SOUTH AFRICAN NATIONAL SURVEY OF RESEARCH AND EXPERIMENTAL DEVELOPMENT

MAIN REPORT 2018/19

science & innovation
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REPUBLIC OF SOUTH AFRICA

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REVISIONS

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FOREWORD

South Africa's R&D statistics are key to monitor the R&D investment and human resource profile of the country and to inform Science, Technology and Innovation (STI) policy implementation by government. These statistics are also of use as a source of evidence to the private sector, the international community, media, and researchers.

The National Survey of Research and Experimental Development (R&D Survey), which forms a part of the National Statistics System, is published annually by the Department of Science and Innovation (DSI) in partnership with Statistics South Africa, and in alignment with the Statistics Act (No. 6 of 1999).

The R&D Survey is conducted by the Human Sciences Research Council's Centre for Science, Technology and Innovation Indicators (CeSTII), in accordance with the international guidelines published by the Organisation for Economic Co-operation and Development (OECD), known as the Frascati Manual. The resulting statistics provide important evidence on the size, growth and composition of R&D expenditure and human resources devoted to R&D.

During the second quarter of 2018, the South African economy slipped into recession to the extent that GDP decreased by 0.6 of a percentage point, from 1.4% to 0.8% (Stats SA, 2020).

Gross domestic expenditure on research and development (GERD) for 2018/19 amounted to R36.784 billion in current values, a decline of 5% (R1.941 billion) from the R38.725 billion recorded in 2017/18. This represents the first such decline since the contraction of GERD recorded between 2009 and 2010.

R&D intensity, measured as GERD as a percentage of gross domestic product (GDP) at current prices, has therefore also declined by eight basis points, from 0.83% in 2017/18 to 0.75% in 2018/19.

In terms of Survey performance, the R&D Survey project's plan is cast according to the phases of the Statistical Value Chain (SVC) promoted by South African Statistical Quality Assessment Framework (SASQAF) requirements. SASQAF is the instrument used for assessing the quality of the statistical reports for accreditation as official statistics. Each year the R&D Survey is subjected to a stringent quality assessment process, which is undertaken by a Clearance Committee comprising experts from various sectors. This report is the ninth in the series of R&D Survey statistical reports since the inception of a clearance process prior to the release of the annual data. To validate the quality of the survey, independent verification by the technical clearance committee was initiated in this survey round.

The assessment revealed that the 2018/19 R&D Survey was conducted following good practice and was found to meet most of the quality requirement of the R&D Survey Assessment Tool. Notably, the current survey was negatively impacted by Covid-19 lockdowns and restrictions, particularly during the final stages of the data collection phase. To mitigate against the likelihood of a lower response rate, the fieldwork period was extended, the top 200 R&D performing business companies were targeted for additional effort, and where possible, data were imputed and signed-off by respondents.

Based on my assessment of the Clearance Committee recommendations, I endorse the 2018/19 R&D Survey, with the caveat that time series analysis of the data using the 2018/19 R&D Survey estimates need to be done with caution, taking into consideration the relatively low response rate due to the advent of COVID-19.

Risenga Maluleke
Statistician-General
REPUBLIC OF SOUTH AFRICA
18 February 2021

PREFACE

The 2019 White Paper for Science, Technology and Innovation was approved by Cabinet at the end of the 2018/19 financial year. The White Paper sets out an ambitious policy agenda for a coordinated effort to enhance the contribution of Science, Technology and Innovation (STI) for an inclusive and just economy and society.

Through a co-creation effort and informed by evidence, a decadal plan is being finalised with all critical stakeholders including STI-intensive government departments, research performers, innovation agents, the private sector and civil society. The decadal plan will detail the programmes, interventions, flagship initiatives as well as institutional and other reforms that will advance the policy intents of the 2019 White Paper. Priority programmes and flagship initiatives will be guided by the priorities of the National Development Plan. The National Survey of Research and Experimental Development (R&D Survey) is a critical source of evidence for the decadal plan as well as subsequent reviews to assess progress. South Africa is amongst leading countries in the use of international STI measurement standards in the compilation of statistics on R&D intensity. This enables international comparison. In line with international developments, R&D spending is now correctly considered as an investment in the National Chart of Accounts.

In addition to using international STI measurement standards, the R&D Survey is also subjected to the national statistical quality control process. Through the clearance committee process involving users and experts, and chaired by Statistics South Africa (Stats SA), the methodology, as well as the results of the R&D Survey, are subjected to stringent quality assessment processes. I would like to extend my thanks and appreciation to the chair and members of the clearance committee for their support in maintaining quality STI indicators.

The R&D Survey is undertaken annually by the Centre for Science, Technology and Innovation Indicators (CeSTII) based at the Human Sciences Research Council (HSRC), on behalf of the Department of Science and Innovation (DSI), and in partnership with Stats SA. I further extend my thanks to the CeSTII team, under the guidance and leadership of Dr Glenda Kruss.

Unfortunately, gross domestic expenditure on research and development (GERD) fell from R38.725 billion to R36.784 billion in 2018/19. South Africa's expenditure on R&D declined for the first time after showing a recovery in 2009. GERD as a percentage of gross domestic product (GDP) in 2018/19 was 0.75%, an eight basis points decline when compared to the 0.83% that was recorded in 2017/18. R&D personnel headcount shows a decline from 84 262 to 84 036 in 2018/19, that is, 226 less R&D personnel. On the positive side, the proportion of female researchers increased by 0.8% from 44.9% in 2017/18 to 45.7% in 2018/19.

The main investors of R&D in South Africa are the government and business sectors. The government sector remains the main funder of R&D in the country. The government plays an important role in the advancement of R&D and innovation in South Africa. Government funding for STI is necessary to address development gaps and to support South African growth and development. To intensify business sector R&D, government has entered into innovation partnerships with joint funding as well as introducing an R&D tax incentive.

Moving forward, a strong commitment is required by all major investors to increase their level of R&D funding in order to achieve the 1.5% target by 2030 envisaged in the National Development Plan. The proposed decadal plan for science, technology, and innovation provides a credible and effective instrument for tying this commitment to social and economic outcomes and returns. I invite all stakeholders to participate actively in the finalisation of the decadal plan and specifically on commitments to increase their investment in science, technology, and innovation, including R&D.

The benefit of long-term sustained investment in R&D was illustrated in the critical role being played by the National System of Innovation in South Africa's response to the COVID-19 pandemic. Previous significant investments in health research, genomics, the social sciences and humanities, energy and water technologies, data science and analytics, chemistry and even astronomy were mobilised in support of the national COVID-19 response. These will be detailed in other documents including the annual performance plan and annual reports of the Department of Science and Innovation.

The 2018/19 R&D Survey was negatively impacted by the COVID-19 lockdown restrictions, particularly during the final data collection phase. To mitigate against the likelihood of a lower response rate, fieldwork was extended to improve the rate of return, especially in the business sector.

Given the impact of COVID-19 on the 2018/19 R&D Survey, the results are published with the caveat that the time series analysis of the data needs to be read with caution owing to the unusually high number of imputations used to estimate the business sector statistics.

Finally, I would like to convey special thanks to all survey respondents in the five institutional sectors that underpin the R&D Survey. Your time and commitment, in a particularly difficult year, on conducting a credible survey for 2018/19 is appreciated. I count on your ongoing support as we maintain a critical data series in ensuring that the National System of Innovation is used optimally in pursuit of our collective social and economic development priorities.

Dr B E Nzimande, MP
MINISTER OF HIGHER EDUCATION, SCIENCE AND INNOVATION

ACKNOWLEDGEMENTS

The South African National Survey of Research and Experimental Development is conducted annually by HSRC-CeSTII on behalf of the DSI.

The project team extends its appreciation to Dr Phil Mjwara, Director-General of the DSI, Mr Risenga Maluleke, Statistician-General, Prof Crain Soudien, CEO of the HSRC, and Prof Leickness Simbayi, Deputy CEO: Research of the HSRC, for their support of the R&D Survey.

The support and contributions of Dr Glenda Kruss, Executive Director of CeSTII, and Mr Imraan Patel, Mr Godfrey Mashamba, Ms Tshidi Lekala, Ms Kgomotso Matlapeng and Mr Thabo Manyaka of the DSI are appreciated.

Technical inputs and advice by the DSI and Statistics South Africa teams as well as the Clearance Committee for Science, Technology and Innovation Statistical Reports have helped improve the quality of this publication and are appreciated.

Interactions with the OECD Working Party of National Experts on Science and Technology Indicators (NESTI) have provided invaluable assistance in maintaining the quality and standard of the South African R&D surveys and analysis of the results.

The HSRC-CeSTII project team for the 2018/19 South African National Survey of Research and Experimental Development comprised: Curtis Bailey, Lindiwe Binda, Yasser Buchana, Mario Clayford, Amy Kahn, Atoko Kasongo, Nhlanhla Malaza, Precious Mudavanhu, Jerry Mathekga, Neo Molotja, Audrey Mahlaela, Sintu Mavi, Nazeem Mustapha, Gerard Ralphs, Janine Senekal, Theodore Sass, Natasha Saunders, Kgabo Ramoroka, Viwe Sigenu, Moses Sithole, Anele Slater, Natalie Vlotman, Luthando Zondi, and Sibusiso Ziqubu.

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We are most grateful for and acknowledge the cooperation of the respondents to the questionnaire.

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
DSI	Department of Science and Innovation
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 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
R&D	Research and experimental development
RF	Research field
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SASQAF	South African Statistical Quality Assessment Framework
SEO	Socio-economic objective
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 Organisation

DEFINITION OF TERMS

Applied research is original investigation undertaken to acquire new knowledge. It is 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.

BERD refers to business expenditure on research and experimental development.

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 is 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 domestic 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.

Master's students refer to students doing a full research master's as well as those doing coursework plus thesis with a research component.

Non-South African personnel are classified as those that are not from South Africa but undertaking research for a period exceeding six months. This classification aligns with the South African System of National Accounts classification that classifies non-South Africans as temporary residents or permanent residents. R&D personnel may be permanent or temporary residents. The conditions are that they have to be involved in the R&D Survey during the survey period, and on contract of six months or longer.

New materials refer 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 motorcar 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 and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge.

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.

Research field (RF) refers to a branch of science, either natural or social and humanities sciences.

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

R&D personnel includes all persons (irrespective of nationality) employed directly on R&D activities, as well as those providing direct services, such as R&D managers, administrators, technicians and clerical staff. These include emeritus professors, honorary fellows and research fellows.[1]

R&D-performing sectors comprise the government, higher education, business and not-for-profit institutional 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, 2019a), 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%.

[1] Prior to 2016/17, R&D personnel were comprised of only South African researchers, technicians and other R&D personnel. Also, emeritus professors, honorary fellows and research fellows were not explicitly included in the estimates of R&D personnel.

EXECUTIVE SUMMARY

This report presents results from the seventeenth South African National Survey of Research and Experimental Development (R&D Survey) 2018/19 conducted by the Centre for Science, Technology and Innovation Indicators (CeSTII) on behalf of the Department of Science and Innovation (DSI).

R&D expenditure decreased to R36.784 billion in 2018/19

Gross domestic expenditure on research and development (GERD) for 2018/19 was R36.784 billion. For the first time since 2010/11, gross expenditure on domestic R&D in South Africa declined. In nominal terms, this represents a decrease of R1.941 billion from the R38.725 billion recorded in 2017/18. At constant 2010 Rand value, GERD prices decreased by R2.231 billion (-8.6%) from R25.963 billion in 2017/18 to R23.732 billion in 2018/19. GERD as a percentage of GDP decreased by eight basis points year-on-year from 0.83% in 2017/18 to 0.75% in 2018/19.

South Africa is not alone in experiencing decline and stagnation in GERD

Select country data shows South Africa's GERD is low compared to high-income countries but high relative to African and comparable middle-income countries in Latin America. This data shows a stagnation, slow down or decline of GERD/GDP in the majority of the selected comparator leading and developing countries in 2018/19.

The higher education and not-for-profit sectors see increases in expenditure

The higher education and not-for-profit sectors experienced slight increases in GERD. The higher education sector was the second largest performer of R&D in South Africa. In current prices, the higher education sector reported R13.183 billion in 2018/19, a slight increase in R&D spend from the R13.010 billion reported in 2017/18. The not-for-profit sector experienced the largest increase in GERD, growing by R269 million to R1.486 billion in 2018/19.

Business, science councils and government sectors see declines in expenditure

Business sector GERD constituted 39.9% of national GERD and amounted to R14.448 billion, a decrease of R1.411 billion (-8.9%) from the R15.859 billion reported in 2017/18. The science council sector GERD decreased by R869 million (-13.8%), amounting to R5.444 billion in 2018/19. Government expenditure on R&D (GOVERD) constituted 6.0% of GERD, and amounted to R2.223 billion in current prices, decreasing by R139 million from R2.326 billion to R2.223 billion.

Government and business funding for R&D declines

Government remained the largest funder of R&D, contributing R17.475 billion (47.5%) of total GERD in 2018/19, followed by the business sector which spent R14.534 billion (39.5%). Funding from the government and business sector declined by 3.4% and 9.5% respectively. The business sector continued funding its own R&D, which amounted to R13.788 billion (94.9%), with the remainder

allocated to the higher education (3.2%) and science council sectors (1.4%). The third largest funder was foreign sources, which increased slightly from R3.937 billion in 2017/18 to R3.999 billion in 2018/19. The higher education sector received the largest share of foreign funding, amounting to R1.852 billion (46.3%), an increase of 23.0% from 2017/18. The not-for-profit sector received 22.5% of foreign funding.

R&D personnel show signs of stagnation year-on-year

The 2018/19 period indicated a decline in headcount and FTE data for the first time. Human capabilities in R&D measured by headcounts declined by a small margin of 0.3% year-on-year, from 84 262 to 84 036 between 2017/18 and 2018/19. Postgraduate student headcounts in the higher education sector are a significant contributor to total R&D personnel, showing consistent growth in headcounts year-on-year. Postgraduate students grew from 80 648 in 2017/18 to 86 395 in 2018/19, boosting growth in R&D personnel and balancing out the decline of researchers in the science council, business and government sectors.

Mining sector experiences a boost in R&D

The largest proportion of BERD in 2018/19 was invested by the financial, intermediation, real estate and business services sector, amounting to R6.402 billion (44.3%) in 2018/19. The manufacturing sector accounted for 21.9% (R3.166 billion) of BERD, a decrease from 28.2% in 2017/18. The spend on R&D in the manufacturing sector has been on a downward trend since 2008/09. The proportion of BERD in the mining sector amounted to R1.748 billion, a year-on-year increase of 58.8%.

South Africa continues to lead with women researchers

The proportion of female researchers was 45.7% of total researchers in 2018/19, an increase from the 44.9% achieved in 2017/18. Female researchers appear to form a higher proportion of total researchers in developing countries, compared with developed countries.

South Africa's spend on health R&D continues to grow as a priority area

Expenditure on health R&D has been on an upward trajectory since 2014/15, with 23.4% (R8.164 billion) of national GERD devoted to health R&D in 2018/19. The majority of health R&D spend (86.1%) was focused in the medical and health sciences research field. A total of R5.106 billion was spent on the communicable diseases priority area (TB, HIV/AIDS and malaria), an increase of R484 million more than reported in 2017/18. The public sector invested the largest share (54.2%) on health R&D, followed by the private sector (45.9%).

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INTRODUCTION

Growing R&D investment for inclusive and sustainable development

Now, more than ever, South Africa needs to redouble its efforts to catalyse the transformative innovation needed to spur inclusive and sustainable growth and development. In this context, the role of and case for R&D could not be more urgent or compelling. Rapid production of SARS-CoV-2 vaccines, and their deployment globally, is an excellent example of how large-scale private and public R&D investment contributed in a timely manner to reducing the risk of infection and stimulating the needed recovery of economies. Yet the ongoing pandemic, and the persistent human and environmental risks that enabled the emergence of the novel coronavirus and its variants, will undoubtedly require much more research and innovation for our economies, societies and ecosystems to 'build back better'.

For the first time since 2010/11, gross domestic expenditure on R&D (GERD) in South Africa declined in 2018/19. An indicator of a country's research intensity, GERD/GDP fell from 0.83% in 2017/18 to 0.75% in 2018/19, close to the lowest level recorded in the last decade, of 0.72% (Table 1). The number of R&D personnel reported in 2018/19 also declined, as did government and business funding for R&D. While this decline must be interpreted in relation to the economic stagnation that intensified in the 2018/19 reference period, it underscores the urgent need to examine how to grow R&D expenditure and human capabilities in South Africa. The challenge is to grow from the baseline 0.75% GERD/GDP recorded for 2018/19, to the targeted level of 1.5% by 2030. The analysis of trends in R&D investment, performance and human resources in this report provide detailed insight into South Africa's R&D landscape and its strengths and weaknesses.

GERD/GDP targets in South Africa

Leveraging investment in R&D across the national system of innovation is integral to South Africa's current science, technology and innovation policy approach, and the goals of the National Development Plan. The Department of Science and Innovation has set a national target to spend 1.1% of GDP on research and development by 2024, as an intermediate step towards the goal of 1.5% by 2030.

Table 1: Key R&D indicators for 2009/10 to 2018/19

KEY INDICATOR	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Gross domestic expenditure on R&D (GERD) (R million)	20 955	20 254	22 209	23 871	25 661	29 345	32 337	35 693	38 725	36 784
Gross domestic expenditure on R&D in constant 2010 prices (R million)	22 286	20 254	20 847	21 283	21 552	23 351	24 467	25 191	25 963	23 732

Continues overleaf...

KEY INDICATOR	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
GERD as a percentage of GDP (%)	0.84	0.74	0.73	0.73	0.72	0.77	0.80	0.82	0.83	0.75
Civil GERD as a percentage of GDP (%)	0.82	0.71	0.72	0.72	0.69	0.72	0.75	0.78	0.79	0.72
Basic research (R million)	5 553	4 848	5 440	6 031	6 102	7 133	8 210	9 543	10 224	10 364
Government-funded* R&D (R million)	9 313	9 019	9 562	10 832	11 007	12 873	14 430	16 428	18 082	17 475
Business-funded R&D (R million)	8 908	8 128	8 663	9 152	10 616	11 982	12 578	14 046	16 067	14 534
Foreign-funded R&D (R million)	2 538	2 445	3 330	3 120	3 315	3 566	4 210	4 172	3 937	3 999
Total R&D personnel (FTE**)	30 891.3	29 486.4	30 978.4	35 050.3	37 956.5	38 465.0	41 054.5	42 533.0	44 259.3	43 774.3
Total researchers# (FTE**)	19 793.1	18 719.6	20 115.1	21 382.4	23 346.0	23 571.9	26 159.4	27 656.2	29 515.2	29 110.8
Total researchers# (headcount)	40 797	37 901	40 653	42 828	45 935	48 479	51 877	56 761	61 840	62 166
Female researchers# (headcount)	8 075	15 794	17 184	18 724	20 231	21 471	23 334	25 591	27 774	28 401
Total R&D personnel (FTE**) per 1 000 in total employment	2.3	2.2	2.3	2.4	2.5	2.5	2.6	2.6	2.7	2.7
Total researchers# (FTE**) per 1 000 in total employment	1.5	1.4	1.5	1.5	1.6	1.5	1.7	1.7	1.8	1.8
Female researcher# headcount as a percentage of total researcher headcount (%)	40.8	41.7	42.3	43.7	44.0	44.3	44.4	45.1	44.9	45.7
Gross domestic product level at current prices (R million)	2 507 677	2 748 008	3 023 659	3 253 852	3 539 977	3 805 350	4 049 884	4 359 060	4 653 579	4 873 899
SA employment ('000)	13 347	13 118	13 497	14 558	15 055	15 459	15 663	16 212	16 378	16 420

Data notes

* Government-funded R&D includes science council and university own funds.

** FTE: full-time equivalent.

\# Includes doctoral students and post-doctoral fellows. Also includes emeritus professors, research fellows and honorary research fellows in 2017/18. These categories of personnel do not incur salary costs, but there are time and other costs associated with their institutional position. Headcount includes non-SA R&D staff in 2018/19

Data sources

South African National Survey of Research and Experimental Development, 2016/17 to 2018/19.
GDP values: Stats SA, GDP, Fourth Quarter 2019b, P0441 Series (Stats SA, 2019b).
Total employment values: Stats SA, Quarterly Labour Force Survey, Fourth Quarter 2019a, P0211 Series (Stats SA, 2019a).

Reading and using this report

In the previous R&D Survey Main Report, covering the 2017/18 reference period, expenditure and personnel trends were interrogated to identify specific areas of growth, decline and stagnation, and to prompt policy-relevant questions. In this report we continue with this approach through an updated, disaggregated analysis of the 2018/19 R&D data. The analysis is organised into three sections. Section 1 focuses on how R&D is oriented to address national priorities. Section 2 interrogates R&D funding flows. Section 3 considers trends in the growth of the human capabilities for R&D. The analysis in each section highlights evidence that is pertinent to policy concerns.

Actors in the national system of innovation, whether government departments, business support groups, universities or civil society organisations, attempt to understand the current R&D trends shaping the future, and the potential R&D growth points in the private and public sectors. At a time when the COVID-19 pandemic is still unfolding, and its long-term societal and economic impacts remain uncertain, reliable data-informed analysis is essential. This report is thus oriented to the needs of officials in government departments, leaders in businesses and business support groups, science council executives, university research leaders, and civil society practitioners.

SA R&D Survey report, at a glance

Purpose

This R&D Survey 2018/19 Main Report provides descriptive analysis and commentary on the latest survey results. It is accompanied by the Statistical Report, which presents data tables for 2018/19 in the form of trend data for the past 10 years, key findings and commentary placing the results in context. Together, these reports provide R&D data and indicators that enable the reader to explore policy issues and develop research questions for further study.

Scope

The R&D 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 satisfies national data needs and is consistent with the international sector categorisation for measuring R&D recommended by the Organisation for Economic Co-operation and Development (OECD) 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, 2015). The data and analysis in the R&D Survey report is presented using globally standard categories of statistics, such as:

- Gross domestic expenditure on research and experimental development (GERD)
- GERD by R&D-performing sectors
- Sources and flows of funding for R&D
- R&D expenditure by economic sector, field of research and socio-economic objective
- R&D expenditure by province
- R&D personnel by occupation (researchers, technicians and support staff) and full-time equivalents (FTEs).

In addition, R&D expenditure in multidisciplinary and selected research fields of policy interest in South Africa is routinely analysed. This includes biotechnology; open-source software; new materials; and tuberculosis (TB), HIV/AIDS and malaria research, in addition to analysis of special research priority areas, such as green and health R&D.

1. R&D EXPENDITURE ORIENTED TO ECONOMIC GROWTH AND INCLUSIVE DEVELOPMENT

Section 1:

- Analyses **high level trends** in gross domestic expenditure on R&D (GERD), by institutional sector, and in **international comparison**.
- Breaks down R&D data to compare trends using **multi-year data points**.
- Identifies **patterns of expenditure** by accounting category and institutional sector.
- Explores the nature of **R&D Standard Industrial Classification codes** in the business sector.
- Describes the focus of R&D expenditure by **type and field** of research.
- Focuses on trends in **priority areas of green and health R&D**.

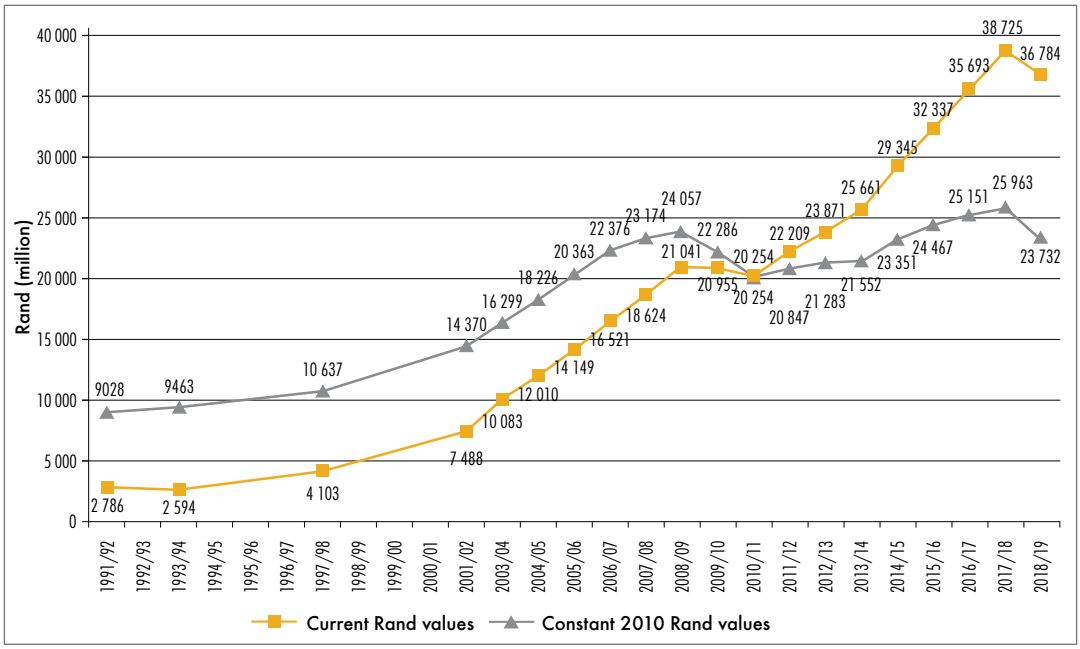
1.1 High-level trends over time

1.1.1 Gross domestic expenditure on R&D

The gross expenditure on research and experimental development (GERD) amounted to R36.784 billion in 2018/19 (Figure 1). In nominal terms, this represents a decrease of R1.941 billion from the R38.725 billion recorded in 2017/18. At constant 2010 Rand value, GERD prices decreased by R2.231(-8.6%) from R25.963 billion in 2017/18 to R23.732 billion in 2018/19. Since 2009/10, average year-on-year growth was 5.9%, but decreased by 5.3% in 2018/19.

South Africa experienced a decline in GERD and GERD/GDP for the first time since 2010/11.

Figure 1: GERD in current and constant 2010 Rand value (R million), South Africa, 1991/92 to 2018/19

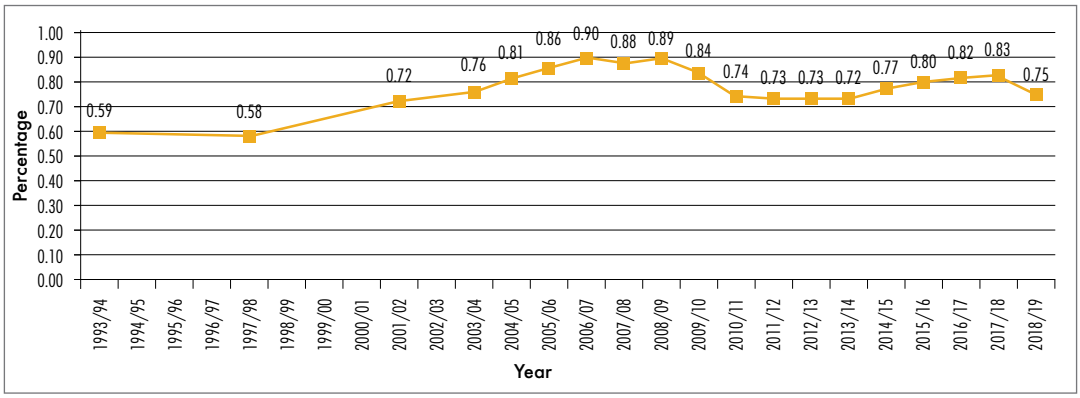


Data note	GDP deflator values derived from the fourth quarter release of the Stats SA GDP series P0441 (Stats SA, 2019a) were used to calculate constant 2010 Rand values for R&D expenditure.
Data sources	Revised GDP (current values): Stats SA GDP Statistical Release P0441, 4th Quarter 2019a R&D expenditure: National Survey of Research and Experimental Development, 2001/02 to 2018/19. R&D expenditure for the period prior to 2001/02 was sourced from archived data (DNE, 1993; DACST, 1996; DACST, 2000).

1.1.2 GERD as a percentage of GDP

GERD as a percentage of GDP, a measure of R&D intensity, was 0.75% in 2018/19 (Figure 2). This indicator decreased by eight basis points from 0.83% in 2017/18. This is the first decline since 2010/11. The trend data show 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. GERD as a percentage of GDP is now far below the maximum level of 0.90% reached in 2006/07, which was closest to the target at that time, of 1%.

Figure 2: GERD as a percentage of GDP, South Africa, 1993/94 to 2018/19



Definition	GERD expressed as a percentage of GDP indicates the intensity of R&D in an economy.
Data sources	Revised GDP (current values): Stats SA GDP Statistical Release P0441, 4th Quarter 2019a R&D expenditure: National Survey of Research and Experimental Development, 2001/02 to 2018/19. R&D expenditure for the period prior to 2001/02 was sourced from archived data (DNE, 1993; DACST, 1996; DACST, 2000).

1.1.3 International comparison

Public authorities expect that increasing investment in R&D will intensify technological progress and in turn, accelerate sustainable socio-economic growth. South Africa's R&D performance can be evaluated relative to international counterparts, bearing in mind the differing economic and structural status of the selected comparator countries, and the availability of the latest data. The selection here encompasses a combination of African countries that have data for the survey period, some of the BRICS countries, other middle and low-income countries, and selected world leaders in R&D performance.[2]

Table 2 shows GERD for the selected countries in both current millions PPP$ and constant million PPP$, in order to reflect trends over time more accurately. Figure 3 shows changes in GERD as a proportion of GDP between 2017/18 and 2018/19, for the selected countries. Table 2 and Figure 3 reflect the reference data that form the basis for comparative discussion of groups of cognate countries, relative to South African trends, in this section.

In general, the comparison shows that South Africa's gross domestic expenditure on R&D is low compared to high-income countries, such as the United States of America (USA), China, Japan and Germany, but high relative to African and comparable middle-income countries in Latin America. The data for the selected countries shows very minor changes on GERD/GDP since the previous reference

[2] The analysis of data in terms of "largest or smallest" expenditure on R&D is based on the countries selected for this report, not according to the lowest/highest OECD Main Science and Technology indicators or UNESCO_UIS.

period. These minor declines or increases point to a stagnation of GERD/GDP in the majority of leading and developing countries in 2018/19.

1.1.3.1 Comparing GERD trajectories in leading countries

Countries such as the USA and Japan are world leaders in GERD investment and largely maintained their steady growth trajectory.

The USA, China, Japan, and Germany are global leaders in GERD investment.

The data shows that the USA, Japan and Germany continued to surpass the $100 000-million-dollar mark, measured in both constant and current prices (OECD, 2020). France, Italy, Russia, Spain and Turkey showed GERD of between $19 000 million and $60 000 million, and are all on a similar growth trajectory (Table 2).

Table 2: GERD for selected countries (millions in current and constant price PPP$), 2016/17 to 2018/19 or the latest available year

COUNTRY	CURRENT PPP$			CONSTANT PPP$		
	2016	2017	2018	2016	2017	2018
United States of America	522 652	556 343	607 474	517 225	540 406	576 237
China	393 015	420 815	465 501	399 390	430 329	464 705
Japan	160 269	166 621	172 785	163 004	169 181	173 280
Germany	122 472	133 668	142 080	116 904	124 577	128 823
Korea	80 815	90 289	99 025	79 364	88 135	95 437
France	63 651	65 730	68 617	61 077	61 945	62 837
Russian Federation	39 651	42 246	41 693	38 947	39 921	36 251
Italy	33 076	34 488	37 044	31 016	31 619	33 129
Spain	20 633	22 293	23 650	19 883	20 817	21 864
Turkey	19 855	21 572	23 590	19 603	21 401	23 713
Israel	14 588	15 873	17 366	13 941	14 998	16 033
Poland	10 354	11 807	14 680	10 133	11 410	14 051
Finland	6727	7 147	7 559	6 522	6 739	6 895
Egypt	7 489	7 217	8 289	6 051	6 045	6 783
South Africa	5 795	6 025	5 642	4 090	4 039	3 640
Argentina	4693	5 781	b)	4 502	4 856	
Chile	1 576	1 608	1 623	1 532	1 494	1 525
Mauritius	b)	99	99	b)	84	82

Data note: b) Time series break.

Data source: South Africa: National Survey of Research and Experimental Development, 2018/19.
Argentina, Chile, China, Finland, France, Germany, Israel, Italy, Japan, Korea, Poland, Russian Federation, Spain, Turkey, USA: OECD (OECD, 2020).
Egypt, Mauritius, : UNESCO (UNESCO, 2019).

China led the BRICS grouping, with a GERD intensity of 2.14%, which is higher than many developed countries, including Italy, Spain and Poland (Figure 3). In 2017/18, Korea overtook Israel to become the country with the highest R&D intensity, at 4.55%. In 2018/19, Israel reclaimed the first position with the highest R&D intensity, at 4.94%. Korea recorded a slight decrease in GERD as a percentage of GDP, from 4.55% in 2017/18 to 4.53% in 2018/19. Although Korea outperformed many European counterparts, other developed states, like Japan (3.28%), the USA (2.83%) and Finland (2.76%) also recorded R&D intensity ratios greater than 2.5%, much greater than the revised 1.5% target set for South Africa.

While developed countries such as Israel, Japan, the USA, Poland, Spain, and Italy showed increases in GERD as a percentage of GDP in 2018/19, comparative data shows that South Africa is not the only country to have experienced a decline (Figure 3). Highly developed countries such as Korea (4.55% to 4.53%), China (2.15% to 2.14%), the Russian Federation (1.11% to 0.99%), and Chile (0.36% to 0.35%) have also shown slight declines or stagnation in this key indicator of R&D intensity.

1.1.3.2 Comparing GERD trajectories with developing economies

While GERD in China and Russia is significantly higher than South Africa, gaps in the data for Brazil (no 2017 data) and India (no data reported since 2015) mean that it is not possible to conduct a full group comparison for the BRICS countries.

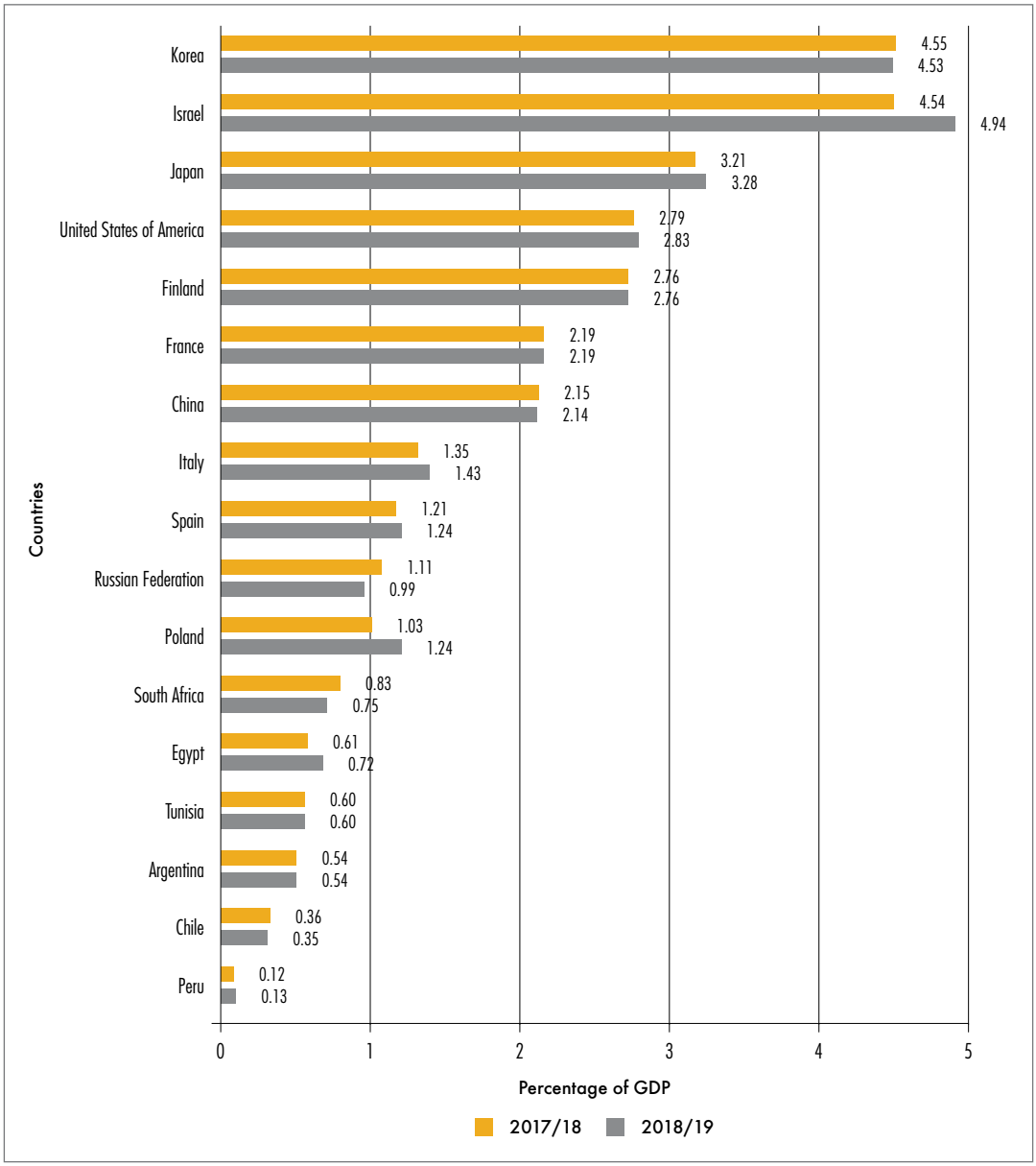
Despite the decline in GERD as a percentage of GDP in 2018/19, South Africa still surpassed the R&D intensity of other African R&D performing nations, such as Egypt, which increased from 0.61% in 2017/18 to 0.72% in 2018/19 and Tunisia, which remained stagnant at 0.60% over the same period.

In current GERD, Mauritius remained steady from 2017/18 to 2018/19, reporting $99 million, but showed a decrease in constant GERD over the same period. Mauritius is still new to the survey and more data points are required to assess its R&D investment trajectory relative to that of South Africa.

The Latin American countries, Argentina, Chile and Peru, reported GERD lower than that of South Africa (Table 2). The World Bank classifies Chile as a high-income country within the Latin American group (World Bank, 2019), while Argentina and Peru, like South Africa, are classified as upper middle-income countries. Over the three-year period, GERD hovered around the same levels for Chile, Argentina and Peru, with slight declines in 2018/19. The Latin American countries' slow GERD growth trajectories are similar to that of South Africa. Figure 3 reflects how South Africa surpassed the R&D intensity of key Latin American countries: Argentina, Chile and Peru.

South Africa is the leading country in Africa in terms of GERD as a percentage of GDP.

Figure 3: GERD as a percentage of GDP for selected countries, 2017/18 and 2018/19 or latest available year



Data source South Africa: National Survey of Research and Experimental Development, 2018/19.
Argentina, Chile, China, Finland, France, Germany, Israel, Italy, Japan, Korea, Poland, Russian Federation, Spain, Turkey, USA: OECD (OECD, 2020).
Egypt, Peru, Tunisia: UNESCO UIS, 2020.

1.2 Patterns of R&D expenditure

1.2.1 R&D expenditure by accounting category

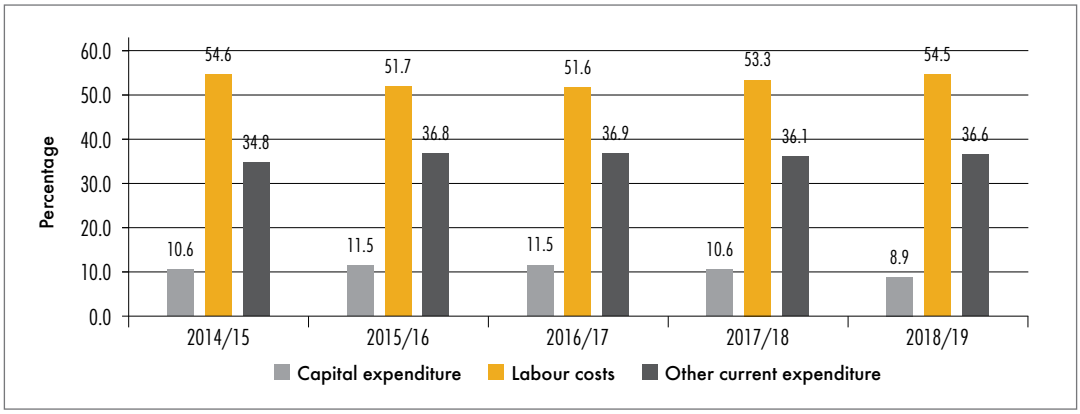
The Frascati Manual (OECD, 2015) differentiates between two types of R&D expenditure: capital expenditure and current expenditure. Current expenditure distinguishes between two types of costs: labour costs and other current costs. Capital expenditure comprises all annual gross expenditure on fixed assets used for R&D performance, and includes the acquisition of software and licensing fees, databases lasting for more than one year, major repairs and modifications on land and buildings.

Labour costs of R&D personnel consist of annual wages, salaries and all associated costs or fringe benefits. The share of R&D labour costs for the five years shown in Figure 4 indicates that labour costs were generally well above 50.0% of GERD. In 2018/19 labour costs accounted for 54.5% of all R&D expenses. There are three scenarios that might explain this: labour costs may have grown as a result of salaries and wages, or as a result of increases in the number of R&D personnel (volume) in FTEs, or both.

Higher investment in capital R&D may be needed to boost national R&D.

Other current expenditure includes non-capital purchases of materials, supplies and equipment to support R&D. Other current expenditure equalled 36.6% of GERD, an increase of five basis points from 36.1% reported in 2017/18.

Figure 4: R&D expenditure by accounting category (percentage), South Africa, 2014/15 to 2018/19



Data source National Survey of Research and Experimental Development, 2014/15 to 2018/19.

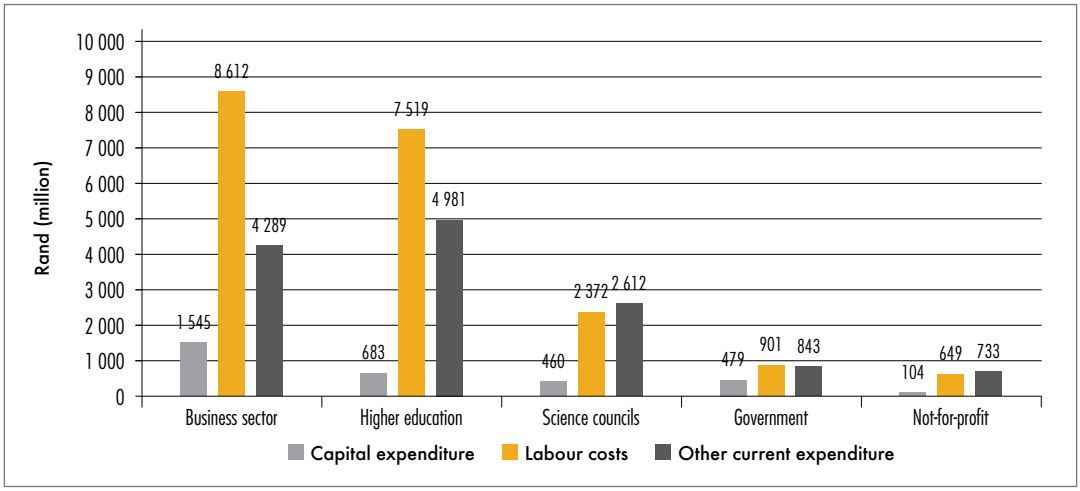
Figure 5 disaggregates R&D expenditure by accounting category for each institutional sector of performance. The business sector allocated the highest proportion of capital expenditure of R1.545 billion, followed by the higher education sector at R683 million. The government and science council sectors had similar investments in capital expenditure of R479 and R460 million respectively. The not-for-profit sector spent the least proportionally on capital expenditure, only R104 million.

The higher education sector spent the largest share (R4.981 billion) on other current expenditure, followed by the business (R4.289 billion) and science council (R2.612 billion) sectors. The government and not-for-profit sectors invested lower other current expenditures of R843 million and R733 million respectively.

Except for the science council sector, the labour costs of the other four sectors were larger than capital and other current expenditure in 2018/19. Labour costs for the business sector were the highest at R8.612 billion, followed by the higher education sector at R7.519 billion.

In the government and not-for-profit sectors, however, labour costs were proportionately closer to current expenditure, at R900 million and R843 million respectively.

Figure 5: R&D expenditure by accounting category (R million), South Africa, 2018/19



Data source National Survey of Research and Experimental Development, 2018/19.

1.2.2 GERD by institutional sector

The business sector remained the largest performer of R&D in South Africa in 2018/19, accounting for 39.3% of national GERD (Figure 6). Business expenditure on R&D at current expenditure amounted to R14.448 billion, a decrease of R1.411 billion (8.9%) from the R15.859 billion reported in 2017/18. At constant prices BERD amounted to R9.321 billion, a decrease of R1.311 billion from the R10.633 billion reported in 2017/18.

The business, government, and science councils sector reflected decreases in R&D investment for 2018/19.

The higher education sector was the second largest performer of R&D in South Africa. Nominally the higher education reported a slight increase in R&D spend, increasing from R13.010 billion in 2017/18 to R13.183 billion in 2018/19. At constant 2010 Rand values however, the higher education sector R&D expenditure (HERD) decreased by 2.5%, from R8.722 billion in 2017/18 to R8.505 billion in 2018/19.

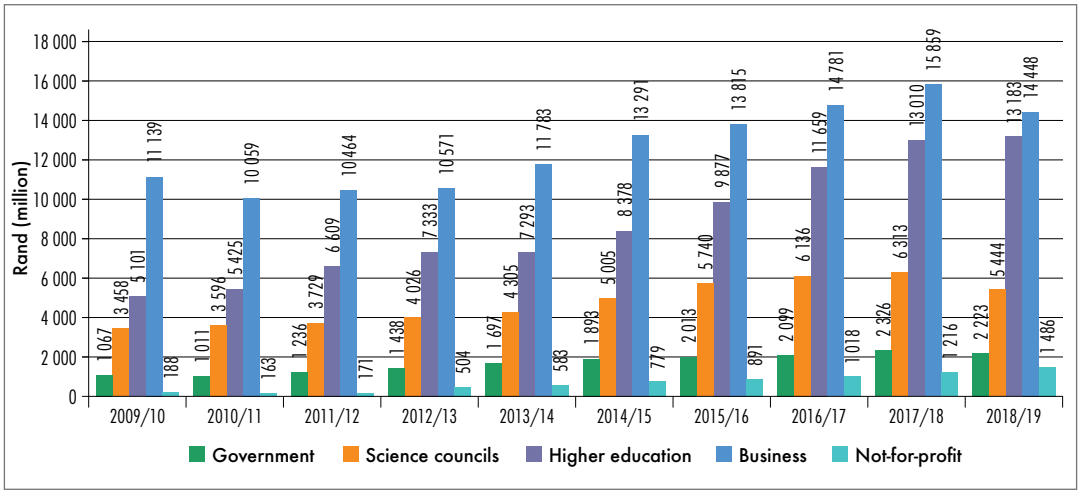
The expenditure on R&D by science councils accounted for 14.8% of GERD, representing R5.444 billion, a decrease of R869 million (13.8%) in 2018/19. In constant 2010 Rand values, their aggregate expenditure decreased by 17.0%, from R4.233 billion in 2017/18 to R3.512 billion in 2018/19.

Science councils are established by acts of Parliament and tasked with complex mandates to conduct research on national priority areas.

Government expenditure on R&D (GOVERD) constituted 6.0% of GERD. It amounted to R2.223 billion in current values, and at constant 2010 Rand values, this represented a decrease of 8.0%, from R1.559 billion in 2017/18 to R1.435 billion in 2018/19.

Not-for-profit organisations recorded, at current Rand values, a 22.1% (R0.269 billion) increase in R&D expenditure, from R1.216 billion in 2017/18 to R1.486 billion in 2018/19. Although this nominal increase was the largest increase in national GERD, it had little impact on the overall growth rate of GERD in 2018/19.

Figure 6: R&D expenditure by sector (R million), South Africa, 2009/10 to 2018/19



Definition	The Frascati Manual (OECD, 2002, 2015) defines the R&D-performing sectors as the government, higher education, business and not-for-profit sectors. In South Africa, science councils are surveyed separately from government departments. 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, 2009/10 to 2018/19.

1.3 Business sector R&D

Given the decline in BERD over the past few years, it is important to focus in greater detail on the R&D expenditure trends within the business sector.

Disaggregation by Standard Industrial Classification codes allows for identification of the industrial clusters where there was growth or decline in the BERD conducted, as well as shifts in the source and destination of R&D investment.

The industrial sector investing the largest proportion of BERD in 2018/19 was financial, intermediation, real estate and business services (Table 3), which accounted for 44.3% of BERD (Figure 7). The manufacturing sector (Table 4) accounted for 21.9% of BERD, compared to 28.2% in the previous reference period (Figure 8). Disaggregation of the contribution of different subsectors (Figure 7) shows that the research and development subsector (88000)

Substantial increases in investment were made in the mining sector, while the manufacturing sector decreased.

contributed a higher percentage, while renting of machinery and equipment and of personal and household goods (85000), contributed the lowest share of BERD in the financial, intermediation, real estate and business services sector.

The fluctuating, but generally declining, expenditure in the manufacturing sector points to a reduced investment in manufacturing sector R&D. The mining sector, however, experienced a 58.8% (R0.647 million) increase in 2018/19. Figure 8 and Table 5 show the contribution of different manufacturing subsectors to BERD. There was a decrease in R&D expenditure between 2017/18 and 2018/19 in seven out of the ten subsectors (Figure 8).

Figure 7: Business R&D expenditure by Standard Industrial Classification (as a percentage of GERD), South Africa, 2017/18 to 2018/19

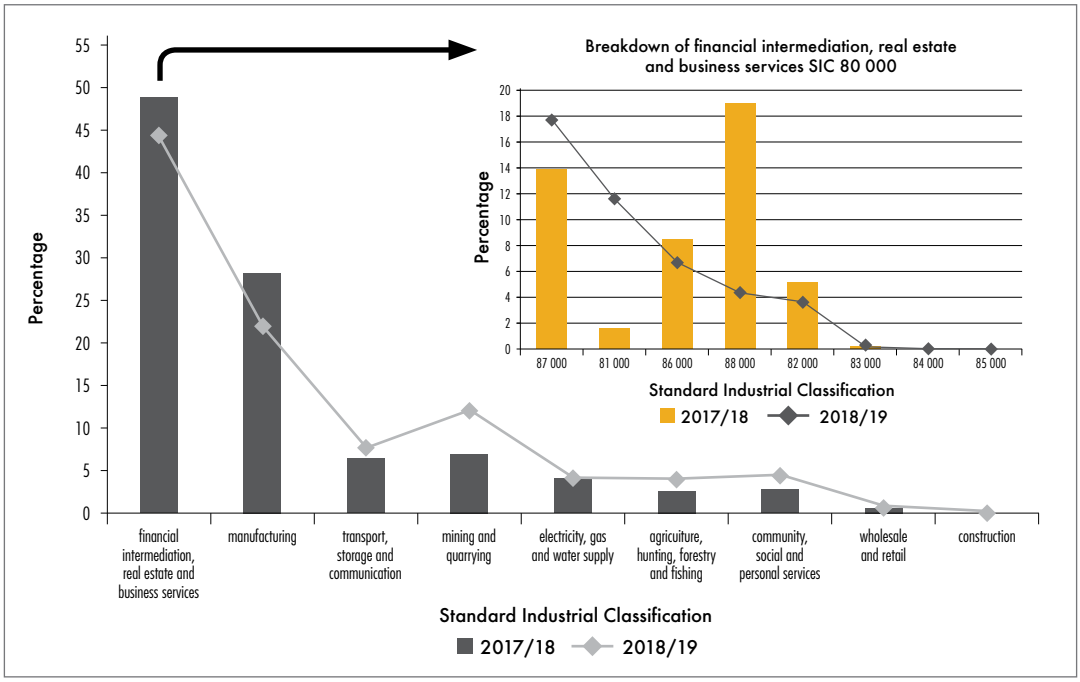
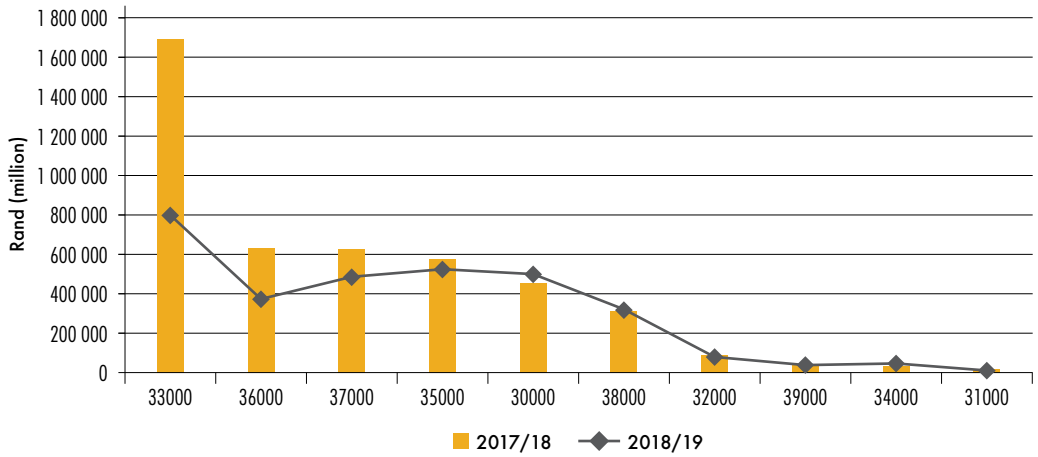


Table 3: Standard Industrial Classification codes in the financial intermediation, real estate and business services sector

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

Definition	Industry classification is based on Stats SA's five-digit SIC codes, which classify businesses according to economic activities.
Data source	National Survey of Research and Experimental Development, 2017/18 to 2018/19.

Figure 8: Business R&D expenditure by manufacturing Standard Industrial Classification category (R million), South Africa, 2017/18 to 2018/19



Data source	National Survey of Research and Experimental Development, 2017/18 to 2018/19.

Table 4: Standard Industrial Classification codes in the manufacturing sector

30000	Manufacture of food products, beverages and tobacco products
31000	Manufacture of textiles, clothing and leather goods
32000	Manufacture of wood and products, except furniture; paper products; publishing and printing material
33000	Manufacture of refined petroleum, coke and nuclear fuel; chemical products (incl. pharmaceuticals); rubber and plastic products
34000	Manufacture of non-metallic mineral products
35000	Manufacture of basic and fabricated metal products, machinery and equipment; office, accounting and computing machinery
36000	Manufacture of electrical machinery and apparatus
37000	Manufacture of radio, television and communication equipment and apparatus; medical, precision and optical instruments, watches and clocks
38000	Manufacture of transport equipment
39000	Manufacture of furniture; recycling; manufacturing not elsewhere classified

Definition	Industry classification is based on Stats SA's five-digit SIC codes, which classify businesses according to economic activities.
Data source	National Survey of Research and Experimental Development, 2017/18 to 2018/19.

Table 5: Manufacturing and service sector R&D expenditure as a percentage of BERD (2014/15 to 2018/19)

SECTOR	2014/15	2015/16	2016/17	2017/18	2018/19
Services	52.2%	55.5%	61.7%	62.3%	62.1%
Manufacturing	33.9%	32.2%	27.8%	28.2%	21.9%

1.4 The focus of GERD expenditure on priority fields

Increasingly, it is recognised that R&D expenditure should be oriented to fields of focus that enable actors in the national system of innovation to engage with development priorities. This section considers the focus of expenditure, by analysing the type of research conducted, as well as an overview of the main research fields prioritised by each institutional sector. It then focuses on two fields that are currently priorities: health, and green R&D.

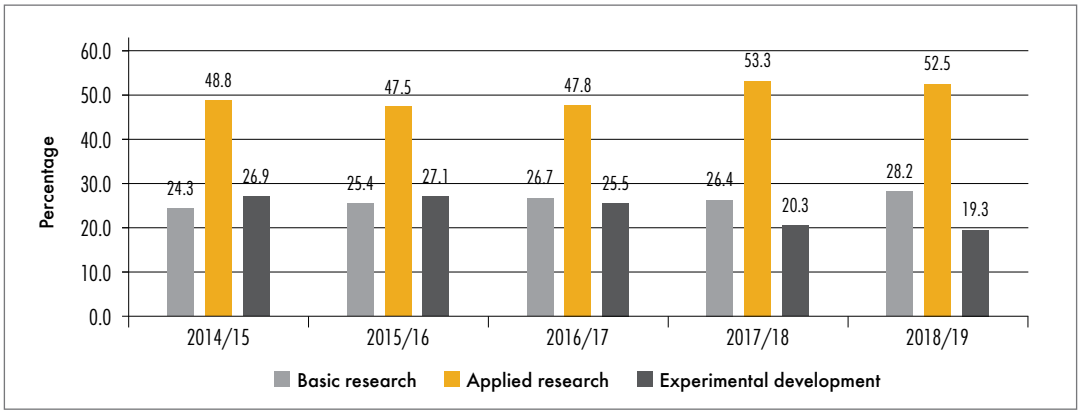
1.4.1 GERD by type of research

Applied sciences continued to dominate as the leading type of R&D conducted in 2018/19, allocated a 52.5% share of R&D spend. The goal of applied science is to produce marketable products and services by determining possible uses for the results of previous research or finding new ways of achieving a goal. This can be beneficial in solving development challenges in South Africa.

Applied research has been the dominant type of research in South Africa for the past 10 years.

There were slight decreases in applied and experimental development in the 2018/19 reference year, and an increase in basic research (Figure 9). Over five years, basic research increased slightly, from 24.3% in 2014/15 to 28.2% in 2018/19. Year-on-year, applied research decreased by 0.8% from 53.3% in 2017/18 to 52.5% in 2018/19. Expenditure allocated to the experimental development category continued the trend of decline, decreasing from 26.9% in 2014/15 to 19.3% in 2018/19.

Figure 9: GERD by type of research (percentage), South Africa, 2014/15 to 2018/19

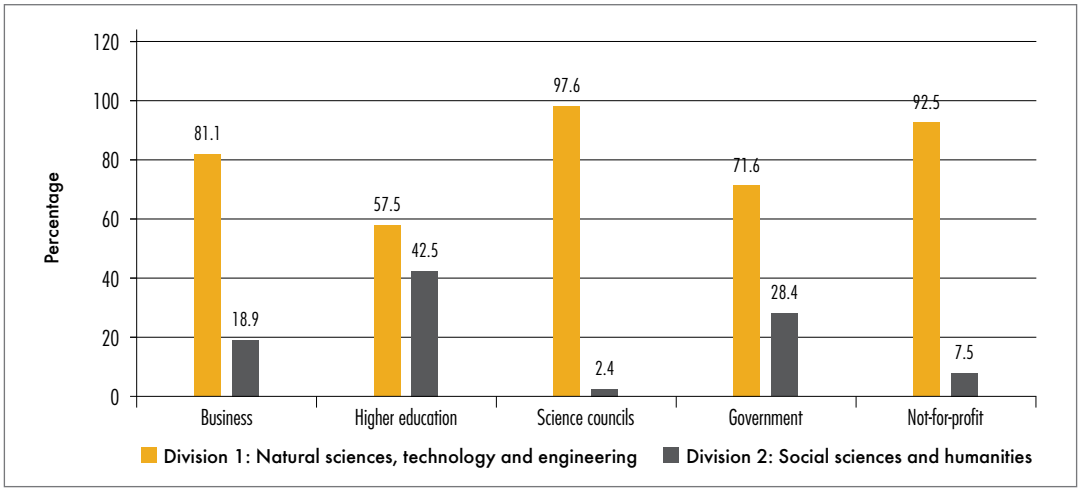


Data source National Survey of Research and Experimental Development, 2014/15 to 2018/19.

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

The South African R&D Survey classifies research fields into two major categories: Division 1, which includes natural sciences, technology and engineering and Division 2, which represents social sciences and humanities. Across all institutional sectors, the largest share of GERD was reported in the natural sciences research fields, and this trend remained constant for the 2018/19 period. National GERD was significantly higher in Division 1 compared with Division 2 (Figure 10). The science council sector devoted the largest share of R&D expenditure to the natural sciences fields (97.6%) followed by the not-for-profit sector (92.5%). The higher education sector spent the largest proportion (42.5%) of total sectoral expenditure on fields in Division 2. The higher education sector invested the most in the social sciences and humanities field.

Figure 10: R&D expenditure by research field and sector (percentage), South Africa, 2018/19



Data note	The Frascati Manual (OECD, 2015) classifies the fields of research (FORD) as follows: natural sciences, engineering and technology, medical and health sciences, agricultural and veterinary sciences, social sciences and humanities and art sciences. Data in South Africa is collected according to most of the research fields in FORD and can be aggregated or disaggregated in the FORD format.
Data source	National Survey of Research and Experimental Development, 2018/19.

1.4.3 Select priority areas in R&D: the case of health

Health care has long been one of South Africa's most pressing national development priorities. The coronavirus pandemic has heightened the urgent need to grow research and experimental development investment in the domains of health related to the country's burden of disease.

Health R&D is defined as R&D that is relevant to human health. Data is extracted by extrapolating 'health' codes, based on the fields of research specified within the South African R&D Survey. These research fields are presented at national level across all economic sectors (Table 6).

Investment in health R&D has continued to grow over the past five years, the public sector being the main driver of this investment.

Table 6: Health R&D by main research fields (R million), 2018/19

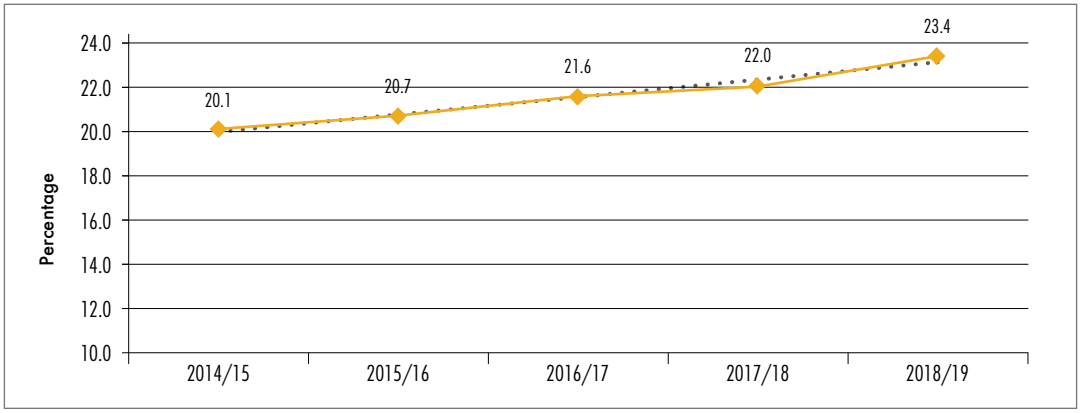
MAIN RESEARCH FIELD	BUSINESS	GOVERNMENT	HIGHER EDUCATION	NOT-FOR-PROFIT	SCIENCE COUNCILS	TOTAL
	R'000	R'000	R'000	R'000	R'000	R'000
Engineering sciences	20 922	0	12 251	0	0	**33 173**
Biological sciences	91 612	91 643	570 694	51 260	38 371	**843 580**
Medical and health sciences	2 855 116	370 294	2 399 107	927 150	871 927	**7 423 595**
Social sciences	0	0	309 361	1 038	2 889	**313 287**
Total	2 967 650	461 937	3 291 413	979 448	913 187	8 613 636

Data source National Survey of Research and Experimental Development, 2018/19.

1.4.3.1 Health R&D over time

Figure 11 presents data on health R&D as a percentage of GERD over the past five years. This indicates a positive direction of growth in R&D devoted to national priority areas.

Figure 11: Health R&D as a percentage of GERD, South Africa, 2014/15 to 2018/19

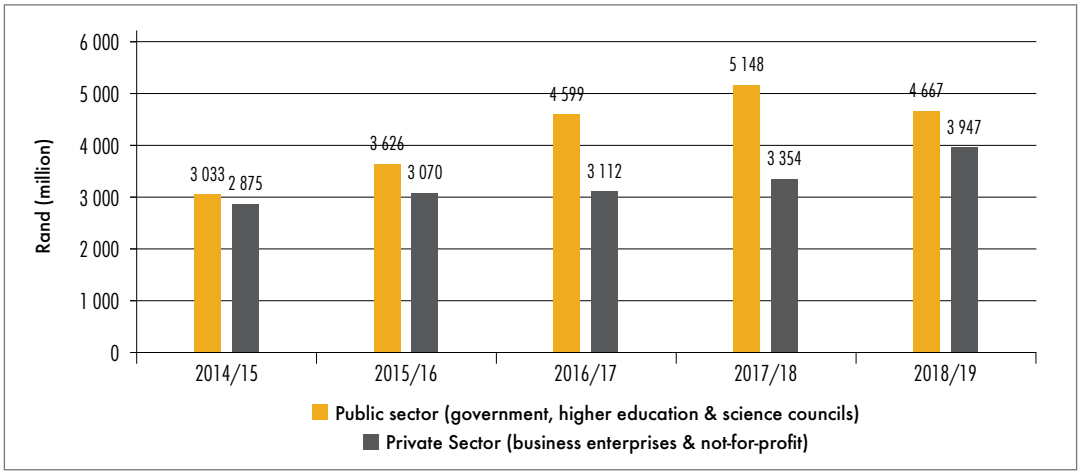


Data source National Survey of Research and Experimental Development, 2014/15 to 2018/19.

The public sector is the largest investor in health R&D in South Africa, a trend that has continued over the past five years (Figure 12). The public sector invested 54.2% of funding devoted to health R&D, whereas the private sector devoted 45.9%. However, public sector funding for health R&D decreased

by -9% from R5.148 billion in 2017/18, to R4.667 billion in 2018/19. This was especially evident in the science councils, which experienced declines.

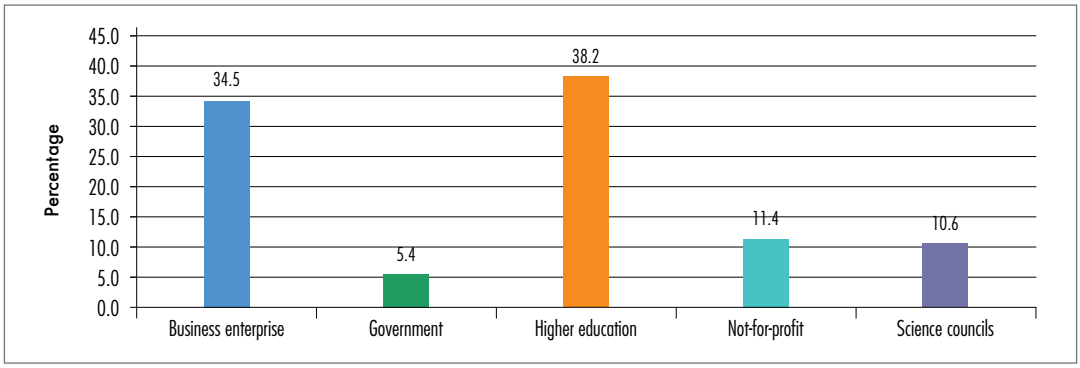
Figure 12: Public versus private health R&D (R million), South Africa, 2014/15 to 2018/19



Data source National Survey of Research and Experimental Development, 2018/19.

The higher education sector invested the largest share of institutional expenditure in health R&D, investing R3.291 (38.2%) billion in 2018/19. The business sector was the second largest investor, investing R2.968 billion (34.5%) over the same period. The not-for-profit sector was the third largest contributor to health R&D investment with R979 million (11.4%), followed by science councils with R913 million (10.6%)

Figure 13: Health R&D by sector (percentage), 2018/19



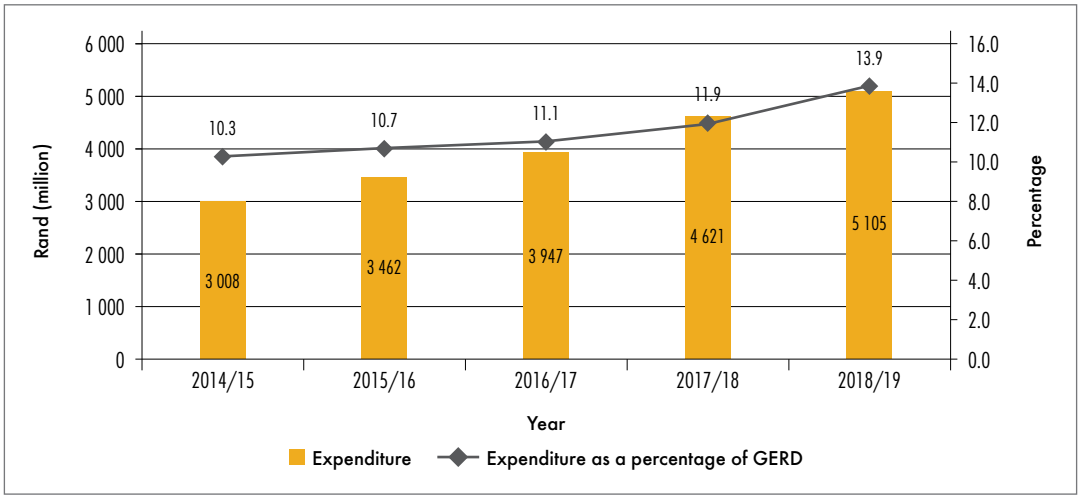
Data source National Survey of Research and Experimental Development, 2018/19.

1.4.3.2. R&D on tuberculosis, HIV/AIDS and malaria

Investment in R&D in priority areas of health research related to the burden of disease in South Africa, specifically, TB, HIV/AIDS and malaria, increased from R3.008 billion in 2014/15 to R5.106 billion in 2018/19 (Figure 14). The growth in R&D investment over the last five years in these health-related fields confirms the priority accorded. This investment lays the foundation for the creation of vaccines and effective diagnostic tools to greatly improve health conditions.

Expenditure on R&D focused on HIV/AIDS, malaria, TB, and biotechnology continued to increase in 2018/19.

Figure 14: R&D expenditure on TB, HIV/AIDS and malaria (R million and as a percentage of GERD), South Africa, 2014/15 to 2018/19



Data source National Survey of Research and Experimental Development, 2014/15 to 2018/19.

1.4.4 Select priority areas: the case of green R&D

Green R&D includes research and experimental development that focuses on the sustainability of natural resources, environmental impact, animal and plant science, energy research, economic impact, sustainable development, mobility and engineering sciences. Communities and other stakeholders who demand environmental responsibility drive the focus on green R&D. The ultimate results of greening the economy are the reduction of pollution, green technologies for waste disposal, mitigation of and

Investment in green R&D in South Africa is vital to the transition to a green economy.

adaptation to climate change and improved ways of managing water scarcity. The R&D Survey should contribute to efforts to green the economy by providing relevant green R&D indicators.

1.4.4.1 R&D investments in green R&D by research field and sector of performance

Expenditure on green R&D amounted to 17.4% (R6.398 billion) of GERD, a decrease of R209 million from the R6.607 billion reported in 2017/18. Division 1 (natural sciences, technology and engineering) spent R6.137 billion and Division 2 (social sciences and humanities) spent R261 million in 2018/19 (Table 7).

The largest share of green R&D expenditure was in the higher education sector, spending R2.020 billion, followed by the business and science council sectors, spending R1.711 and R1.491 billion respectively. Government increased its spend on green R&D from R878 million to R1.013 billion in 2018/19. The not-for-profit sector devoted R102 million to green R&D.

For Division 1, the higher education sector was the largest performer of green R&D investment in 2018/19 at R1.773 billion, followed by business at R1.771 billion. The third largest spender in Division 1 (R1.497 billion) was the science council sector (Table 7). Only the higher education (R247 million) and government sector (R14 million) invested in green R&D in the social sciences and humanities fields.

Within the natural sciences, technology and engineering research fields, higher education led on R&D investment in agricultural sciences (R535 million), biological sciences (R491 million) and earth sciences (R356 million). Business sector expenditure was higher on agricultural science, at R1.008 billion and engineering sciences at R361 million.

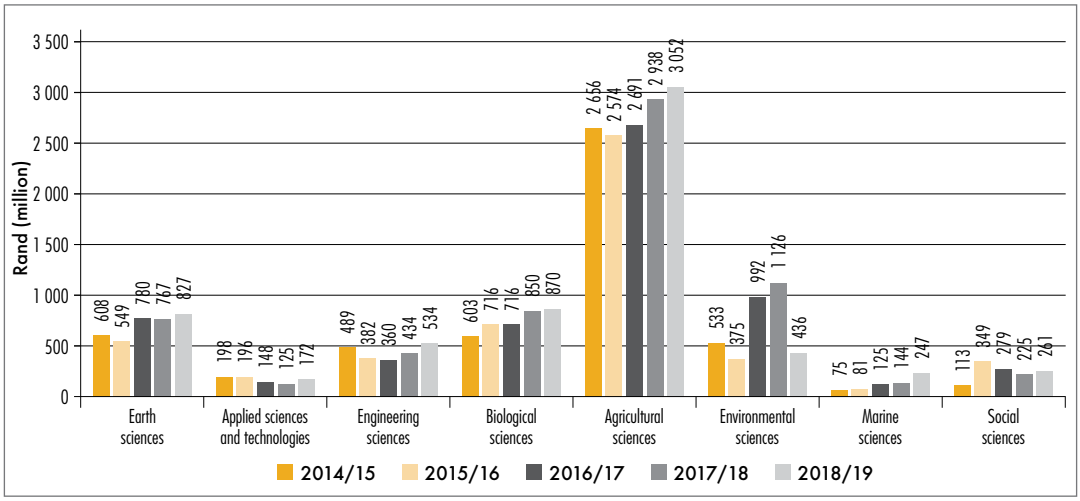
The science council sector's highest expenditure in green R&D was on agricultural sciences at R898 million, and environmental sciences at R213 million. Government expenditure on green R&D was highest in the agricultural sciences and biological sciences fields, at R557 million and R205 million respectively.

Table 7: Green R&D expenditure by research field, 2018/19

MAIN RESEARCH FIELD	BUSINESS	GOVERNMENT	HIGHER EDUCATION	NOT-FOR-PROFIT	SCIENCE COUNCILS	TOTAL
	R'000	R'000	R'000	R'000	R'000	R'000
Division 1: Natural sciences, technology and engineering	1 771 147	999 467	1 772 997	102 074	1 497 443	6 137 127
Earth sciences	156 112	103 767	356 360	8 594	202 037	826 869
Applied sciences and technologies	90 268	17 101	64 956			172 325
Engineering sciences	361 194	546	172 686			534 425
Biological sciences	84 932	204 613	491 096	13 478	75 406	869 525
Agricultural sciences	1 008 216	557 157	535 299	52 807	898 199	3 051 678
Environmental sciences	69 676	17 270	110 409	25 335	212 887	435 578
Marine sciences	750	99 013	42 192	1 860	102 913	246 728
Division 2: Social sciences and humanities		13 818	246 947			260 766
Social sciences		13 818	246 947			260 766
Total	1 771 147	1 013 285	2 019 944	102 074	1 491 443	6 397 893

Data source National Survey of Research and Experimental Development, 2018/19.

Figure 15: Green R&D expenditure by research field (R million), South Africa, 2014/15 to 2018/19



Data source National Survey of Research and Experimental Development, 2014/15 to 2018/19.

Figure 15 shows the disaggregation of green R&D by research field over five years. The largest share was expended in the agricultural sciences from R2.656 billion in 2014/15, increasing steadily from 2016/17 to R3.052 billion in 2018/19. The biological sciences were the second largest field, expending R870 million in 2018/19, followed by earth sciences, which spent R827 million over the same period. The environmental sciences decreased by 61.3% from R1.126 billion in 2017/18 to R436 million in 2018/19.

1.4.4.2 R&D investments in green R&D by socio-economic objective and sector of performance

Table 8: Green R&D by socio-economic objective from 2014/15 to 2018/19

SOCIO-ECONOMIC OBJECTIVE	2014/15	2015/16	2016/17	2017/18	2018/19
	R'000	R'000	R'000	R'000	R'000
Economic development	3 593 176	3 834 899	4 288 313	4 516 366	4 621 638
Plant production and plant primary products	1 353 036	1 414 277	1 539 767	1 584 868	1 672 631
Animal production and animal primary products	694 423	655 059	729 713	696 895	675 314
Energy resources	29 910	35 179	38 710	6 682	16 901
Energy supply	440 338	332 137	398 643	441 429	488 798
Commercial services	53 433	68 565	62 324	60 321	65 698
Economic framework	266 128	565 782	660 209	824 174	678 769
Natural resources	755 909	763 900	858 947	901 997	1 023 527
Environment	1 403 621	1 458 273	2 015 344	1 999 703	2 081 419
Environmental knowledge	820 590	840 485	969 476	983 976	934 482
Environmental aspects of development	286 097	299 812	361 391	309 051	411 672
Environmental and other aspects	296 934	317 975	684 478	706 676	735 265
Advancement of knowledge	590 618	640 544	791 520	797 471	954 788
Natural sciences, technologies and engineering	590 618	640 544	791 520	797 471	954 788
Total	5 587 415	5 933 715	7 095 177	7 313 540	7 657 845

Data source National Survey of Research and Experimental Development, 2018/19.

Table 8 shows expenditure on green R&D by socio-economic objective from 2014/15 to 2018/19, reflecting a steady increase over the five-year period, from R5.587 billion in 2014/15 to R7.658 billion in 2018/19. Markedly, and over time, R&D expenditure for 2018/19 was concentrated within plant production and plant primary products (21.8%), followed by natural resources (13.4%), and the natural sciences, technologies, and engineering (12.5%). Only 0.2% of green R&D was devoted to energy resources. This field of research and sector of performance should be closely monitored, given the energy crisis South Africa faces.

Green R&D investment in energy resources is very low.

Table 9 shows expenditure on green R&D by socio-economic objective and sector of performance. Green R&D expenditure by SEO is largest in the higher education sector at 41.2% (R3.161 billion) of total green expenditure. The second largest performer of green R&D was the science councils, spending 22.5% (R1.720 billion), followed by the business sector at 21.3% (R1.633 billion) and government at 13.3% (R1.019 billion). NPO sector performance was the lowest, at 1.6% (R124 million) of green R&D. In terms of SEOs, green R&D was more prominent in the plant production and plant primary product, energy supply, economic framework and natural resources.

Green R&D expenditure is most strongly concentrated in economic development, with a total of R4.622 billion invested, followed by the environment at R2.081 billion, and advancement of knowledge at R955 million. For green R&D oriented to economic development, the largest expenditure was on plant production and plant primary SEO, at R1.673 billion. These investments came primarily from business (R791 million) and higher education at R1.024 billion.

Green R&D is mostly invested by the public sector in government, higher education and science councils (77.1%). R&D investment from the private sector in business and not-for profit organisations is needed to assist South Africa to reduce environmental risks and ecological scarcities to protect the environment.

Table 9: Green R&D expenditure by SEO and sector of performance, 2018/19

SOCIO-ECONOMIC OBJECTIVES	BUSINESS	GOVERN-MENT	HIGHER EDUCATION	NOT-FOR-PROFIT	SCIENCE COUNCILS	TOTAL
	R'000	R'000	R'000	R'000	R'000	R'000
Economic development	1 403 846	740 869	1 509 451	53 235	914 236	4 621 638
Plant production and plant primary products	791 508	115 406	399 242	26 579	339 896	1 672 631
Animal production and animal primary products	55 615	135 755	268 650	2 858	212 435	675 314
Energy resources	0	0	11 333	0	5 568	16 901
Energy supply	323 235	36 162	124 770	4 631	0	488 798
Commercial services	51 241	1 993	9 465	0	2 998	65 698
Economic framework	163 551	172 528	237 092	12 036	93 562	678 769
Natural resources	18 697	279 024	458 899	7 131	259 777	1 023 527
Environment	207 806	237 373	985 505	39 974	610 761	2 081 419
Environmental knowledge	50 017	117 228	439 311	23 201	304 725	934 482
Environmental aspects of development	52 754	64 148	273 733	7 544	13 493	411 672
Environmental and other aspects	105 035	55 997	272 461	9 229	292 543	735 265
Advancement of knowledge	21 397	41 193	666 034	31 102	195 061	954 788
Natural sciences, technologies and engineering	21 397	41 193	666 034	31 102	195 061	954 788
Total	1 633 048	1 019 436	3 160 991	124 312	1 720 058	7 657 845

Data source National Survey of Research and Experimental Development, 2018/19.

2. FUNDING FOR R&D

Section 2:

- Analyses **major flows** between R&D funders and performers.
- Explores government, business, and **foreign sources** of R&D funding.
- Compares **international funding** flows.
- Maps the **spatial dimension** of R&D funding in the nine provinces.

2.1 Major flows of R&D funding

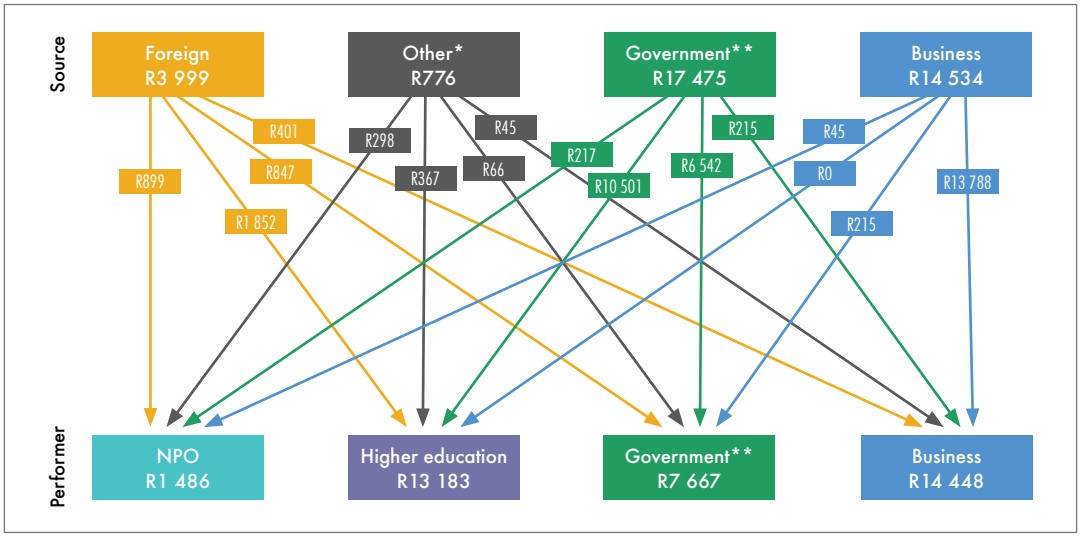
Funding from government decreased by 3.4% in 2018/19, but the government sector continued to fund the largest proportion of R&D in South Africa (Figure 16). Funding from government decreased from R18.082 billion in 2017/18 to R17.475 billion in 2018/19, and represented 47.5% of total R&D funding. Higher education institutions received the largest share of total government funding at 60.1% (R10.501 billion), followed by science councils at 26.6% (R4.644 billion), and government institutions at 10.9% (R1.898 billion). Funding to higher education and government institutions increased from 2017/18. The not-for-profit and business sectors were the smallest recipients of direct R&D funding from government, receiving 1.2% (R217 million) and 1.2% (R215 million) respectively.

Although decreasing nominally, the South African government funded 47.5% of R&D in South Africa in 2018/19.

The business sector (including SOEs) was the second-largest funder of R&D, contributing 39.5% (R14.534 billion) towards total national R&D funding. The business sector continued to fund R&D using its own sources of funds, which amounted to 94.9% (R13.788 billion) of total business funding. The rest was allocated mainly to the higher education and science council sectors receiving R463 million (3.2%) and R207 million (1.4 %) respectively.

Foreign sources were the third largest funder, amounting to 10.9% (R3.999 billion) in 2018/19, and directed primarily to the higher education sector (46.3%).

Figure 16: Major flows of funding, (R million), South Africa, 2018/19



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, 2018/19.

2.2 GERD by sources of funds

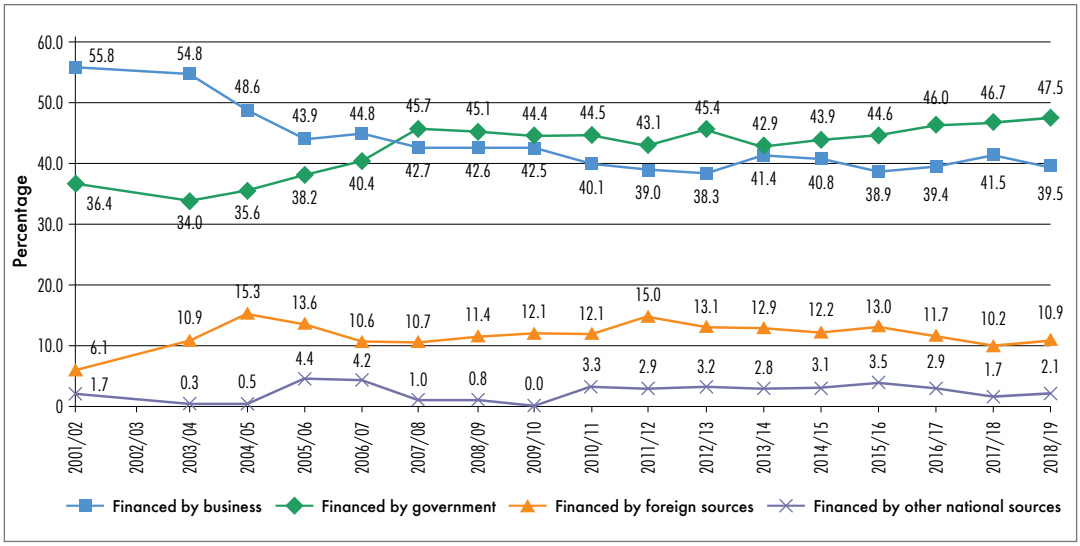
2.2.1 Trends over time

Government and business enterprises consistently continued to fund the largest proportion of GERD in South Africa in 2018/19 (Figure 17). The proportion of R&D funding by government increased in 2018/19, while business funding decreased.

Business funding for R&D in 2018/19 decreased, but remained the second largest R&D funder after government.

Although government funding for R&D decreased in current terms, proportionally it increased by 0.8%, from 46.7% of total funding in 2017/18 to 47.5% in 2018/19. Foreign funding increased by 0.7%, from 10.2% in 2017/18 to 10.9% in 2018/19, while contributions from higher education, not-for-profit organisations and individual donations increased by 0.5% from 1.6% in 2017/18 to 2.1% in 2018/19. Funding of R&D from business decreased by 2.0% from 2017/18 (41.5%) to 2018/19 (39.5%).

Figure 17: GERD by source of funds (percentage)*, South Africa, 2001/02 to 2018/19



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 2018/19.

2.2.2 Business-funded R&D

The business sector continued to fund its own research almost exclusively, funding 94.9% of its own R&D expenses in 2018/19 (Table 10). Funding for higher education institutions and science councils continued to decrease in 2018/19. Business funding for R&D in the science council sector decreased by 41.8%, from R355 million in 2017/18 to R207 million in 2018/19. Similarly, funding of R&D from business sources to higher education decreased by 31.8% from R679 million in 2017/18 to R463 million in 2018/19. This could be an indication of decreased university and business interaction. The not-for-profit sector received similar investment (R72 million) in 2018/19 as it did in 2017/18.

The government sector showed a slight increase in R&D investment from the business sector, increasing from R519 thousand in 2017/18 to R4 million in 2018/19, indicating progress in collaborative efforts.

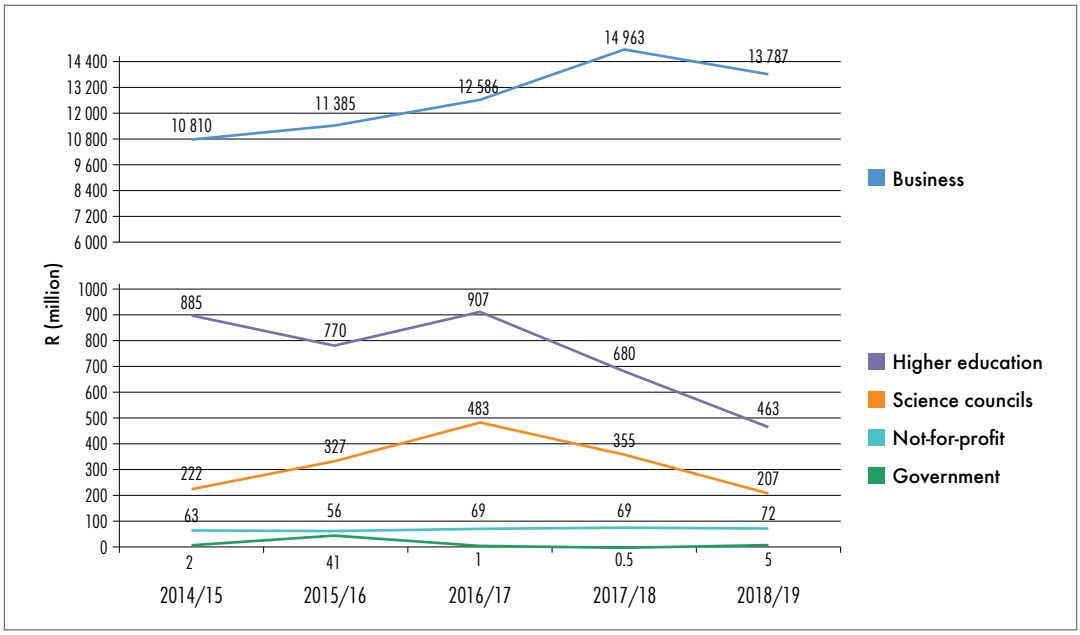
Table 10: Business-funded R&D by sector of performance (R'000), South Africa, 2014/15 to 2018/19

SECTOR	2014/15	2015/16	2016/17	2017/18	2018/19
Business	10 810 428	11 384 709	12 586 109	14 963 198	13 787
Not-for-profit	63 084	55 584	68 705	68 747	71 937
Government	290	41 109	1 261	519	4 614
Science councils	222 892	326 647	483 166	354 820	206 648
Higher education	885 280	770 448	906 651	679 563	463 413
Total (current Rand value)	11 981 974	12 578 497	14 045 892	16 066 846	14 534 123
Total (constant 2010 Rand value)	9 515 357	9 513 948	9 957 895	10 771 991	9 377 117

Data note *GDP deflator values derived from Stats SA (2019b) were used to calculate constant 2010 Rand values for R&D expenditure. Revised GDP (current values) Stats SA GDP statistical release P0441 (2019a, Quarter 4)

Data source National Survey of Research and Experimental Development, 2014/15 to 2018/19.

Figure 18: Business-funded R&D by sector of performance (R million, South Africa, 2014/15 to 2018/19



Data source National Survey of Research and Experimental Development, 2014/15 to 2018/19.

2.2.3 Government funding of local R&D

Although government funding in 2018/19 decreased nominally, government is still the largest funder (46.7%) of R&D nationally (Table 11). Higher education institutions and science councils continued to be the largest recipients of government funding. The higher education sector received the highest proportion of government funding, R10.501 billion in 2018/19. Government funding of R&D to the science councils sector decreased substantially by 12.6%, from R5.311 billion in 2017/18 to R4.644 billion in 2018/19. Funding of R&D to other government departments, such as research institutions and museums (excluding science councils), increased by 7.2%, whereas funding to the not-for-profit sector doubled, increasing by 51.7%. Funding from government to the business sector decreased by 27.0% from R371 million in 2017/18 to R215 million in 2018/19.

Table 11: Government-funded R&D (R'000), South Africa, 2014/15 to 2018/19

SECTOR	2014/15	2015/16	2016/17	2017/18	2018/19
Business	690 396	522 631	453 958	371 165	214 541
Not-for-profit	131 288	161 682	143 623	142 908	216 922
Government	1 711 809	1 425 598	1 530 964	1 769 929	1 898 230
Science councils	4 319 393	4 922 222	5 076 805	5 311 190	4 644 414
Higher education	6 020 572	7 393 857	9 222 246	10 486 989	10 501 066
Total (current Rand value)	12 873 458	14 425 990	16 427 596	18 082 182	17 475 173
Total (constant 2010 Rand value)	10 223 319	10 911 329	11 593 995	12 123 170	11 274 621

Data note	*GDP deflator values derived from Stats SA (2019b) and were used to calculate constant 2010 Rand values for R&D expenditure. Revised GDP (current values) Stats SA GDP statistical release P0441 (2019a, Quarter 4)
Data source	National Survey of Research and Experimental Development, 2014/15 to 2018/19.

2.2.4 Foreign funding of local R&D

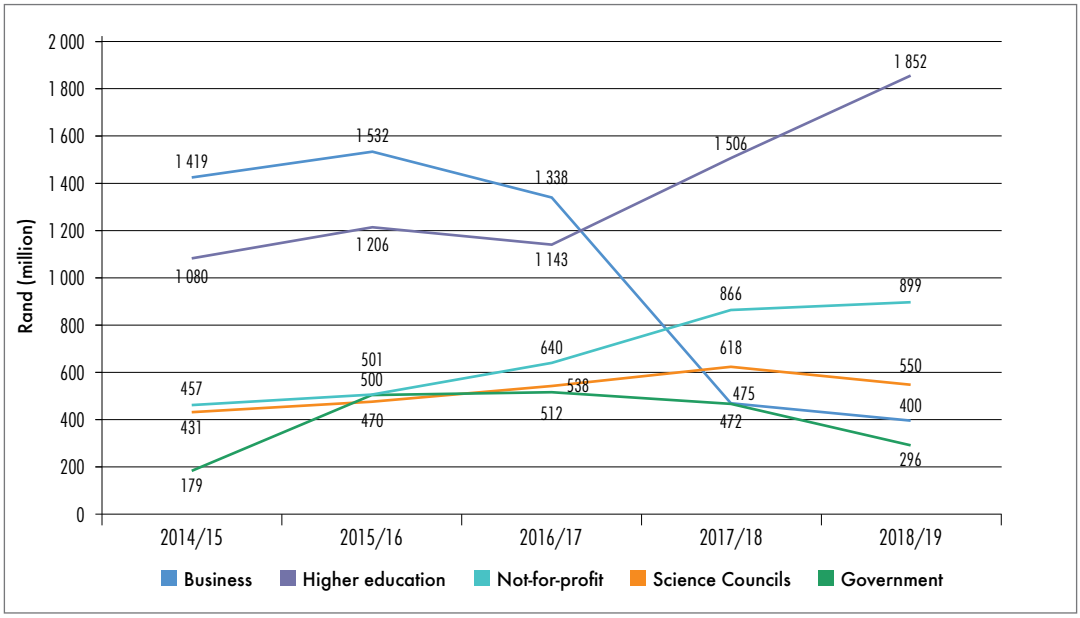
R&D funding from abroad increased slightly from R3.937 billion in 2017/18 to R3.999 billion in 2018/19 (Figure 19). The higher education sector received the largest share of foreign funding at R1.852 billion (46.3%), and the not-for-profit sector at R899 million (22.5%). Foreign funding of R&D to the higher education sector increased by R346 million (23.0%), from R1.506 billion in 2017/18 to R1.852 billion in 2018/19, whereas the share of funding to the not-for-profit sector increased slightly by R32 million (3.8%).

Foreign funding of higher education and NPOs increased, but declined for the government, science council and business sectors.

Foreign funding of the government, science council and business sectors all declined. The largest decline of foreign-funded R&D was to the government sector, which decreased by 37.0%, from R472 million

in 2017/18 to R297 million in 2018/19. Foreign funding of R&D to the business sector continued its declining trend, decreasing by 15.6%, while funding for science councils decreased by 10.9%.

Figure 19: Foreign-funded R&D by sector of performance (R million), South Africa, 2014/15 to 2018/19



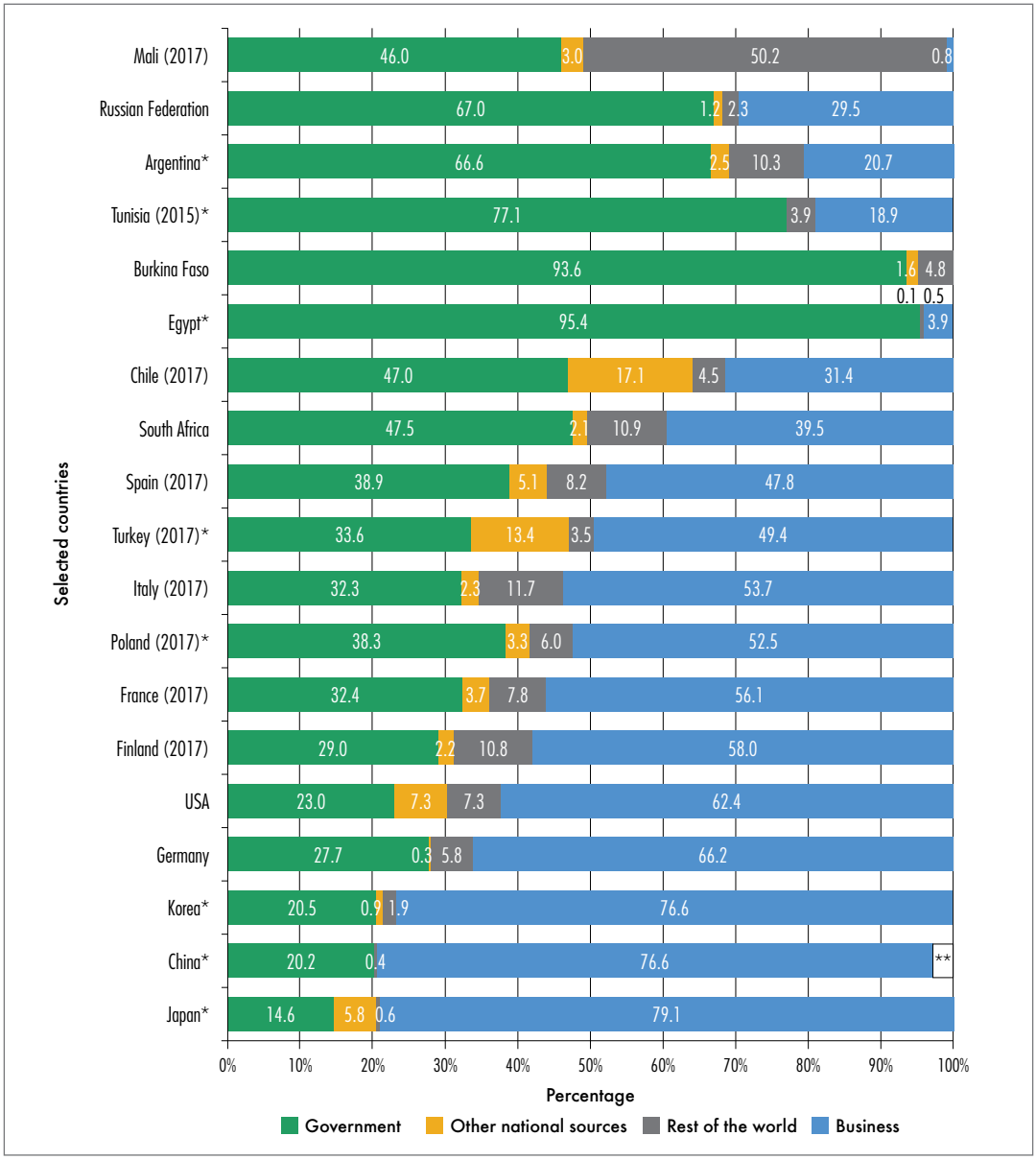
Data note	Foreign sources include all funding from foreign sources from all sectors.
Data source	National Survey of Research and Experimental Development, 2014/15 to 2018/19.

2.3. Comparing GERD by source of funds for selected countries

The proportion of business sector funding in high-income countries continued to grow, when compared to low- and middle-income countries (Figure 20). Government funding is usually dominant in low- and middle-income countries, where the NPO sector also plays a role, but minimally so, in funding R&D. Business is typically the largest funder of R&D in research-intensive countries. Argentina, Chile, Mali, Russia, and Egypt reported that more than 40.0% of their R&D funding emanated from the government sector. Countries that received more than 60% of R&D funding from the business sector were Japan (79.1%), China (76.6%), Germany (66.0%) and the USA (62.4%).

Comparatively, South Africa fell between these two poles. Even though the government sector was the main funder of R&D, there remained a considerable proportion of funding from the business sector.

Figure 20: GERD by source of funds in selected countries (percentages), 2018/19 or the latest available year



Data notes

* Totals in the figure may not add up to the sum of their constituent items due to rounding effects and the statistics published in this format by selected countries.

** Unspecified

Data sources

South Africa: National Survey of Research and Experimental Development, 2018/19. Argentina, Chile, China, Finland, France, Germany, Israel, Italy, Japan, Korea, Poland, Russian Federation, Spain, Turkey, USA: OECD (OECD, 2020).
Burkina Faso, Egypt, Mali, Peru, Tunisia: UNESCO (UIS, 2020).

2.4 Spatial dimensions of R&D

2.4.1 R&D expenditure by province

The provincial level plays an important role, as it is where R&D capabilities reside. While R&D takes place in all provinces in South Africa, it is skewed because of size, composition of research institutions, location of firms and the level of funding. This section assesses R&D expenditure in provinces by institutional sector, and traces the extent to which the patterns of expenditure have changed.

R&D expenditure remains concentrated in the Gauteng, Western Cape, and KwaZulu-Natal provinces. This trend has remained constant since 2014/15.

Table 12 presents an overview of R&D expenditure by province from 2014/15 to 2018/19. R&D expenditure was concentrated in three provinces in 2018/19, namely Gauteng (42.9%), Western Cape (23.1%) and KwaZulu-Natal (11.1%). While Gauteng recorded the largest R&D expenditure, there has been a decline in the relative proportion of its R&D expenditure, which stood at 46.6% in 2014/15, but declined to 42.9% in 2018/19.

The second largest expenditure on R&D activities in 2018/19 was in the Western Cape, even though the province proportionally experienced a slight decline. Western Cape expenditure on R&D increased proportionally from 2014/15 onwards, peaking in 2017/18 at 24.1%, and decreasing to 23.1% in 2018/19.

The proportion of R&D expenditure in KwaZulu-Natal is at its highest since 2014/15, as shown in Table 12. R&D in the North West, Northern Cape, Mpumalanga, and Eastern Cape provinces showed increases from 2017/18. The lowest R&D expenditure was recorded in the Northern Cape, Limpopo and Mpumalanga with 2.5%, 2.2% and 2.3% of GERD in the 2018/19 period, respectively.

Table 12: R&D expenditure by province (R million and percentages), South Africa, 2014/15 to 2018/19

YEAR	GERD	EASTERN CAPE	FREE STATE	GAU-TENG	KWA-ZULU-NATAL	LIMPOPO	MPUMA-LANGA	NORTH-ERN CAPE	NORTH WEST	WESTERN CAPE
	R'000	%	%	%	%	%	%	%	%	%
2014/15	**29 344 977**	5.9	5.0	46.6	10.9	2.1	2.9	2.0	4.8	19.8
2015/16	**32 336 679**	6.6	5.5	45.4	10.3	1.9	2.4	2.0	3.7	22.0
2016/17	**35 692 973**	6.2	5.1	46.0	10.2	2.0	2.0	1.5	3.6	23.3
2017/18	**38 724 590**	5.9	5.6	44.7	10.8	2.2	1.8	1.5	3.4	24.1
2018/19	**36 783 968**	6.0	5.4	42.9	11.1	2.2	2.3	2.5	4.6	23.1

Data source National Survey of Research and Experimental Development, 2014/15 to 2018/19.

2.4.2 R&D expenditure by province and sector of performance

The assessment of provincial R&D by sector of performance (Figure 21) shows that in eight of the nine provinces, the business and higher education sectors were the largest performers of R&D. Five provinces surpassed the R1 billion mark, including Gauteng (R15.767 billion), Western Cape (R8.506 billion), KwaZulu-Natal (R4.074 billion), Eastern Cape (R2.212 billion) and Free State (R1.977 billion).

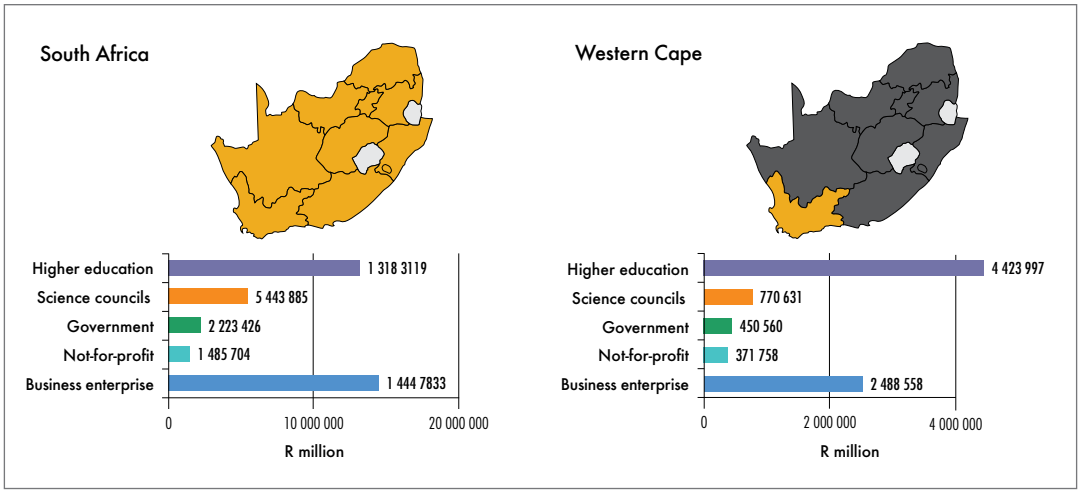
Expenditure in the business sector was predominantly concentrated in Gauteng (52.7%), Western Cape (17.2%) and KwaZulu-Natal (10.0%). Similarly, expenditure in the higher education sector was most concentrated in the Western Cape (33.6%), Gauteng (28.3%) and KwaZulu-Natal (12.5%) provinces.

Business funding in 2018/19 decreased by R668 million (8.1%) in Gauteng and by R438 million (14.9%) in the Western Cape, compared to 2017/18. Further analysis is needed to interrogate these decreases.

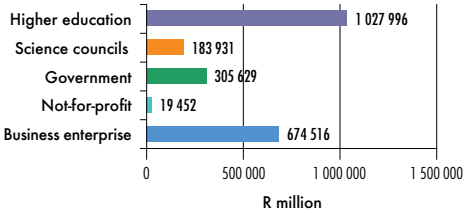
R&D expenditure in the science councils across South Africa was concentrated in three provinces, with the highest overall expenditure in Gauteng (R3.053 billion), Western Cape (R0.771 billion) and Northern Cape (R602 million). Science council expenditure in the Western Cape decreased (49.4%) from R1.524 billion in 2017/18 to R771 million in 2018/19. This indicates projects may have shifted to other provinces, but also reflects the serious decline in science council investment overall.

Although R&D is highly concentrated in the Western Cape, R&D in science councils declined by R773 billion in the province, while the Northern Cape saw an increase of R365 million in the same period.

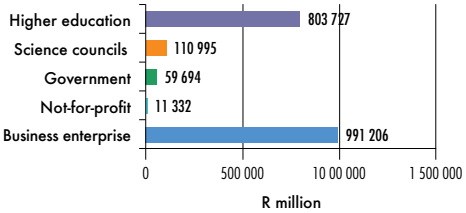
Figure 21: R&D expenditure by province and sector of performance (R million), South Africa, 2018/19



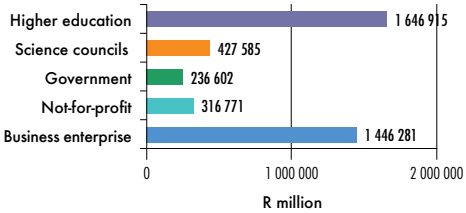
Eastern Cape



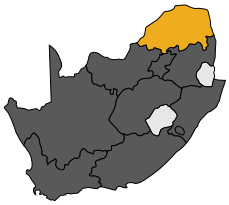
Free State

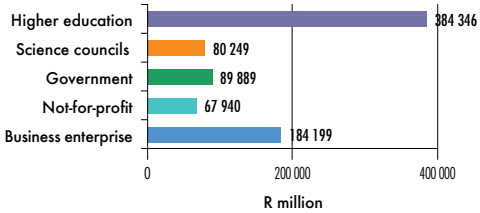


KwaZulu-Natal

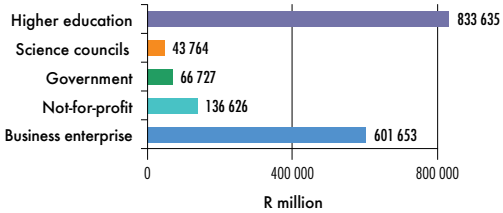


Limpopo

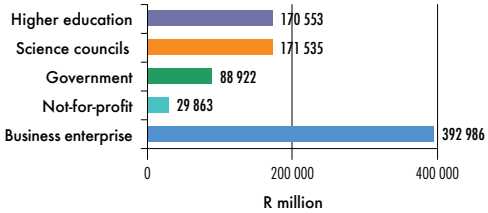


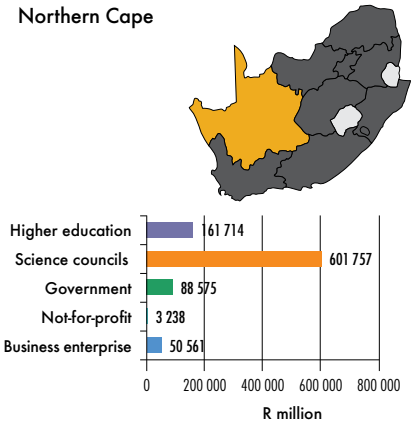


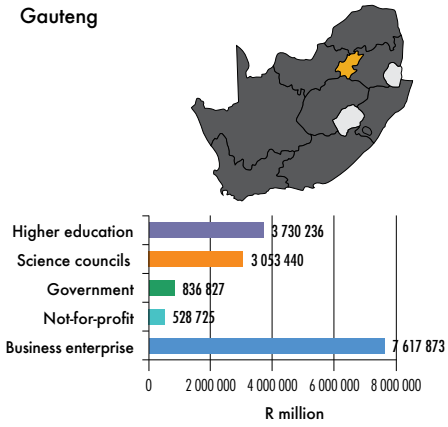
North West



Mpumalanga







Data source National Survey of Research and Experimental Development, 2018/19.

3. R&D HUMAN CAPABILITIES

Section 3:

- **Analyses** R&D personnel headcounts by occupation, qualification, gender, race, and full-time equivalents.
- **Breaks down** R&D data for comparison of trends using five-year data points.
- **Explores** the South African cohort and distribution of researchers and postgraduate students.

3.1 R&D personnel

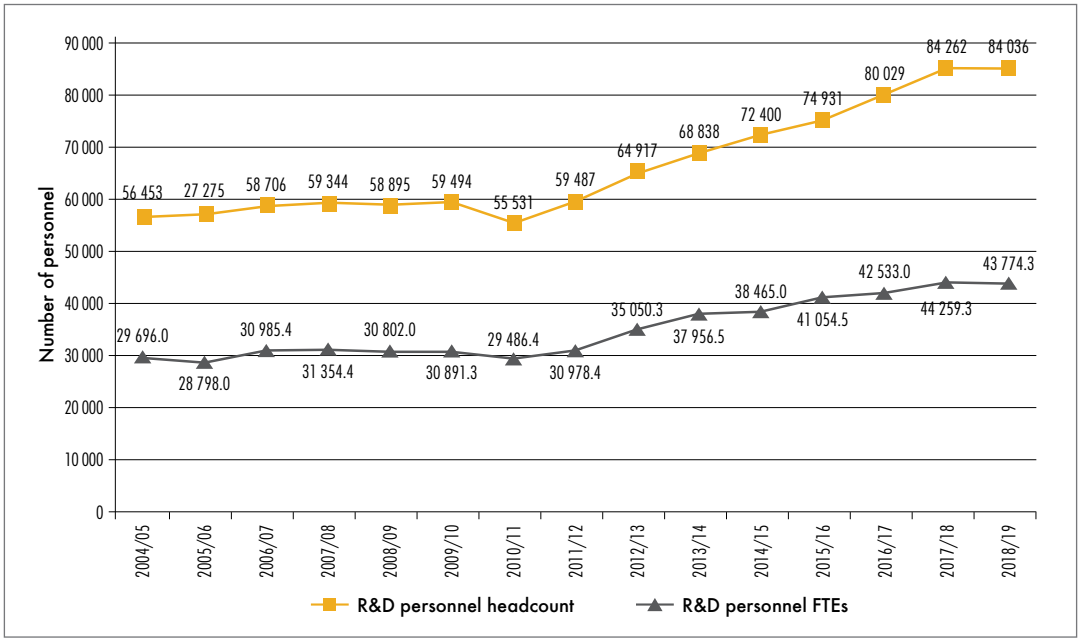
Growing the national system of innovation in South Africa requires not only investment in R&D to reach GERD/GDP targets, but also entails developing and growing an R&D workforce with the skills and expertise to conduct research in key fields. In the process, it is particularly important in South Africa to assess the progress of transformation goals in relation to race and gender.

Year-on-year change in R&D personnel, measured by headcount and number of full-time equivalents, recorded a decline by a small margin in 2018/19.

Historic data reveal a general upward trend in South Africa's R&D personnel headcounts and full-time equivalents (FTEs), with gradual growth trends noted between 2004/05 and 2010/11, and more robust year-on-year growth between 2010/11 and 2017/18.

The 2018/19 period for the first time indicated a decline in headcounts and FTEs. R&D personnel headcounts declined by a small margin of 0.3% year-on-year, from 84 262 to 84 036 between 2017/18 and 2018/19 (Figure 22). Prior survey periods reported growth rates of 5.3% and 6.8% respectively, between 2015/16 and 2016/17, and 2016/17 and 2017/18. Postgraduate student headcounts in the higher education sector contributed significantly to R&D personnel.

Figure 22: R&D personnel (headcount and FTEs), South Africa, 2004/05 to 2018/19



Data note	Following OECD (2015) practice, doctoral students and post-doctoral fellows are counted as researchers. Non-South African personnel are classified as those that are not from South Africa but undertaking research for a period exceeding six months. In addition, emeritus professors, honorary fellows and research fellows were explicitly included in the estimates of R&D personnel.
Data source	National Survey of Research and Experimental Development, 2004/05 to 2018/19.

3.1.1 R&D personnel headcount by institutional sector of performance

The largest proportion of R&D personnel was located in the higher education sector, with consistent growth in headcounts year-on-year. A total of 57 799 headcounts was reported in 2018/19 (Figure 23). A significant growth rate of 30.0% for R&D personnel was obtained between 2014/15 and 2018/19. It should be noted that postgraduate students within the higher education sector contributed most to the growth of R&D personnel, particularly at the researcher level.

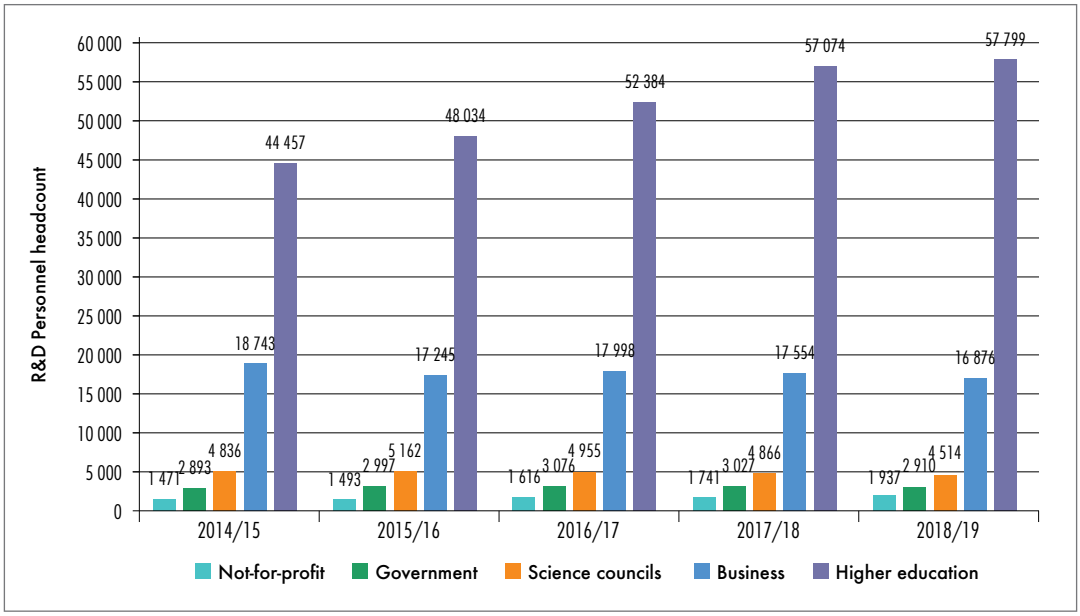
The business and science council sector headcounts declined from 17 554 to 16 876, and 4 866 to 4 514 respectively, between 2017/18 and 2018/19. The government sector also displayed a decline in R&D personnel, with the NPO sector reporting an increased headcount, during the same reference period.

In line with the policy focus on growing and improving South Africa's R&D workforce, some of the data trends observed highlight areas that need further consideration. In 2018/19, headcounts of R&D

personnel in the business, government and science council sectors were nearly the same and, in some instances, lower than that recorded in 2014/15.

Between 2014/15 and 2018/19, declines in either the researcher, technician or other personnel supporting R&D categories were observed at various points. Although not definitive, this pattern can be linked to slow economic growth in South Africa during the relevant period, leading to the closure of research projects, non-renewal of contracts, and vacant positions not filled due to budget constraints.

Figure 23: R&D personnel by sector (headcount), South Africa, 2014/15 to 2018/19



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, 2014/15 to 2018/19.

3.1.2 R&D full-time equivalents personnel by institutional sector of performance

Overall R&D FTE personnel decreased by 1.1% between 2017/18 and 2018/19, showing a decline for the first time in the past five years. For the previous years, FTEs increased by 4.1% between 2016/17 and 2017/18, and by 6.7% between 2014/15 and 2015/16.

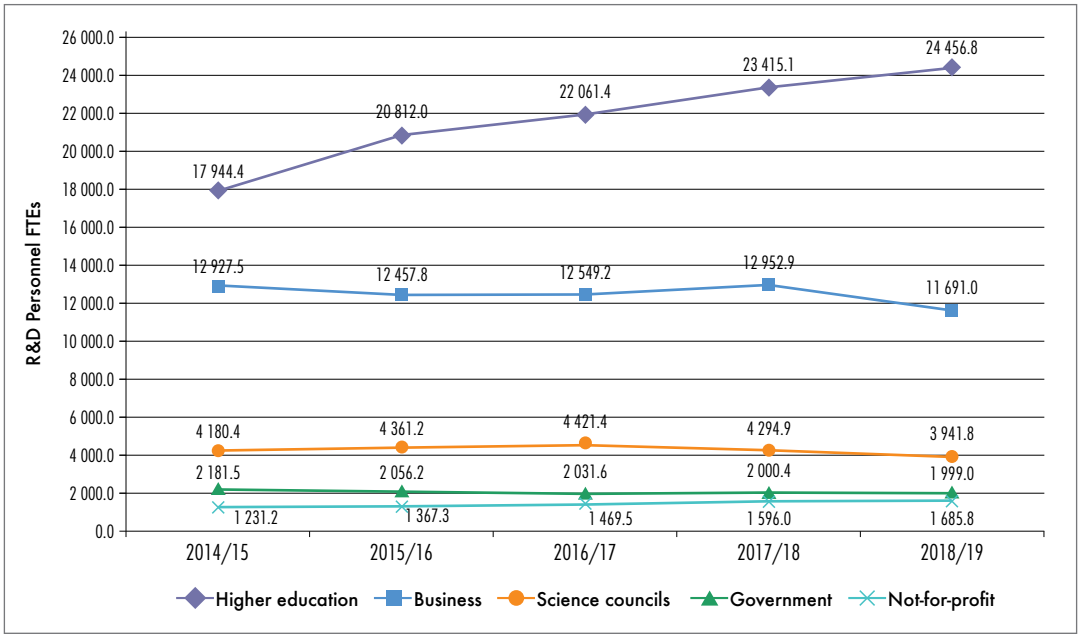
The R&D FTE personnel per thousand in total employment indicator remained fairly static, reaching 2.6 in 2015/16 and 2016/17, and increasing by 0.1 to remain at 2.7 in the years 2017/18 and 2018/19.

The government sector saw a slight decrease in FTEs during 2018/19, whilst business and science councils indicated more notable declines (Figure 24). The highest numbers of FTEs and greatest year-on-year changes were noted in the higher education and not-for-profit sectors, both indicating increases in their FTEs in 2018/19, and reporting year-on-year growth of 4.5% and 5.6% each.

The R&D personnel FTEs per thousand in total employment indicator increased by 0.1 remaining at 2.7 in the years 2017/18 and 2018/19.

While continued improvement in headcounts and FTEs in R&D personnel are welcomed, the survey data reveal a contraction of time devoted to research activities evident in the declines reported in FTE numbers. This could be a knee-jerk response to the current economic climate. Further observation of this data trend will provide more insight into whether entities are prioritising their time and efforts to increase their R&D activities.

Figure 24: R&D personnel by sector (FTEs), South Africa, 2014/15 to 2018/19



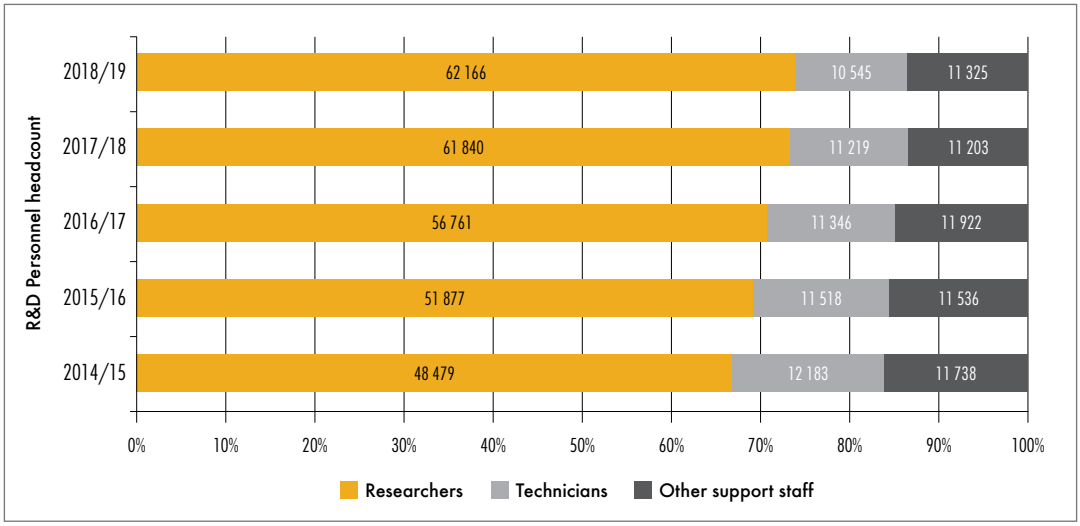
Data note	Following OECD (OECD, 2015) practice, doctoral students and post-doctoral fellows are counted as researchers.
Data source	National Survey of Research and Experimental Development, 2014/15 to 2018/19.

3.1.3 R&D personnel by occupation

The 2018/19 survey revealed that the R&D personnel contingent was made up of 74.0% researchers, 12.5% technicians and 13.5% other R&D support staff (Figure 25). This profile ratio has remained relatively consistent over time, showing an increased proportion of researchers and a proportional decline in technician and other support staff.

The overall headcount of researchers increased over the last five years, from 61 840 to 62 166 between 2017/18 and 2018/19. Technician headcounts continued to decline from 11 219 in 2017/18 to 10 545 in 2018/19. The headcounts of other support staff showed an increase to 11 325 in 2018/19, after a year-on-year decrease in the previous survey cycle.

Figure 25: R&D personnel by occupation (headcount), South Africa, 2014/15 to 2018/19



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, 2014/15 to 2018/19.

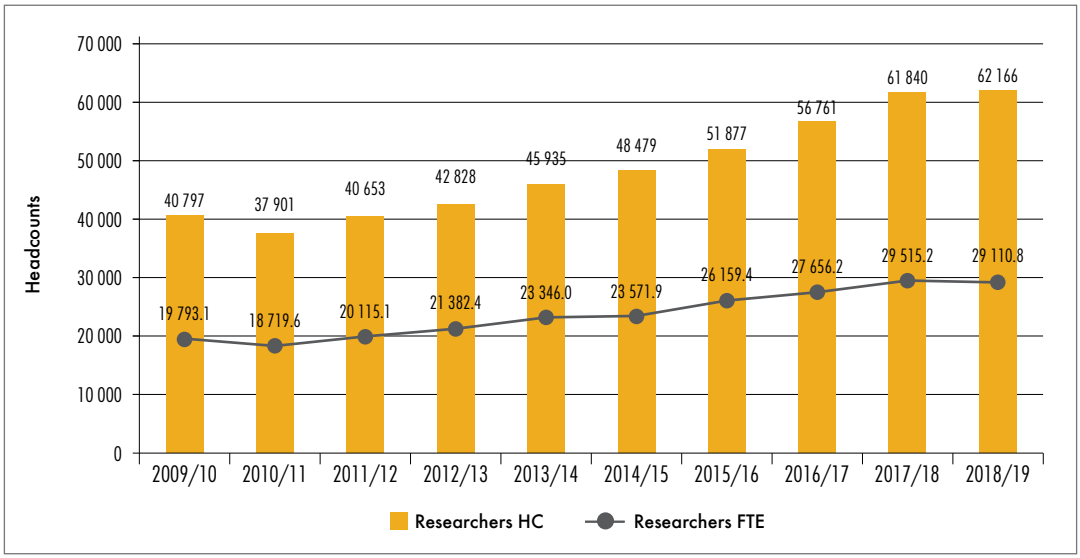
Globally, the shift to a more technologically intensive society requires skilled, technology-orientated personnel. The success of the national system of innovation relies on a well capacitated and functioning R&D workforce. Researchers are the driving force in the conception and creation of new knowledge, hence, analysis of this group is covered in more detail in the following section.

3.2 Researchers

As most R&D activities are carried out by researchers, the continuous evaluation of the performance of this cohort is key. The period 2011/12 to 2018/19 reflected steady growth in researcher headcounts and FTEs (Figure 26). Total researcher headcounts reached 62 166 in 2018/19, with 29 110.8 FTEs for the same period.

Of the country's researcher cohort, 45.7% were women in 2018/19, with approximately 28.8% holding, or enrolled for, a PhD.

Figure 26: Researchers (headcount and FTEs), South Africa, 2009/10 to 2018/19



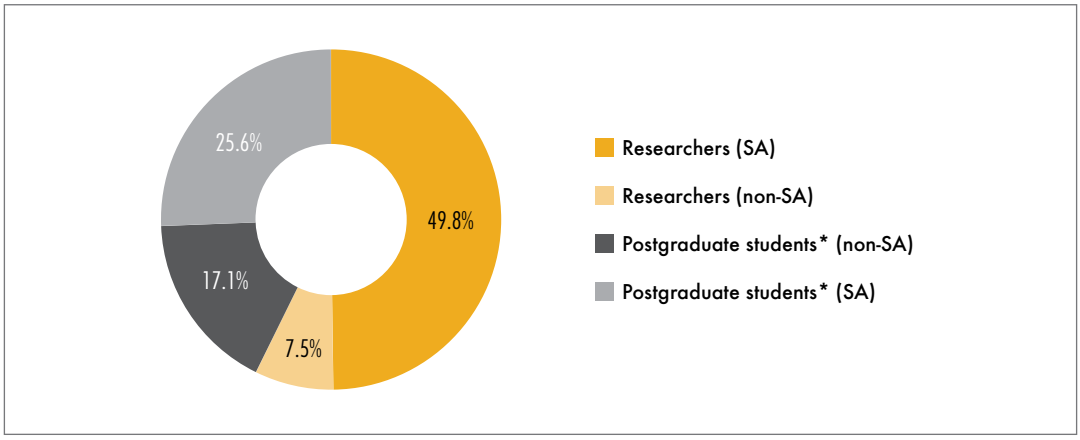
Data note	Following OECD (OECD, 2015) practice, doctoral students and post-doctoral fellows are counted as researchers.
Data source	National Survey of Research and Experimental Development, 2009/10 to 2018/19.

3.2.1 Distribution of researchers by headcount

The 2016/17 R&D Survey and subsequent surveys allow for the disaggregation of R&D personnel in terms of whether they are South African or foreign nationals. Reviewing data through this lens may provide insight on how well capacitated the system really is, through producing domestic research capacity, and how much the system relies on attracting skilled and experienced talent from abroad.

In 2018/19 South African researchers (excluding students) comprised 49.8% of total researchers, with a smaller representation of non-South African researchers at 7.5% (Figure 27). Postgraduate students made up the balance of 42.7% in 2018/19. South African postgraduates constituted 25.6% and non-South African postgraduates 17.1% of this cohort.

Figure 27: Distribution of researchers (headcount, percentage), South Africa, 2018/19

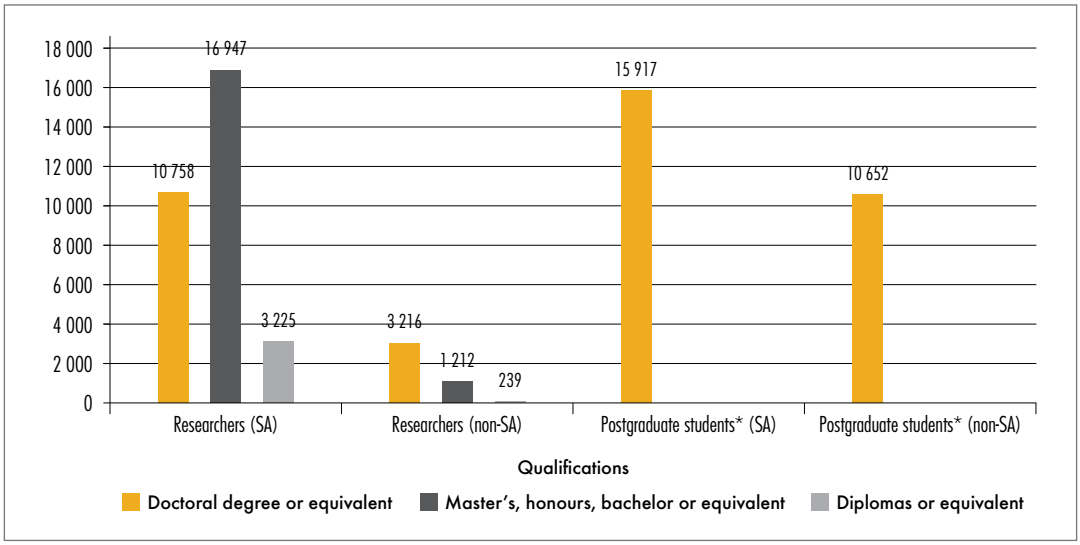


Data note	Higher education R&D personnel include post-doctoral fellows and doctoral students under the 'researcher' category.
Data source	National Survey of Research and Experimental Development, 2018/19.

A closer look at the qualification of researchers shows that just over one-third (34.8%) of South African researchers held a doctoral qualification, 16 947 had a master's, honours or equivalent qualification, and a very small proportion had a diploma or equivalent qualification (Figure 28).

Even though the representation of non-South African researchers was much smaller by headcount, 68.9% have obtained a doctoral degree. The high proportion of researchers with doctoral qualifications in this grouping is evidence of South Africa's ability to attract highly qualified staff to the country. Of the 26 569 postgraduate students, 61.6% are South African holding a doctoral degree or enrolled for one. Detailed analyses of postgraduate students by nationality is included in Figure 32.

Figure 28: Researcher (headcount) by qualification, South Africa, 2018/19



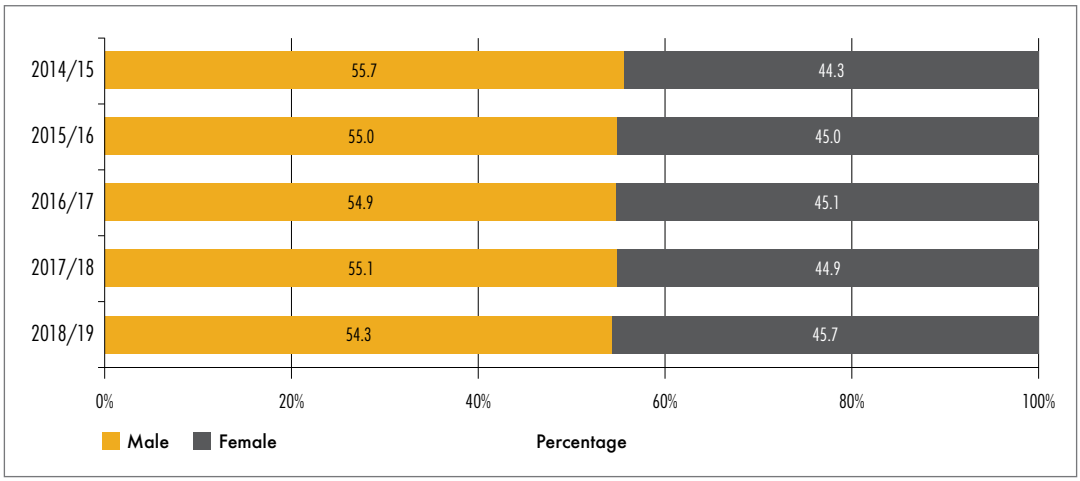
Data note	R&D personnel include postgraduate students* (post-doctoral fellows and doctoral students) under the 'researcher' category. In terms of the disaggregation, the 'researcher' category includes South African and foreign national researchers, and South African and foreign national postgraduate students (post-doctoral fellows and doctoral students).
Data source	National Survey of Research and Experimental Development, 2018/19.

3.2.2 Researcher headcount by gender

In 2018/19, women researchers accounted for 45.7% of all researchers. A slow but steady growth of female researchers was evident over the last five years, showing growth from 44.3% in 2014/15 to 45.7% in 2018/19 (Figure 29).

Of the total researchers approximately 28.8% were women holding a PhD, or enrolled for a PhD.

Figure 29: Researchers by gender (percentage), South Africa, 2014/15 to 2018/19



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, 2014/15 to 2018/19.

3.2.3 Researcher headcount by institutional sector of performance

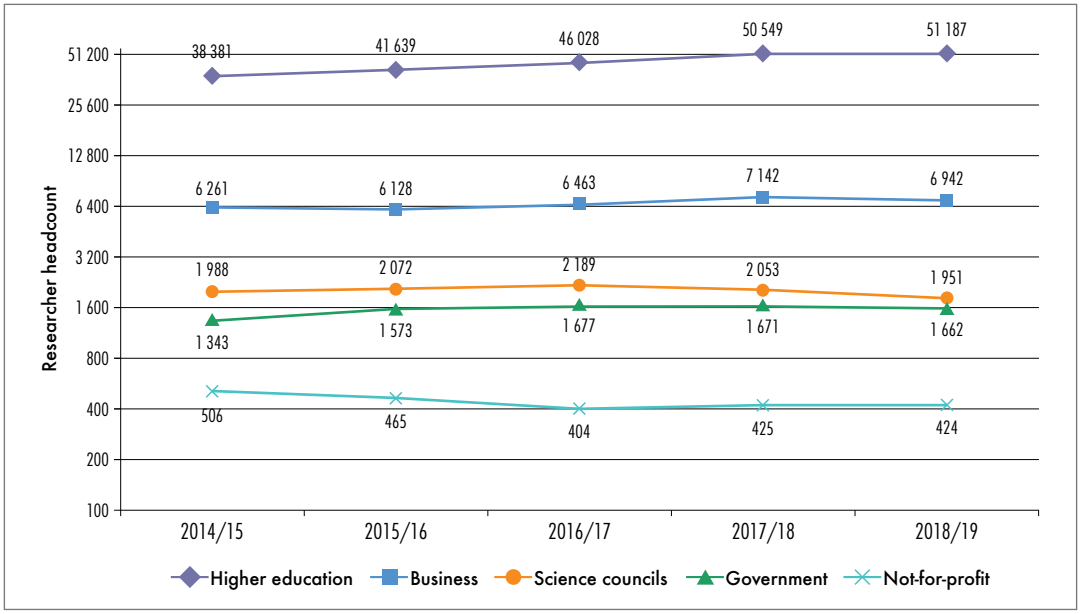
The largest concentration of researchers is found within the higher education sector, business enterprises and science councils. Researcher headcount by sector between 2014/15 and 2018/19 revealed minimal changes in researcher numbers over time. The slow growth observed was influenced by several factors, such as internal restructuring, leading to a reduction in the number of researchers, vacant posts and reduced financial income.

Higher education remained the sector with the greatest concentration of researchers and contributed the most to the increase in researcher numbers. Researchers in the sector increased by a small margin of 1.3% from the 50 549 recorded in 2017/18 to 51 187 in 2018/19 (Figure 30).

Researcher headcounts shows stagnation and decline in certain sectors. While overall headcounts show an increase, this was largely due to students.

Minimal changes in the headcount of researchers were reported in the business, not-for-profit and government sectors, with year-on-year percentage declines of 2.8%, 0.2% and 0.5% respectively between 2017/18 and 2018/19. The science council and business sectors reflected declines in both financial and human resources, showing the largest decline of 5.0% and 2.8% respectively in researcher headcounts over the same period.

Figure 30: Researchers by sector (headcount), South Africa, 2014/15 to 2018/19



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, 2014/15 to 2018/19.

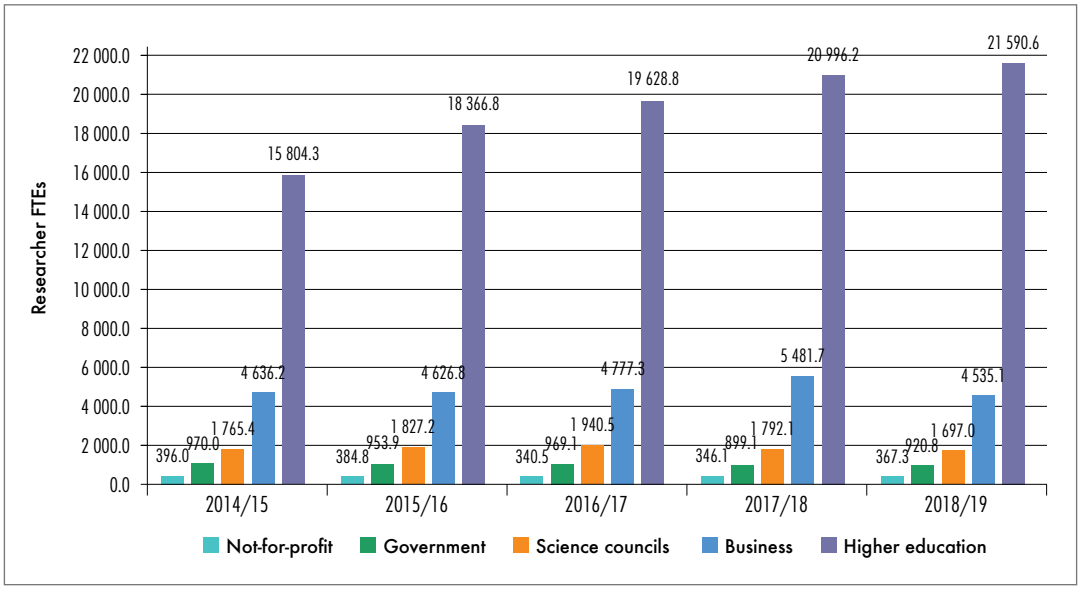
3.2.4 Researcher full-time equivalents by sector of performance

The upward trend of researcher FTEs in the higher education sector continued in 2018/19, increasing by 2.8%, from 20 996.2 in 2017/18 to 21 590.6 in 2018/19 (Figure 31). These increases are associated with increased postgraduate student numbers, as well as the additional personnel categories included from 2016/17 onwards.

The FTEs of researchers in the government and not-for-profit sectors remained stagnant, increasing slightly between 2017/18 and 2018/19.

In the business sector and science councils, researcher FTEs decreased from 5 481.7 to 4 535.1, and 1 792.1 to 1 697.0. between 2017/18 and 2018/19. Despite increases or decreases noted in a specific year, the overall FTEs in both sectors did not change considerably between 2014/15 and 2018/19.

Figure 31: Researcher (FTEs) by sector, South Africa, 2014/15 to 2018/19



Data note	Higher education researchers include post-doctoral fellows and doctoral students under the 'researcher' category. Full-time equivalent (FTE) refers to the number of hours (in terms of person years of effort) spent on R&D activities.
Data source	National Survey of Research and Experimental Development, 2014/15 to 2018/19.

3.2.5 Researchers by population group

The proportions of the various population groups differ somewhat from previous survey data.

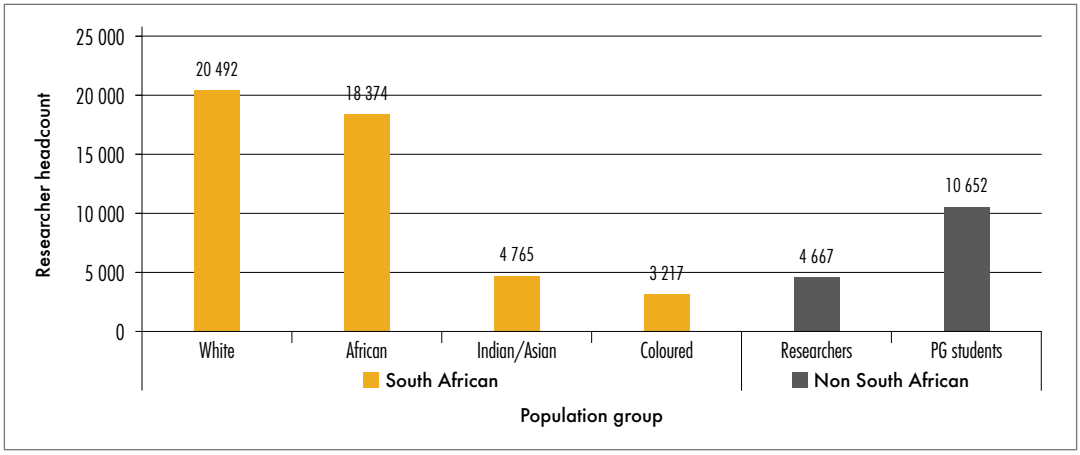
Nominal changes in population group representations may be accounted for by the inclusion of a non-South African classification from the 2016/17 survey cycle. This was a methodological adjustment, based on the recommendations of the revised Frascati Manual. This new category of non-South African researchers constituted 7.5% of the R&D researchers, an increase from the 6.6% reported in 2017/18. A total of 15 319 (24.6%) of the researchers active in South African R&D were non-South Africans, including 10 652 (17.1%) foreign post-doctoral fellows and doctoral students (Figure 32).

Black researchers (African, coloured and Indian/Asian) constituted 42.4% of the total R&D researchers in 2018/19, while 24.6% were citizens of foreign countries.

One-third of researchers (including post-doctoral fellows and doctoral students) were from the white population group (32.9%) in 2018/19. The collective representation of other population groups (African, coloured and Indian/Asian)

constituted 42.4% of the total R&D workforce in 2018/19, a slight proportional decrease from the 43.3% recorded in 2017/18. Within this grouping, 17.0% were African researchers holding a PhD.

Figure 32: Researchers by population group (headcount), South Africa, 2014/15 to 2018/19



Definition	Higher education researchers include post-doctoral fellows and doctoral students under the 'researcher' category. Student data differentiates between South African and non-South African nationals. 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, 2014/15 to 2018/19.

3.3 Postgraduate students

3.3.1 Post-doctoral fellow and postgraduate student headcount and full-time equivalents

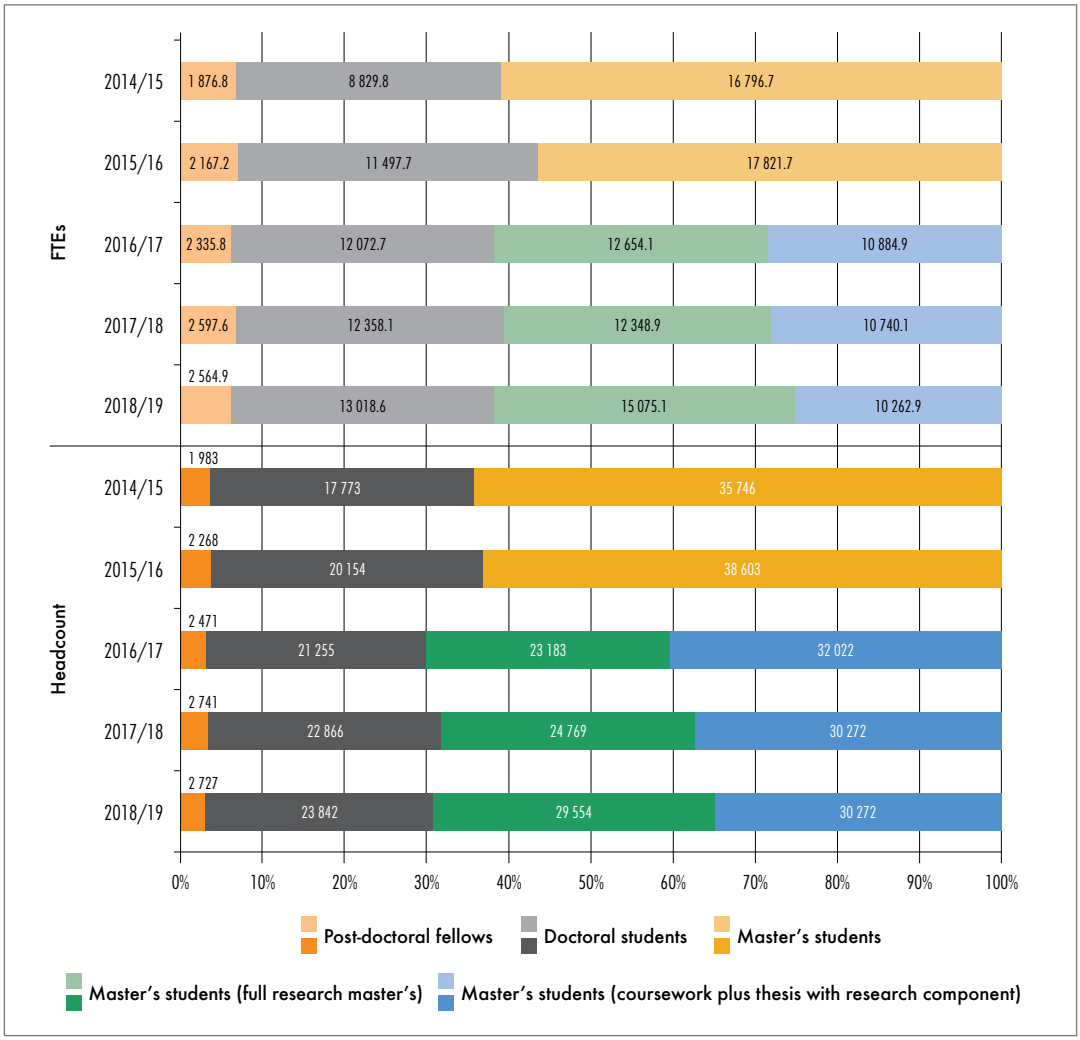
The overall number of post-doctoral fellows and postgraduate students (doctoral and master's students) engaged in R&D grew from 80 648 in 2017/18 to 86 395 (Figure 33). The 2018/19 survey reported 2 727 post-doctoral fellows, 23 842 doctoral students, 29 554 master's (full research) and 30 272 master's (coursework plus thesis with research component).

Post-doctoral fellows and doctoral student numbers combined grew by a smaller margin of 3.8% from 2017/18 to 2018/19, in comparison to the 7.9% between 2016/17 and 2017/18. The headcount of doctoral students increased by 4.3% from 22 866 in 2017/18 to 23 842 in 2018/19.

The growth in postgraduate numbers is slowing down.

Historically, post-doctoral fellows increased by substantial margins, with a 10.9% increase recorded from 2016/17 to 2017/18. The 2018/19 data showed no growth in the number of post-doctoral fellows, and in fact, reflected a 0.5% decline, with headcounts decreasing from 2 741 in 2017/18 to 2 727 in 2018/19.

Figure 33: Higher education post-doctoral fellows and postgraduate students (headcount and FTEs), South Africa, 2014/15 to 2018/19



Data note	The revised Frascati Manual (OECD, 2015) classifies Master's students as R&D personnel. This change in methodology will be implemented in future R&D surveys.
Data source	National Survey of Research and Experimental Development, 2014/15 to 2018/19

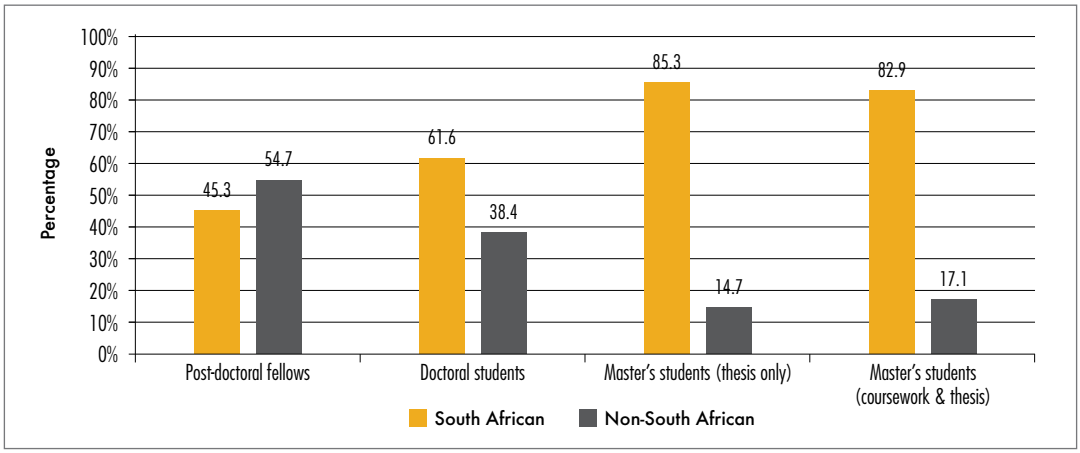
3.3.2 Profile of South African and non-South African postgraduate students

Of the 86 395 postgraduate students in 2018/19, 76.6% were South African and 23.3% were non-South African nationals. Post-doctoral fellows and doctoral students are included as researchers and accounted for 26 569 headcounts at higher education institutions in the 2018/19 R&D Survey. Analyses of the group of post-doctoral fellows and doctoral students revealed that 15 917 (59.9%) were South African nationals and the remaining 10 652 (40.1%) were foreign nationals.

A closer disaggregation of postgraduate students within the individual categories revealed notable trends. The proportion of South African to foreign nationals observed among doctoral students for 2018/19 was 61.6% and 38.4% respectively (Figure 34). An inverted trend was observed for post-doctoral fellows, with a split of 45.3% South African nationals to 54.7% foreign nationals. The majority of master's students were South African nationals in 2018/19, representing 85.3% of the master's by thesis students and 82.9% of master's by coursework and thesis students. The number of non-South African post-doctoral fellows and master's by thesis levels showed a decline between 2017/18 and 2018/19.

The COVID-19 pandemic had no effect on researcher headcounts in the 2018/19 financial year. However, the restriction of movements introduced during lockdown periods had a major impact on foreign nationals at local higher education institutions. The impact of this may become more evident in future trend data for the R&D workforce of South Africa.

Figure 34: Higher education postgraduates by qualification (headcount, percentage), South Africa, 2018/19

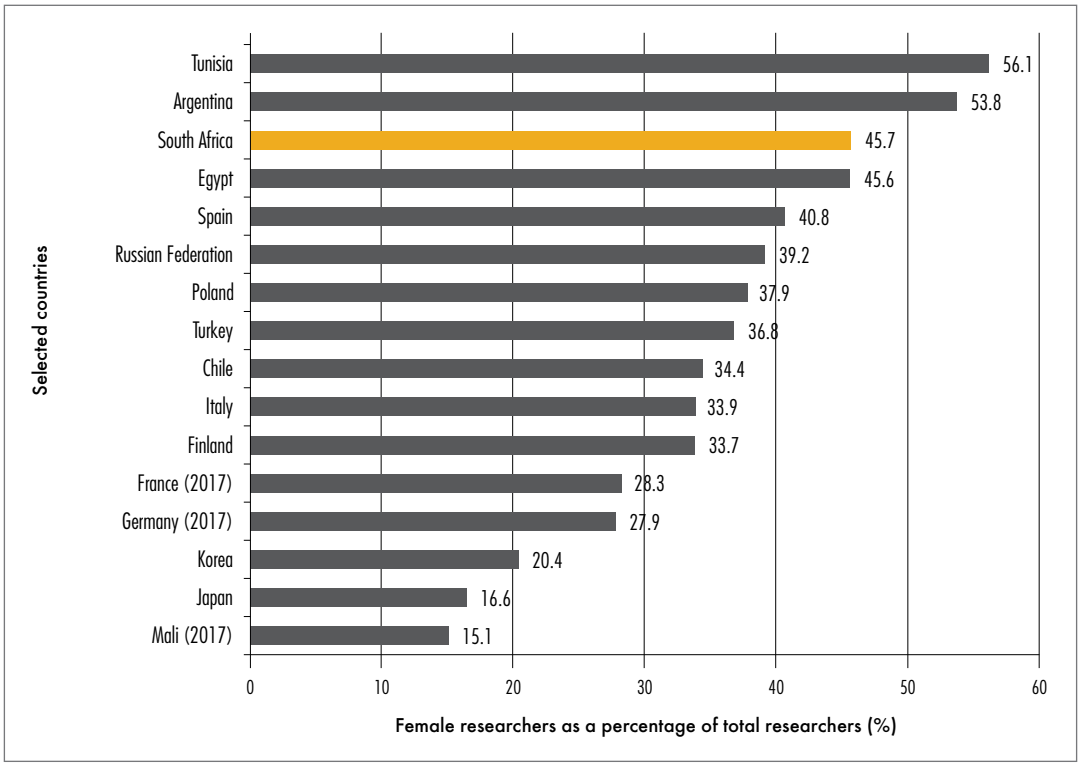


Data note	The 2018/19 survey distinguished between South African and non-South African nationals for post-doctoral fellows, doctoral and master's students. Non-South African personnel are classified as those that are not from South Africa but are undertaking research in South Africa for a period exceeding six months. They can be temporary or permanent residents as described by SNA.
Data source	National Survey of Research and Experimental Development, 2018/19.

3.3.3 Female researchers as a percentage of total researchers

In South Africa, a higher proportion of researchers are female when compared with countries with comparatively large R&D expenditure, such as Germany and France (Figure 35). The proportion of female researchers in South Africa was 45.7% of total researchers in 2018/19, which is slightly higher than the 44.9% achieved in 2017/18. South Africa has improved on this indicator gradually over the past eight years. From the comparative data in Figure 35, female researchers appear to form a higher proportion of total researchers in developing countries, compared with developed countries.

Figure 35: Female researchers as a percentage of total researchers (headcount, percentage) in selected countries, 2018/19 or latest available year

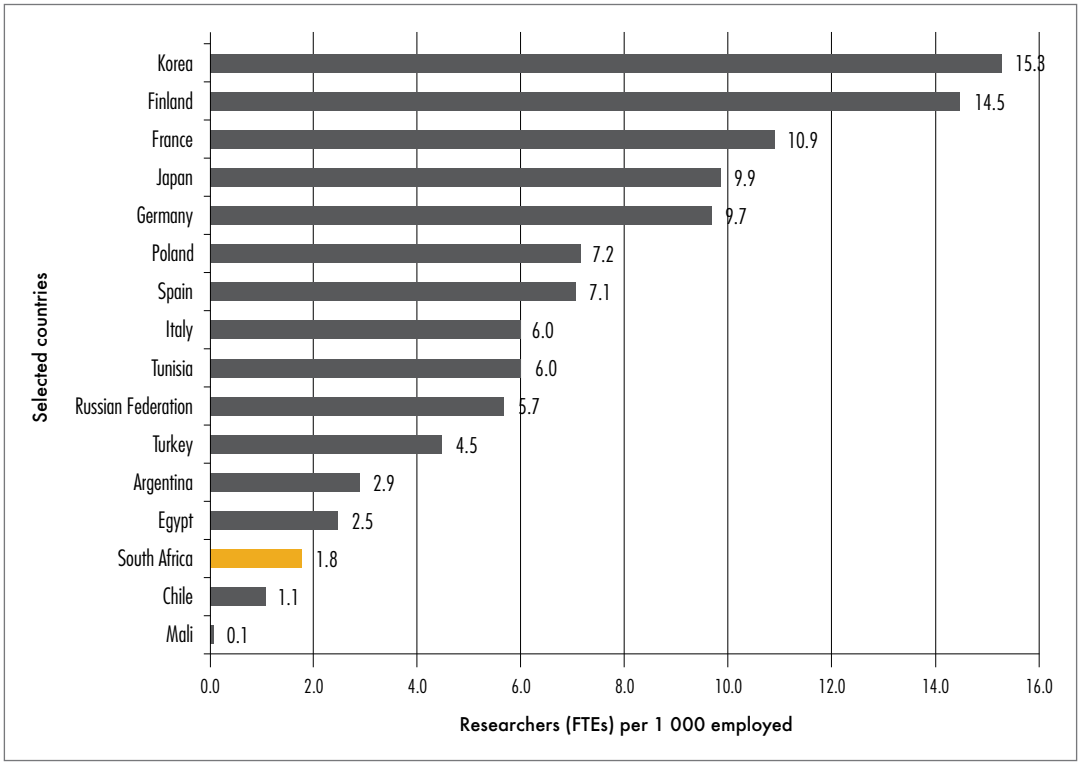


Data sources South Africa: National Survey of Research and Experimental Development, 2018/19.
Argentina, Chile, Finland, France, Germany, Italy, Korea, Japan, Poland, Russian Federation, Spain, Turkey: OECD, (OECD, 2020).
Egypt, Mali, Tunisia: UIS, (UNESCO, 2020).

3.3.4 Researcher full-time equivalents per thousand in total employment

South Africa's figure of 1.8 researcher FTEs per thousand employed places it at the bottom end of the scale in comparison with its global counterparts in developed and developing countries (Figure 36). The growth in R&D personnel in 2018/19 within the higher education sector did not seem to impact positively on this figure in any significant manner. By contrast, in high-income countries, Korea reported 15.3 and Finland reported 14.5 researchers per thousand employed in 2018, which was higher compared to 2017. In the BRICS group, for Russia the number of researchers per thousand employed (5.7) was much higher compared to South Africa. South Africa falls between Egypt (2.5) and Chile (1.1).

Figure 36: Researchers per 1 000 in total employment in selected countries, 2018/19



Data sources South Africa: National Survey of Research and Experimental Development, 2018/19.
Argentina, Chile, Finland, France, Germany, Italy, Korea, Japan, Poland, Russian Federation, Spain, Turkey: OECD, (OECD, 2020).
Egypt, Mali, Tunisia: UIS, (UNESCO, 2020).

4. CONCLUDING REMARKS

In the period under review globally, many comparator countries displayed signs of slowing growth and stagnation in R&D intensity. For the first time since 2010/11, gross expenditure on domestic R&D in South Africa declined, and GERD/GDP fell from 0.83% to 0.75%, close to the lowest level over the last decade, of 0.72%. This decline must be interpreted in relation to the economic stagnation and lack of growth that intensified during the 2018/19 reference period, with growing levels of unemployment and poverty. Now, more than ever, South Africa needs to attain the R&D intensity targets it set to promote inclusive and sustainable development.

This chapter concludes by highlighting key areas for R&D growth. Section 4.1 focuses on the need to support the growth of business sector R&D. Section 4.2 considers health R&D as a niche area, and section 4.3 considers R&D personnel and the impact of postgraduate students on the workforce. Finally, section 4.4 considers ways to grow GERD.

4.1 The need to support business sector R&D

Government funding of R&D has continued to dominate over the past ten years, with higher education receiving most of the funds. Unlike the pattern in most developing countries, however, the business sector remained the largest performer of R&D in South Africa, over all the years of the survey. The decline of business R&D in 2018/19, falling lower than the sector's investment in 2016/17, is therefore particularly significant. The business sector has a central role to play in driving economic growth and development, safeguarding the environment and creating employment.

The business sector funds almost 95% of its R&D activities, with only 1.2% of all government funding going to business. How can government increase its support to businesses to boost investment in R&D, and how can businesses focus their strategies effectively?

Two common public policy instruments are tax incentives and subsidies, which increase R&D efforts by making R&D more affordable. A recent study of micro-and macro-economic factors that determine firms' investment in R&D (Kahn, Kasongo, Sithole & Ramoroka, 2021) found that receipt of government subsidies and tax incentives both have a positive impact on R&D intensity, and encourage firm R&D activities. This evidence supports the value of the South African R&D tax incentive programme.

The study also found that collaboration within South Africa, as well as highly qualified personnel, have positive effects on R&D intensity (Kahn et al., 2021). Investment in higher education and other research institutions that offer collaborative potential may serve to aid firms in their R&D efforts. Firms in particular areas, for example, those near universities or other similar firms, may focus their activities to

benefit from resource and knowledge spill-overs. Therefore, encouraging networking and collaboration in geographical areas may help stimulate firm R&D activity.

The study also highlighted the importance of the macro-environment in fostering R&D, showing that political stability and the attraction of foreign investment are important to stimulate R&D in the business sector.

When planning public R&D investment, the effect it may have on private investment should be considered. If government aims to boost private R&D investments, it needs to know what types of R&D business is likely to fund itself, and what R&D activities business will not fund, but are crucial to economic growth. Government currently provides support to businesses through sector innovation funds, technology for new industry development, and by creating opportunities for domestic private sector firms to participate in international platforms for capacity building, innovation, and R&D resources. Avenues such as innovation funds for small businesses can also be explored.

To achieve the optimal level of R&D investment, it is recommended that government and business associations find ways to further strengthen the uptake of the existing incentives.

4.2 Priority research areas: the example of health R&D

Identifying priority research fields for R&D investment can highlight niche areas to be supported and exploited to enhance R&D performance. The COVID-19 pandemic and the resultant national lockdowns affected most businesses and academic institutions. Clinical research is needed to focus on health issues related to the pandemic, with such investment likely to boost R&D expenditure in subsequent years. Here we consider the case of health R&D, which has long been one of South Africa's most pressing national development priorities, and an area of R&D strength.

South African trend data shows expenditure in health R&D steadily increasing since 2014/15, with 23.4% of GERD devoted to health R&D in 2018/19. This indicates a positive direction for R&D devoted to this national priority area.

The public sector is the largest investor in health R&D in South Africa, a trend that has continued over the past five years. The public sector, including government, higher education and science councils, invested 54.2% of funding devoted to health R&D, with the private sector contributing a substantial 45.8%. However, public sector investment in health R&D decreased by 9% from R5.148 billion in 2017/18 to R4.667 billion in 2018/19. This has important policy implications at the national and provincial level, highlighting the need to increase efforts to support research in this priority area.

4.3 R&D personnel: the impact of postgraduate students

R&D personnel play a role in the production, development, diffusion and application of knowledge. South Africa requires high-level skills, achieved through targeted curricular and cross-disciplinary learning for graduates, and an open system that allows for the diffusion of knowledge and in-flows of foreign talent. Growing the national system of innovation in South Africa also entails growing new entrants for an R&D workforce equipped with the skills and expertise for research in key fields. It is also important to assess the progress of transformation goals to promote race and gender representation in the R&D workforce.

Notable data trends are a general upward trajectory in South Africa's R&D personnel headcounts and full-time equivalents (FTEs), with gradual growth trends noted between 2004/05 and 2010/11, and more robust year-on-year growth between 2010/11 and 2017/18. These increases can be disaggregated by institutional sector, to understand the origin and levels of this growth, and to assist in understanding where growth can be promoted further.

The 2018/19 period indicated a decline in headcount and FTE data for the first time. R&D personnel headcounts declined by a small margin of 0.3% year-on-year, from 84 262 to 84 036 between 2017/18 and 2018/19. This stagnation contrasts with the previous survey periods when robust growth rates of 5.3% and 6.8% respectively were reported between 2015/16-2016/17 and 2016/17-2017/18.

The postgraduate student headcount in the higher education sector, which contributes significantly to total R&D personnel, stood out in 2018/19, showing consistent headcount growth year-on-year.

Postgraduate students within the higher education sector contributed the most towards the growth of R&D personnel, particularly at the researcher level. This raises the policy question whether sufficient human resources are being produced for R&D nationally. The data reflects that at the doctoral level, there is a higher proportion of South African nationals in the potential cohort. An inverted trend was observed at the level of post-doctoral fellows, where non-South African nationals predominate, suggesting that South African doctoral graduates are being lost to the R&D system.

This concern is reinforced by examining the distribution of researchers across institutional sectors. In 2018/19 there was a decline in the number of researchers in science councils, government, and business, and only modest increases in higher education (if postgraduate students are excluded), and the not-for-profit sector. The stagnating number of researchers per 1000 in the population, coupled with climbing unemployment in South Africa, raises the question of where South African postgraduates go once they leave the higher education system. Are the incentives sufficient to keep the required researcher cohort?

The DSI and the Council for Scientific and Industrial Research have introduced a Comprehensive Bursary Programme to target honours students and improve the retention of postgraduate students (DST, 2017/18). Similarly, the National Research Foundation promotes and supports research through funding, human resource development and the provision of research facilities to facilitate the creation of knowledge, innovation and development in all fields of science and technology.

It is recommended that more initiatives like these are supported in the higher education sector, aimed at specific research fields based on national priority areas.

4.4 Using the R&D survey data to inform strategies to grow GERD

The White Paper on Science, Technology and Innovation 2019 outlined new policy goals including responding to the challenges of the Fourth Industrial Revolution; promoting specialisation in key research areas, industries and technologies aligned to the Sustainable Development Goals and the Science, Technology and Innovation Strategy for Africa (STISA); and the expansion and upgrading of South Africa's science, technology and innovation infrastructure. Achieving these will require increased investment in and performance of R&D. This final section highlights data trends that point to potential spaces for growth.

The 2018/19 survey results reflect a decline in R&D expenditure in the business, government and science council sectors. Section 4.1 considered how to grow business sector R&D. The science council and government sectors play a vital role in funding other sectors. There is an urgent need for greater public investment in these sectors to prevent further declines in system capabilities (section 1.2.2).

Data trends also highlight that there may be value in promoting greater investment in capital R&D categories, as opposed to labour costs (section 1.2.1). Investing in scientific infrastructure and equipment in higher education and other research institutions may also aid firms or government departments in their R&D efforts. It is not feasible for some sectors to invest in expensive laboratory and research equipment when this work can be outsourced or conducted in collaboration with universities and public research institutes.

Attracting more foreign investment may increase investment in R&D both directly and indirectly (section 3.2.4). Foreign investment has a positive impact on job creation, technology transfers, innovation, and economic growth.

Sectoral disaggregation trends are significant for policymakers committed to promoting science, technology and innovation opportunities to strengthen the recovery of priority sectors, and contribute to much needed economic development (section 1.3). The 2018/19 survey showed an increase in R&D in the mining sector, and a decline in the manufacturing sector, both identified as vital spaces for future investment growth.

Much research and policy debate is needed to establish how South Africa can reach the targeted levels of R&D expenditure. The report highlights growth, decline and stagnation trends in R&D expenditure and human resources, to contribute to the discussion. In future, it is recommended that the R&D data series is analysed and disaggregated in greater depth, alongside complementary datasets, to provide policy-related evidence in a more systematic manner.

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METHODOLOGICAL NOTE

The South African National Survey of Research and Experimental Development (R&D Survey) is one of the tools for monitoring and evaluating the performance of the national system of innovation (NSI).

The R&D Survey covers four main sectors described in the Frascati Manual: business enterprise, government, private not-for-profit and higher education. In South Africa, the science councils are combined with the government sector and are reported separately, thus comprising a fifth sector.

The scope of the survey includes all units performing R&D, either continuously or occasionally. The survey collects data in accordance with the guidelines recommended by the OECD in the Frascati Manual (OECD, 2002, 2015, 2020). This helps to maintain coherence and international comparability. The System of National Accounts (EC, IMF, OECD, UN and the World Bank, 2009) and the national system of innovation differ on the identification of target units and definitions.

HSRC-CeSTII performs quality management in line with practices recommended by Stats SA in the South African Statistical Quality Assessment Framework (SASQAF), (Stats SA, 2010). The survey was conducted according to a project plan aligned with the phases of the Statistical Value Chain (SVC), which is modelled on practice at Statistics SA.

Three questionnaires were used in the survey: for the business sector, for the higher education sector, and for government departments (national, provincial, municipalities, research institutes, and museums), science councils and not-for-profit organisations.

R&D performers in sectors were taken to be any units with R&D expenditure or were likely to have had R&D expenditure, in 2018/19. The R&D data were collected by means of questionnaires that were sent to the units in each sector by electronic mail. Quality indicators of survey coverage, fieldwork, data processing and analysis were assessed in the metadata report of the survey.

Readers are cautioned that time series analysis of the data using the 2018/19 R&D Survey's estimates should be read with caution, taking into consideration the relatively low response rate due to the advent of COVID-19.

A detailed methodology and metadata are provided in the Statistical Report.

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