**Analytical Brief**
No. 2025/01

# FUNDING R&D IN A DEINDUSTRIALISING SOUTH AFRICA*

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## Introduction

Spending by firms on research and development acts as an investment to generate new technological knowledge, which in turn acts as a production factor to drive growth. Innovation economics contends that when the generated knowledge—an output of the R&D investment process—is deployed as a production factor, its contribution to productivity (and thus to higher GDP per capita in the long run) can be reasonably inferred.

Related is the generally accepted association between R&D intensity and economic wellness and the presence of a strong business sector. Robust industrial capabilities and technological infrastructure for both research and production, are essential to translate R&D investments into economic performance.

### About this brief

This brief explores the current state of research and development (R&D) funding in South Africa and the need for increased investment to achieve the country's targets for R&D expenditure as a proportion of gross domestic product (GDP). It aims to show how South Africa can return to a pathway of high R&D intensity and suggests a benchmark value and approach to government funding of R&D to facilitate this.

Public authorities expect that increased investment in R&D will intensify technological progress and in turn, accelerate economic growth. As Jones and Williams (1998) assert, "The functional relationship between the social rate of return and the share of resources devoted to research depends only on the production possibilities of the economy."

This brief distinguishes between R&D activity, represented by R&D expenditure, and investment in R&D, represented by R&D funding, for reasons which we will discuss. In the business sector, these two indicators are almost identical as businesses primarily fund their own R&D. However, this is not the case for the government sector, which funds other sectors but performs little R&D itself.

In most countries, R&D funding is predominantly provided by government (including for higher education) and businesses, and this is essential to drive R&D activity. Nonetheless, the sector that performs the most R&D is not necessarily the biggest funder of it. The role of these funders of R&D seems to be determined by a country's stage of development. The public sector provides funding for most R&D activity in emerging economies, while the opposite is largely the case for developed economies.

* A list of definitions of key terms used in this brief appear on pages 14 and 15.

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This raises important questions including: What constitutes a healthy level of funding for R&D in South Africa? Is South Africa's funding of R&D adequate to meet the targets set by the National Development Plan 2030? What strategies can government use to shift from low levels of R&D intensity, with heavy reliance on government funding, to higher levels of R&D intensity with greater funding by the business sector?

## A healthy level of funding for R&D

Healthy funding levels for a country's R&D depend on multiple factors. These include the size of the economy (GDP); fiscal policies that promote R&D; human capital, such as the number of researchers (Wang, 2010); openness to trade and knowledge sharing with other countries; tax relief instruments to promote R&D including government incentives, current sales and cash flow (Howe & McFetridge, 1976); and foreign direct investment. Additional factors include changes in capital stocks and employment levels, cyclical swings in the economy, growth in output, and shifts in relative prices (Nadiri, 1979). A healthy level of both public and private funding for R&D should enable a country to reach its R&D intensity targets. This, however, is not always the case, as the determinants of R&D intensity are not always well understood, and countries, including South Africa, repeatedly miss their set targets (Tudor & Sova, 2022).

**R&D funds**

"The source of R&D funds is the unit that provides the funds for R&D performance. Sources may be internal or external to the reporting unit. In surveys and data presentation, external sources are grouped by main sector and relevant subsectors. In broad terms, there are five main sources for R&D funding: Business enterprise, Government, Higher education, Private non-profit and the Rest of the world".

Source: OECD (2015) Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development, Annexure 2, pg. 380.

## Major funding sources for R&D

Investment in R&D is primarily provided by two sectors in an economy: business and government, with distinctive patterns evident for high-income and middle-income countries.

### Business funding of R&D

The business sector is made up of enterprises that engage in professional, commercial, or industrial activities. Their purpose is to organise the economic production of goods or services with the aim of earning a profit. Most R&D activity in businesses takes place in high-income, research-intensive countries, with less in low- and middle-income countries.

Business is typically the largest funder of R&D in research-intensive countries. Countries that receive more than 60% of their R&D funding from the business sector include the U.S.A., Germany, South Korea and Japan. R&D spending is primarily devoted to the salaries and wages of highly educated scientists and engineers. As a result of their efforts, firms develop intangible assets, namely a knowledge base, from which profits will be made in the future (Hall, 2002). Knowledge may also be sourced from other areas, and a rich source of cutting-edge knowledge stems from basic research conducted at universities.

### Government funding of R&D

Government employs two primary funding mechanisms for R&D: direct and indirect funding. Direct funding encompasses parliamentary grants allocated to government departments, as well as support programmes and innovation funds aimed at prioritised activities within the private sector. Indirect funding involves R&D tax incentives provided to businesses engaging in qualified R&D activities, subject to specific criteria. A country's government has a broader set of priorities than business. Government must regulate the country and is responsible for the protection and wellbeing of its citizens, instituting policies and legislation aimed at growing employment and providing education and health.

#### The government sector

In the case of South Africa, the government sector viewed as a performer of R&D includes national and provincial departments, research institutes, museums and municipalities. The national government also acts as the major funder to all of the spheres of government, and research organisations including science councils and all public universities.

## R&D funding in the context of developed and developing economies

The R&D intensity of a country appears to be closely tied to whether R&D funding comes mainly from government or the business sector. Two scenarios can be applied to most countries in terms of R&D intensity.

#### Defining R&D intensity

"R&D intensity for a country is defined as the R&D expenditure as a percentage of GDP."

Source: Eurostat (2022) Statistics Explained, Glossary: R&D Intensity.

## Scenario 1: Low R&D intensity with heavy reliance on government funding

Countries with low R&D intensity are characterised by limited investment in research and development activities, resulting in a lower capacity for innovation and technological advancement. Common characteristics include:

1. Limited funding for R&D: Governments often allocate a smaller portion of their budget to R&D, resulting in a lack of resources for scientists and researchers to innovate and develop new technologies.
2. Weak intellectual property protection: An absence of strong intellectual property laws can discourage innovation and R&D investments, as companies may be reluctant to invest in new ideas if they are not confident they can protect their intellectual property.
3. Poor education systems: Countries with low R&D intensity often have weak education systems, resulting in a smaller pool of skilled and educated workers to contribute to R&D activities.
4. Lack of collaboration: Countries with low R&D intensity may have limited collaboration between academic institutions, industry, and government, resulting in fewer opportunities to share knowledge and resources.
5. Limited private sector involvement in R&D activities, with companies preferring to focus on short-term profits rather than long-term R&D investments.

As there is limited funding of R&D by the business sector, government has to stimulate investment by subsidising the cost of R&D, promoting collaborations or through other support mechanisms.

## Scenario 2: High R&D intensity with more business funding

Countries with high R&D intensity invest a significant number of resources, both public and private, in R&D activities. They tend to have these characteristics:

1. A highly skilled workforce with a strong emphasis on science, technology, engineering, and mathematics (STEM) education.
2. A supportive policy environment with government policies that promote and incentivise R&D activities, such as tax credits, grants, and subsidies.
3. Well-developed R&D infrastructure to support R&D activities, such as advanced laboratories, universities, and research institutions.
4. Strong collaboration between industry and academia, with universities and research institutions working closely with businesses and industry to develop new technologies and innovations.
5. High levels of innovation with very novel innovations and a strong focus on developing new products and technologies that can be commercialised and generate economic growth.
6. Strong business sector R&D activity. In all countries with high R&D intensity, the business sector is the largest contributor to R&D. Applied research is more common in these countries with a focus on developing practical applications and solutions to real-world problems; or in maintaining high-technology operations.

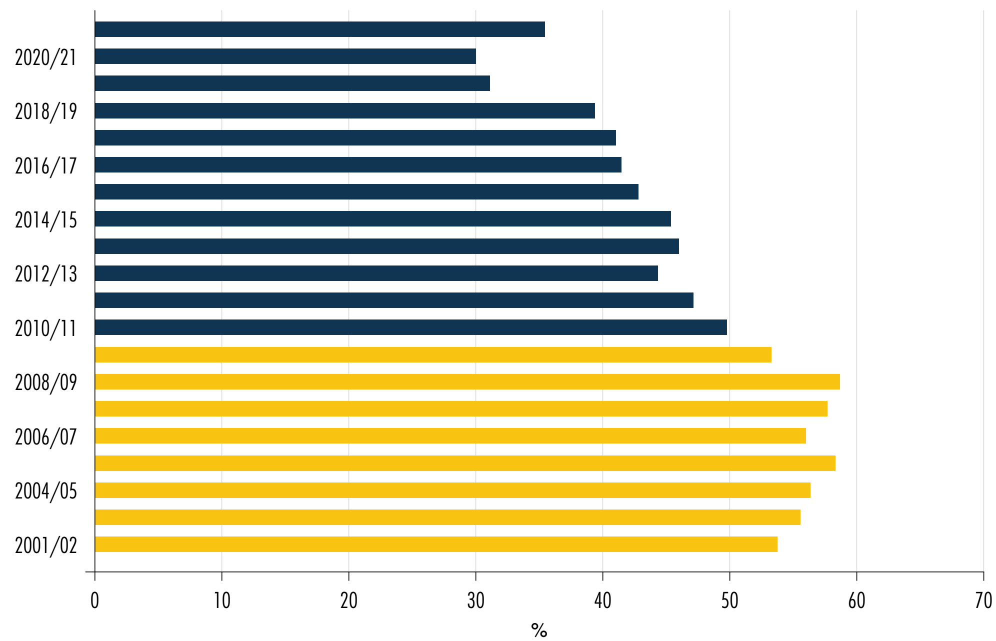
The ratio of R&D expenditure by the business sector (BERD) to a country's gross domestic expenditure on R&D (GERD) is the defining indicator of which source of R&D funding predominates. Countries with a BERD/GERD ratio of less than 50% are commonly MICs or LMICS (OECD, n.d.).

## Reaching the National Development Plan 2030 target for R&D funding

South Africa's National Development Plan has set as a target spending 1.5% of the country's GDP on scientific and technological R&D. Achieving this will require a significant increase, with R&D investment currently standing at only 0.61% of GDP (2020/21). The indicator most pertinent for achieving this policy target is the contribution of business expenditure on R&D (BERD) to GDP over time.

Figure 1.1 shows that over the last 20 years South African business expenditure on R&D as a percentage of GDP (GERD) has regressed to low business expenditure levels typically associated with LMIC's. In contrast South African business expenditure on R&D as a percentage of GERD in the period 2001/2 to 2009/10 (the yellow bars) was comparable with countries enjoying a high R&D intensity as described in Scenario 2.

**Figure 1.1 Business expenditure on R&D as a percentage of GDP on R&D in South Africa, 2001/02 to 2020/2021**



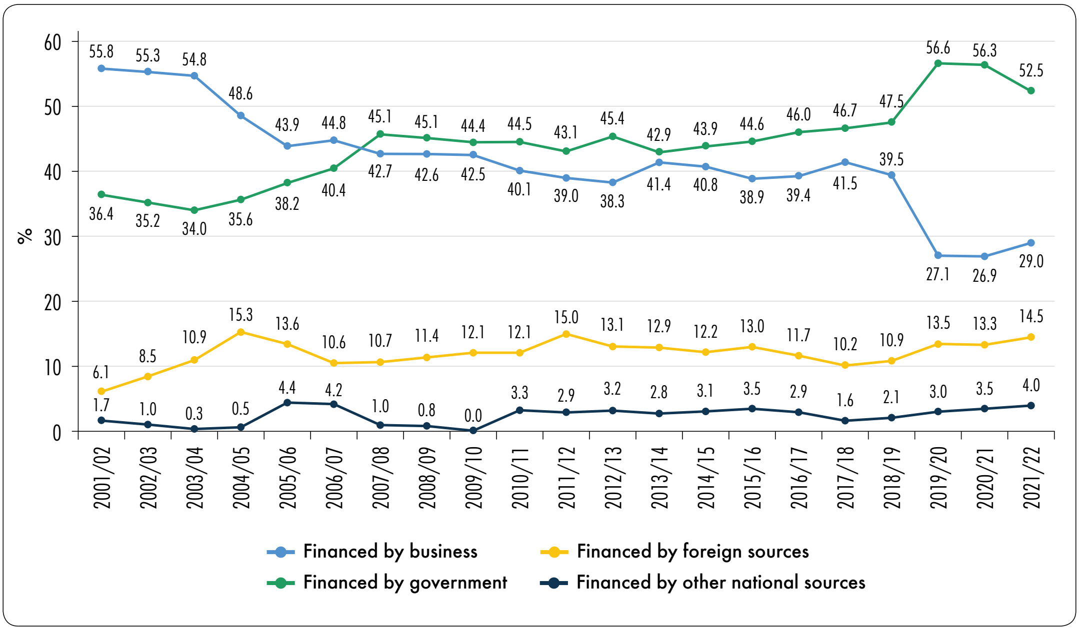

Source: South African National Survey of Research and Experimental Development, 2001/02 to 2020/21.

To address this the onus is on government to stimulate R&D activity in the business sector. This can be done by:

- funding R&D,
- incentivising business R&D,
- promoting collaboration,
- improving education systems,
- enhancing IP protection,
- and other means.

South Africa's annual national R&D survey provides data to analyse government funding of R&D by looking at historic trends in R&D investment. Government has contributed more funding to R&D activity than the private sector since 2007/08 as shown in Figure 1.2. In recent years, this disparity has grown even more.

Figure 1.2 Contribution to GERD by source of funds in South Africa, 2001/02 to 2021/22




Note: *Other national sources include contributions from higher education, not-for-profit organisations and individual donations.
**Government includes science councils.
Source: South African National Survey of Research and Experimental Development, 2001/02 to 2021/22.

However, the question still remains: Is there enough funding by government to steer South Africa back to a high R&D intensity scenario?

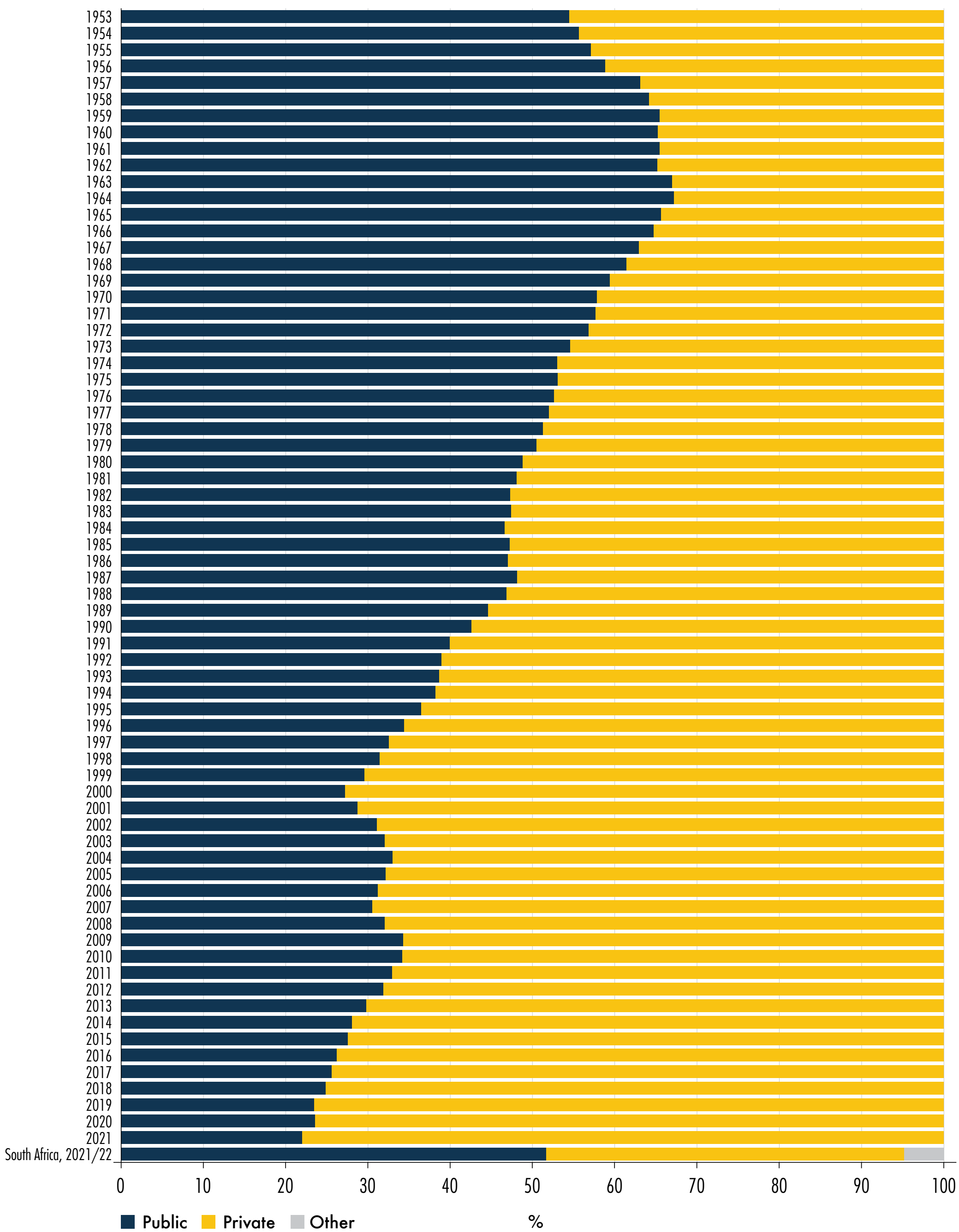
This may be partially answered by looking at the proportion of government funding in countries that have propelled themselves into high R&D contexts, such as the USA, South Korea and Japan, prior to achieving high-income status. Bear in mind that this indicator is not definitive, and there are myriad other economic circumstances that determine whether a country achieves a state of high R&D intensity.

## How South Africa can change its R&D trajectory

### Funding for R&D by the USA government post-World War II

The USA is often cited as a model for achieving high R&D intensity. In 1946, the U.S. government played a significant role in funding R&D, driven by the post-World War II economic boom and a commitment to advancing scientific and technological frontiers. This funding, estimated to constitute up to 80% of total R&D expenditure immediately after the war, supported diverse projects, including defence-related research, space exploration, and medical advancements. Over time, the proportion of government funding for R&D fluctuated, influenced by economic and political dynamics, while private sector and academic institutions also contributed to R&D endeavours. By 1953, the US had firmly established itself as a global technology leader, with government funding still accounting for 68% of R&D expenditure in 1964 (Figure 1.3). Subsequent years witnessed a gradual decline in government funding, accompanied by a rise in private sector investment. By 2020/21, US government funding of R&D had decreased to 22.9%, largely due to increased business expenditure on R&D (BERD). Presently, South Africa's R&D funding profile mirrors that of the US in 1973.

## Figure 1.3 USA government funding for R&D (percentage), 1953 to 2021, and South Africa, 2021/22




Note: Other includes the contribution from higher education, not-for-profit organizations and individual donations.
Source: National Science Foundation (2023); South African National Survey of Research and Experimental Development: Statistical Report, 2020/21.

Considering this and South Africa's current status:

- The South African government needs to lift the R&D funding level, which was 56.3% in 2020/21.
- Post-WWII USA funding of R&D of around 70% gives a ballpark estimate of what is required in South Africa.

Following a similar trajectory as observed in the U.S.A., government has the potential to incentivise business investment in R&D by indirectly subsidising future technologies through the promotion of university research. The objective is to foster R&D activities at universities, anticipating that these innovations will eventually be commercialised in the business sector when economic conditions are conducive. However, it is important to recognise that this approach represents a long-term strategy.

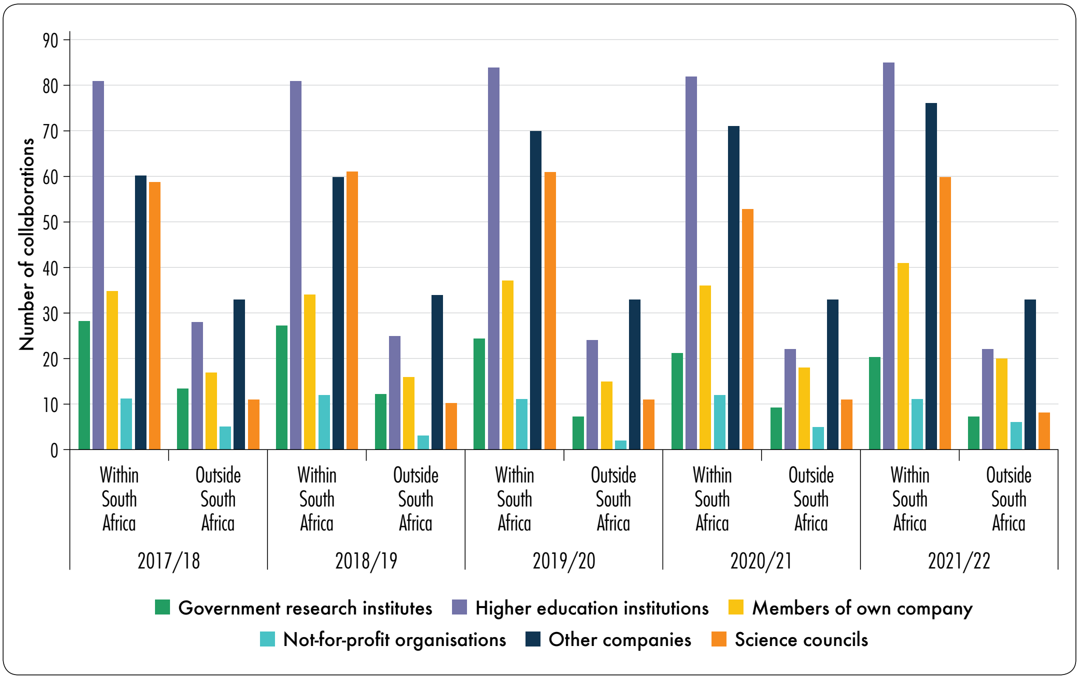
Another strategy employed by the South African government is the use of indirect incentives, such as the tax incentive scheme, which subsidises R&D conducted by businesses through tax rebates on such activities (Department of Science and Technology, 2002).

### Promoting collaboration of business sector with other sectors

For a more immediate impact on R&D growth in the business sector, collaboration is a promising approach. Leveraging its influence and funding in various sectors, including universities, research institutes, science councils, and state-owned enterprises, government can incentivise the initiation of new R&D projects. This is particularly attractive as it allows government to prioritise funding in areas of high significance, thereby driving innovation and economic development more efficiently.

Figure 1.4 illustrates the frequency of collaborations between the business sector and various entities, including other businesses, universities, science councils, and government research centres over the past decade. These encompass partnerships, alliances, and formal collaboration. The interactions between businesses and institutions in higher education, science councils, and government research centres reflects the public sector's role in stimulating R&D activity by providing public funds. Some engagements extend to international partners outside South Africa. Notably, the number of collaborations has remained relatively stagnant in recent years, suggesting the potential for further stimulation, particularly collaborations with higher education institutions and science councils.

Figure 1.4 South African business sector R&D collaborations with other businesses, universities, science councils and government research centres, locally and internationally, 2017/18 to 2021/22




Note: Collaborative R&D entails partnerships, alliances and collaborations.
Source: South African National Survey of Research and Experimental Development, 2001/02 to 2020/21.

## Targeting R&D intensity growth in an environment of deindustrialisation

South Africa exemplifies a deindustrialising country. Industrial activity has declined, reflected in reduced manufacturing output, reduced employment, and reduced investment in industrial sectors over recent decades. This has accompanied a shift to service-based industries resulting in significant structural changes in the labour market and posing challenges including decreased export competitiveness and the loss of skilled industrial jobs. Regional economic imbalances have also emerged, with certain areas more affected by the decline of traditional industries. The transition has strained social and economic systems as communities and workers struggle to adapt to these new economic realities.

Greater R&D intensity is necessary to facilitate the transition from a deindustrialised economy to a reindustrialised more modern one. However, R&D investment alone is insufficient. In the South African context, where the share of business sector R&D has been declining—an indicator of ongoing deindustrialisation—recommendations must first focus on building production capabilities. This ensures that investments in R&D generate technological knowledge that private firms in the industrial sector can exploit profitably, thereby enabling them to make their own R&D investments and support reindustrialisation.

The availability of a capable and skilled workforce is a critical component, with several key elements pertinent to South Africa. Firstly, a modernising economy requires a culture of continuous learning to develop both technical and soft skills development. Secondly, a healthy workforce needs institutional support to promote and support worker wellbeing. Lastly, high unemployment levels and challenges in education contribute to a shortage of employable workers with skills and experience in problem-solving and innovation.

Economic events that drive unemployment cause many South Africans to find work in the informal sector. This sector, despite its challenges, could potentially serve as an organically created incubator of the skills and capabilities needed to empower businesses and drive re-industrialisation. Since the 1970s, experts have examined the connections between the formal and informal sectors. Many view the informal sector as subordinate to the formal sector, but other perspectives explore why the informal sector grows even when income declines (Tokman, 1978). More recently, scholars like Mustapha et al. (2021) have described the informal sector as dynamic and driven by entrepreneurship and innovation. From an innovation systems perspective, the linkages between the formal and informal sectors provide learning pathways from the formal to the informal sector. This raises the intriguing question of whether the formal sector can also benefit from the learning occurring in the informal sector. The informal sector requires individuals to be resourceful, adaptable, and entrepreneurial—traits that are valuable in a reindustrialising economy. Workers in the informal sector frequently engage in diverse activities that can enhance their problem-solving abilities and innovation skills. Recognising and harnessing the potential of the informal sector could be a strategic approach to workforce development. By providing targeted support and integrating informal experiences into broader economic strategies, South Africa could develop a more skilled and capable workforce through improved linkages between the formal and informal sectors (Kruss, 2021). This, in turn, would facilitate the transition to a more industrialised economy and enhance the effectiveness of R&D and innovation initiatives.

## Conclusion

The effectiveness of a country's R&D funding model is closely linked to the level of development of its economy. In middle-income countries such as South Africa, the public sector often bears a greater responsibility for R&D investment than the private sector. This contrasts with developed countries, where the private sector, driven by high levels of innovation in goods and services development, is typically the largest investor in R&D.

Despite this, the state can play a pivotal role in influencing private sector investment in R&D. Governments can incentivise R&D activities in the business sector through direct means, such as R&D tax incentives, or indirect means. In South Africa, the government has at least two tools at its disposal to encourage private sector R&D investment. In the long term, the state can subsidise the cost of developing future technologies by funding R&D at universities, which businesses can later commercialise. In the short term, the government can fund strategic projects within state institutions that collaborate with businesses, thereby stimulating private sector R&D activity. An example of this would be the Biovac Institute, which is a public-private partnership established to revive and enhance vaccine production in South Africa and the broader SADC region. This approach allows government to direct its spending on priority policy initiatives.

By fostering a productive private sector driven by capable and creative workers, government initiatives to promote R&D and innovation may have a greater impact. This approach can create conditions for a sustainable modern economy, where government investments in R&D do not exist in a void but rather contribute to a thriving, innovative industrial sector. The availability of skilled and capable workers is a challenge in a country with education shortcomings and high unemployment.

Finally, this brief suggests a proposed contribution to GERD that government can aim for, to help catalyse business expenditure on R&D, to achieve higher R&D intensity and less reliance on government funding in future. The figure was reached by comparing South Africa with the USA at an earlier developmental state in its R&D performance. The US government initially developed innovative technologies primarily for military purposes, which were later transferred to private industries. The strength of the private sector and its capacity to absorb and exploit these technologies is crucial for initiating its own R&D funding. Can South Africa emulate this strategy and its outcomes, without necessarily replicating the US focus on military or space technology? We acknowledge that areas of R&D that the USA directed the most funding to in the post-WWII years may not be the same areas that South Africa would want to concentrate on today. As such, this brief leaves open the question of which areas of policy attention are demanded by the current situation in South Africa, and which countries are better suited to compare South Africa to in terms of patterns of R&D funding. The latter is a subject for more comprehensive exploration in a companion brief.[1]

The **South African National Survey of Research and Experimental Development data** for the period 2001/02 to 2021/22 that is cited in this report was created by the Centre for Science, Technology and Innovation Indicators at the Human Sciences Research Council. Data is available for download and use by readers in different formats on the HSRC's website (hsrc.ac.za). For specialised data requests from CeSTII, visit https://data-request.hsrc.ac.za/

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[1] See the companion brief in this series, *Comparing R&D: What South Africa can learn from other countries* accessible for download from https://hsrc.ac.za/about-cestii/measuring-rd-activity-in-south-africa/

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# 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.

**Constant 2015 (Real) Rands** is the value of goods and services of a given year using the prices of a determined base reference year, which is 2015 in this case. These values were obtained by deflating with the GDP deflator using data published in the Statistics South Africa GDP survey P0441, Fourth quarter 2021 (Stats SA 2021).

**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).

**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, nanomaterials, nanocomposites and nanotechnology.

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

**Research and experimental development (R&D)** comprises creative and systematic work undertaken 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** include 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.[2]

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

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

**State-owned enterprises (SOEs)** are public corporations owned by government units mainly engaged in market production and sale of the kind of goods and services often produced by private enterprises.

**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 2022), 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%.

[2] Prior to 2016/17, emeritus professors, honorary fellows and research fellows were not required to be explicitly included in the estimates of R&D personnel.

Produced by the Centre for Science, Technology and Innovation Indicators (CeSTII)

First published: December 2024

Recommended citation: Centre for Science, Technology and Innovation Indicators (CeSTII). (2024). Funding R&D in a De-industrialising South Africa. In: *Boosting R&D Funding in South Africa in the Context of Reindustrialisation.* Pretoria: Human Sciences Research Council (HSRC).

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# ACKNOWLEDGEMENTS

The editors and authors wish to extend their sincere gratitude to the three local and international experts who served as external reviewers—Dr Petrus Letaba, Dr Alexis Habiyaremye, and Dr Andrew Hansen-Addy—and to our internal reviewer, Dr Glenda Kruss, CeSTII Executive Head. Their invaluable expertise and insightful feedback have significantly enriched the quality and depth of this work.

Design and layout: Tracey Watson.
Copy editing: Katharine McKenzie
Publication advice: Katharine McKenzie, Gerard Ralphs

**Companion publications**

- Centre for Science, Technology and Innovation Indicators (CeSTII). (2024). *South African National Survey of Research and Experimental Development: Statistical Report 2021/22.* Pretoria: Human Sciences Research Council (HSRC).
- Centre for Science, Technology and Innovation Indicators (CeSTII). (2024). *Main Trends in South African R&D 2021/22.* Pretoria: Human Sciences Research Council (HSRC).

Science, Technology and Innovation Statistics South Africa

HSRC Human Sciences Research Council

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