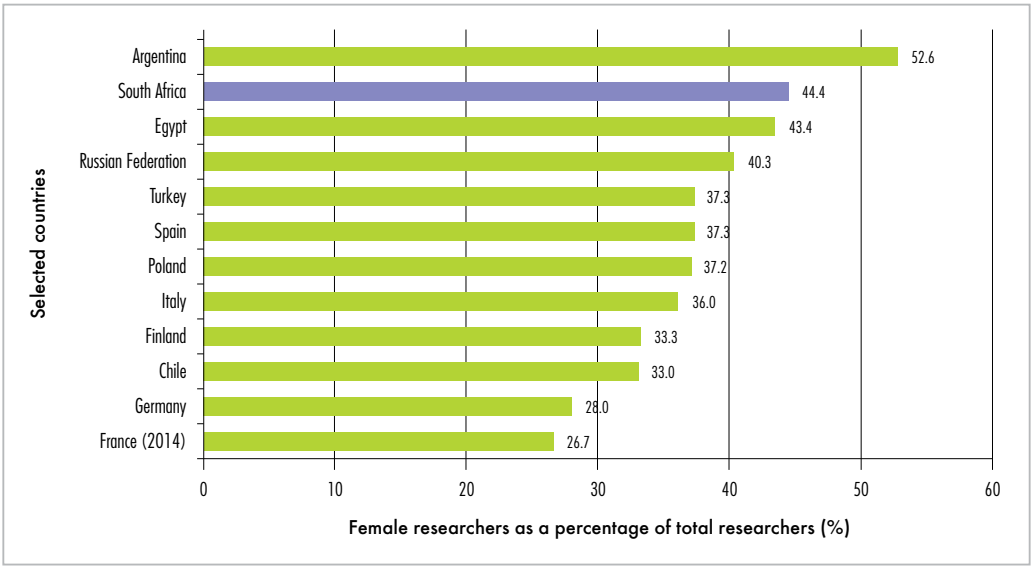
Figure 37: Researchers per 1 000 in total employment in selected countries, 2015/16

Data note	Data are for 2015/16 or the latest available year as indicated in brackets. Other national sources include the not-for-profit and higher education sectors.
Data source	Country data: South Africa: National Survey of Research and Experimental Development, 2015/16; Argentina, Mexico: OECD, 2016; Brazil, Spain, Italy, Poland, Russian Federation, China, Germany, Finland, France: UNESCO UIS, 2017

6.2.2 Female researchers as a percentage of total researchers

In South Africa and several other countries, more than 44% of the researchers are female, which is a higher proportion than for most of the countries with high R&D expenditure. The proportion of female researchers in South Africa was 44.4% of the total researchers in 2015/16, approximately the same level as in 2014/15. South Africa has improved on this indicator gradually over the last eight years. Female researchers appear to form a higher proportion of total researchers in developing countries than in most of the developed countries.

Figure 38: Female researchers as a percentage of total researchers (headcount) in selected countries, 2015/16 or latest available year



Data note	Data are for 2015/16 or the latest available year as indicated in brackets. Other national sources include the not-for-profit and higher education sectors.
Data source	Country data: South Africa: National Survey of Research and Experimental Development, 2015/16; Argentina, Mexico: OECD, 2016; Brazil, Spain, Italy, Poland, Russian Federation, China, Germany, Finland, France: UNESCO UIS, 2017

7. CONCLUDING REMARKS

Like many other countries, South Africa is facing a number of critical challenges, including very slow economic growth, high levels of unemployment, and increased poverty levels. The exponential impact of digitalisation, automation and artificial intelligence will test the country's readiness to adapt to its external environment, and to do things differently. The current conditions provide an opportunity to consider whether the national system of innovation has reached a stage where it is necessary to revise funding instruments, research agendas, and policy goals.

The R&D Survey instrument serves as a useful tool to identify where the national system of innovation can be strengthened. Over time, the Survey must be improved so that it can be used to identify issues and areas that need further investigation, or more in-depth policy analysis. In this conclusion, we highlight three striking trends from the 2015/16 data and point to policy implications.

7.1 Promoting counter-cyclical R&D and innovation to stimulate inclusive economic growth

The decline in funding for business sector R&D and its root causes have potentially negative implications for policy attempts to stimulate and support business innovation.

Empirical studies from other countries indicate that firms prefer to use their own cash flow to fund R&D. With the retraction of the economy and increasing unemployment, as may be expected there is evidence of pressure on investment in R&D. Expenditure by the business sector on R&D declined in real terms in 2015/16, after two years of growth. Business expenditure on R&D in a given year tends to follow a cyclical pattern, declining in countries faced with recession, and is influenced by a myriad of activities, including fluctuations of GDP, government funding, and industry structures locally and in the global context.

In countries faced with recession, governments usually follow a counter-cyclical pattern. That is, government increases funding of R&D, mostly in the public sector and through incentives for the business sector. In South Africa, government expenditure on R&D has increased steadily, but to science councils and higher education. A notable trend is that government funding of business R&D continues to decline, from 24.5% in 2006/07 to 3.6% in 2015/16.

Moreover, there has been a decline in expenditure on experimental development by firms, from 63.8% in 2006/7 to 39.2% in 2015/16. Experimental R&D typically leads to improved goods and services. On a positive note, there is more R&D expenditure on applied research, an indication of potential innovation and contribution to knowledge in future.

Together, these trends have implications for policy attempts to stimulate and support business innovation. A critical policy question, then, is: How can government promote counter-cyclical funding for private sector R&D? The typical mechanisms are tax incentives but the trends suggest the need to review existing, and identify new, funding instruments.

7.2 Growing the human resources for R&D

South Africa requires high-level skills to perform R&D and innovate. Are skilled, suitable and sufficient candidates being produced for firms, the public sector and civil society roles?

There is a sharp contrast between the rapid growth in post-graduate students and the slow growth in researchers active in R&D in the higher education sector. Notably also, researcher FTEs are not increasing at the same rate as R&D expenditure in higher education institutions. This is significant, considering the training and research roles higher education researchers play. The lower proportion of South African to foreign post-doctoral fellows requires further interrogation in terms of potential positive or negative ramifications for the national system of innovation. The low levels of FTEs could be seen as an endemic issue, constrained by systemic problems stemming from the primary and secondary schooling levels and, in turn, impacting on universities.

These data trends highlight the need to review and refine current policy mechanisms aimed to grow the human resources for R&D. One possible avenue is to encourage the business sector to support education in South Africa, to assist in creating a more innovative and entrepreneurial labour force.

7.3 Supporting R&D in the NPO sector

The NPO sector receives most of its funding from abroad. This is a small but important sector as it performs research aligned to advocacy that responds to pressing socio-economic objectives; research that is mostly not performed in other sectors. A consistent policy concern is that the NPO sector may be under pressure to adopt the research agendas of their foreign funders, which may not necessarily in line with the needs of inclusive development in South Africa. Further investigation of how greater policy support can be afforded to applied research in the NPO sector will be of value.

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METHODOLOGICAL NOTES

The 2015/16 R&D Survey was conducted according to the OECD guidelines presented in the 2002 Frascati Manual. The Frascati Manual defines R&D as follows:

> *Research and experimental development (R&D) is creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. (OECD, 2002)*

The Frascati Manual proposes several approaches to surveying R&D-performing entities, including a census, a sample survey, or a hybrid of the census and sample survey approaches, comprising a census of all large R&D performers and a stratified random sample survey of the remaining R&D-performing entities. In South Africa, the R&D Survey is currently conducted using the census approach in all the sectors, except the business and not-for-profit sectors, where in each case a purposive sample of the entities is surveyed. As with the previous R&D surveys, the 2015/16 survey followed this approach. In accordance with the Frascati Manual, the Survey covered the following sectors: business, government, higher education, not-for-profit and science council sectors.

The sectors were surveyed between 17 September 2016 and 31 May 2017.

For science councils and all government departments, the survey covered expenditure in the year beginning 1 April 2015 and ending 31 March 2016. The data collected for the business and NPO sectors were for the financial year ended 28 February 2015 (or the nearest complete financial year). Data for the higher education sector correspond to the 2015 academic (calendar) year. Therefore, the Survey mainly recorded R&D activities that took place in the 2015 fiscal and calendar years.

In addition to following the guidelines in the Frascati Manual, the Survey was conducted according to a project plan aligned with the phases of the Statistical Value Chain (SVC), as described in the South African Statistical Quality Assessment Framework (SASQAF). As with previous surveys, it was conducted to ensure that it is compliant with certain SASQAF criteria for data quality on official statistics, as detailed in the Quality Management Plan (QMP). The resultant reports were subjected to a data quality clearance process, managed by a clearance committee established by the DST especially for that purpose.

The full and detailed methodology is presented in the technical notes section of the companion *Statistical Report.*

NOTIFICATIONS

Dissemination

This report may be downloaded free of charge from:

http://www.dst.gov.za/index.php/resource-center/rad-reports
http://www.hsrc.ac.za/en/departments/CeSTii/reports-cestii

Data extractions

Data extractions in response to users' special data requests are generally provided free of charge, unless fairly substantial analytical work is required to meet any such request. Such data extractions are done in accordance with the approved data access protocol, and requests should be sent to msithole@hsrc.ac.za.

Revisions

The Department of Science and Technology (DST), Statistics South Africa (Stats SA) and the Human Sciences Research Council's Centre for Science, Technology and Innovation Indicators (HSRC-CeSTII) jointly reserve the right to revise the data, indicators and analysis contained in this report. Such revisions may result from revisions by Stats SA of socio-economic indicators such as the gross domestic product (GDP), or population or employment numbers, or amendments in response to internal or external data quality and consistency monitoring such as that carried out by the Organisation for Economic Co-operation and Development (OECD), which conducts quality checks through global comparative analysis, time-series analyses and other methods. Explanations of any revisions will be made available and accessible on the DST and HSRC websites.

USER SATISFACTION SURVEY

In order to improve the quality and relevance of the R&D statistics, it would be useful to receive the views of users of this publication. It would therefore be appreciated if you could complete the following questionnaire and return by fax to +27 (0)21 461 1255 or by e-mail to CeSTIIData@hsrc.ac.za. The feedback is analysed following each survey cycle to ensure the continued improvement of the R&D survey.

1. Name and address of respondent:

Name and title _____

Designation/occupation _____

Name and address of organisation or enterprise _____

_____

_____

2. Which of the following describes your area of work? Mark with 'X'.

- ☐ Government
- ☐ Private enterprise
- ☐ Public enterprise
- ☐ Academic or research institution
- ☐ International organisation
- ☐ Media
- ☐ Not-for-profit organisation
- ☐ Other, specify _____

_____

_____

3. In which country do you work?

_____

4. What is your assessment of the contents of this publication?

☐ Excellent ☐ Good ☐ Average ☐ Satisfactory ☐ Poor

5. How useful is this publication for your work?

☐ Extremely useful ☐ Very useful ☐ Useful ☐ Partly useful ☐ Not at all useful

6. How accurate is the picture of R&D in your sector or research field/s as presented in this publication?

☐ Very accurate ☐ Fairly accurate ☐ Unsure

☐ Not very accurate ☐ Not at all accurate

7. How easy was it to find specific information that you required in the publication?

☐ Extremely easy ☐ Very easy ☐ Easy

☐ Not very easy ☐ Not at all easy

8. What information (i.e. tables, text or figures) were of most interest to you? Please be as specific as possible e.g. provide table, page or figure numbers.

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9. What did you like best about the publication?

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10. Provide any comments or recommendations for the improvement of the publication.

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