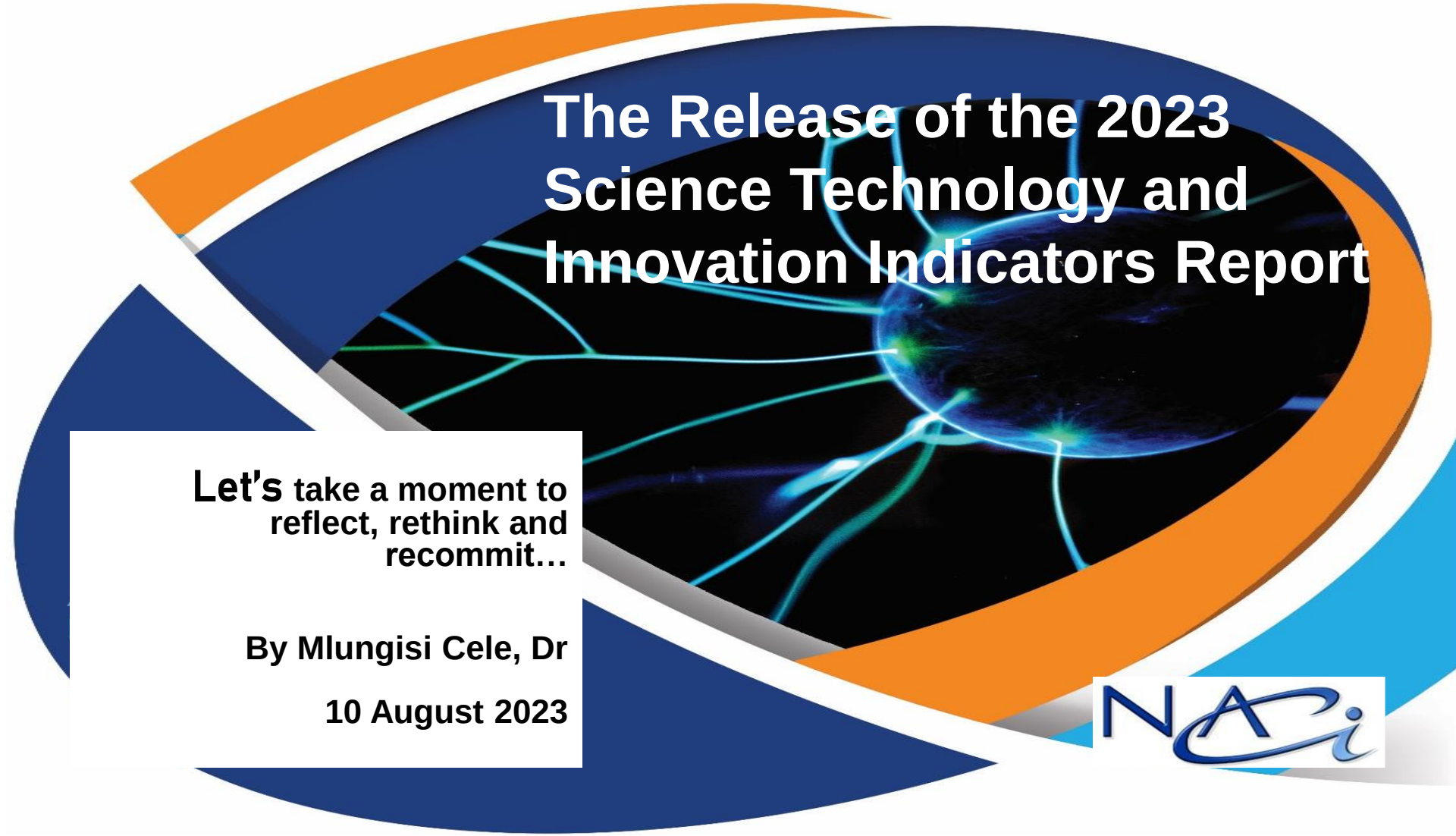
The Release of the 2023 Science Technology and Innovation Indicators Report



Let's take a moment to reflect, rethink and recommit…

By Mlungisi Cele, Dr

10 August 2023

LEGISLATIVE MANDATE

NATIONAL ADVISORY COUNCIL ON INNOVATION

Section 3 of the NACI Act (Act 55 of 1997)

"…advise the Minister for Science and Technology, and through the Minister, the Minister's Committee and Cabinet, on the role and contribution of science, mathematics, innovation and technology, including indigenous technologies, in promoting and achieving national objectives"

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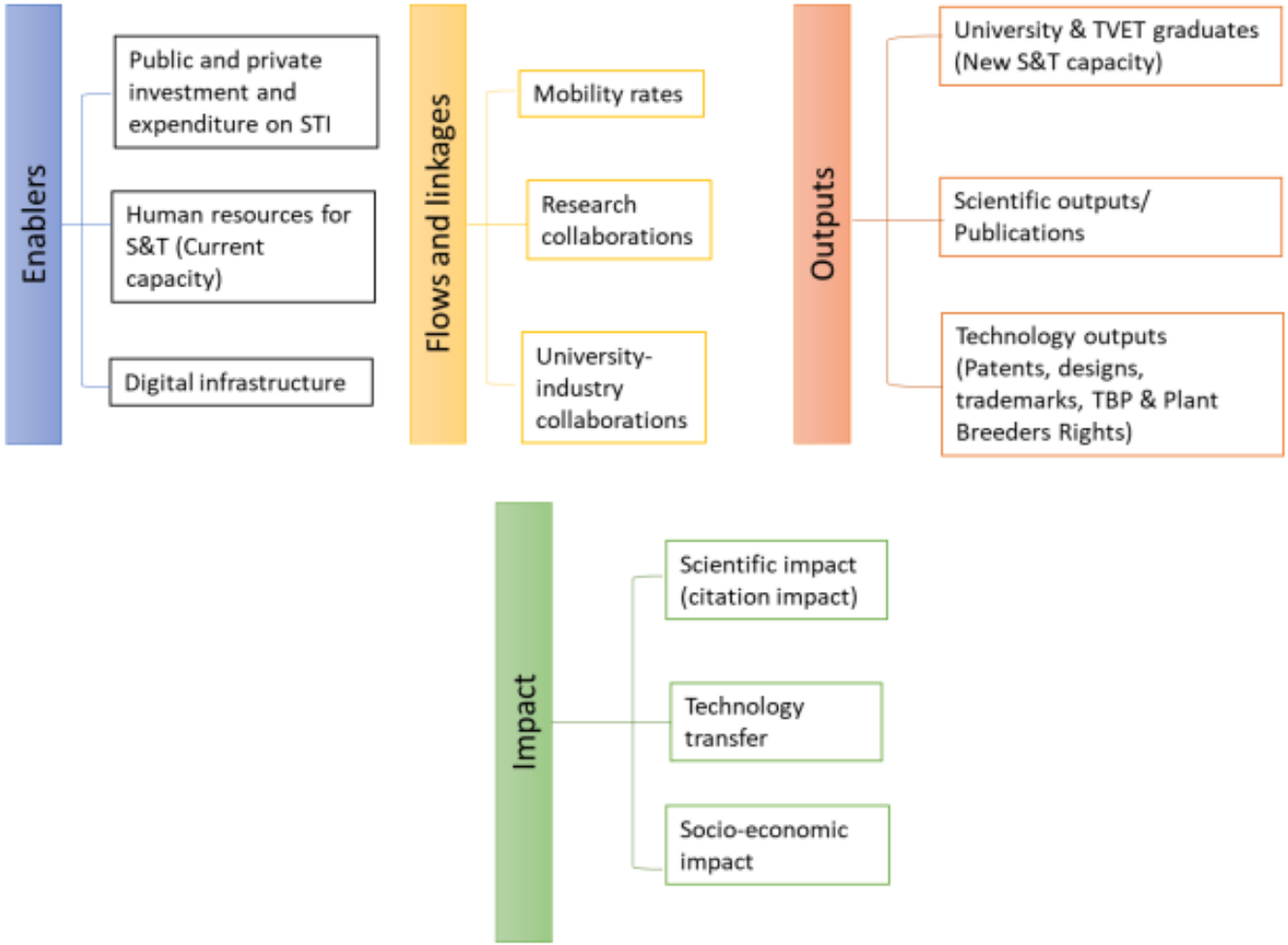
Context of the STI Indicators Report

- Socioeconomic crisis-deepening high-levels of poverty, unemployment and inequality with youth and women at the receiving end.
- Climate change.
- Energy-water-food nexus challenge.
- Geopolitical crisis-Russian and Ukraine conflict.
- The effects and post-COVID-19 era.
- The 2019 White Paper and 2020 Decadal Plan for STI herald hope, promise and inspire a new sense of optimism.

Key issues

- Human resources for STI and expansion of research capacity
  - Pipeline
  - Academic qualifications
  - Staff-student ratio
- Investment and financing of the NSI
  - GERD and BERD
  - Business R&D funding to science councils and HEIs
  - Funding of main research fields-marine sciences, earth
  - Investment in relevant areas, health (hiv, TB and Malaria), Environmental Sciences and Bioeconomy
  - Investment in postgraduate students decline
- Knowledge production and exploitation
  - Publications
  - Areas of specialisation-health, climate change/environmental, bioeconomy/biotechnology
- Outcomes and impacts
  - Employment
  - Social
  - Economic

Framing of the Report



STI ENABLERS: Human resources for STI and investment

Human resources for STI and Research Capacity

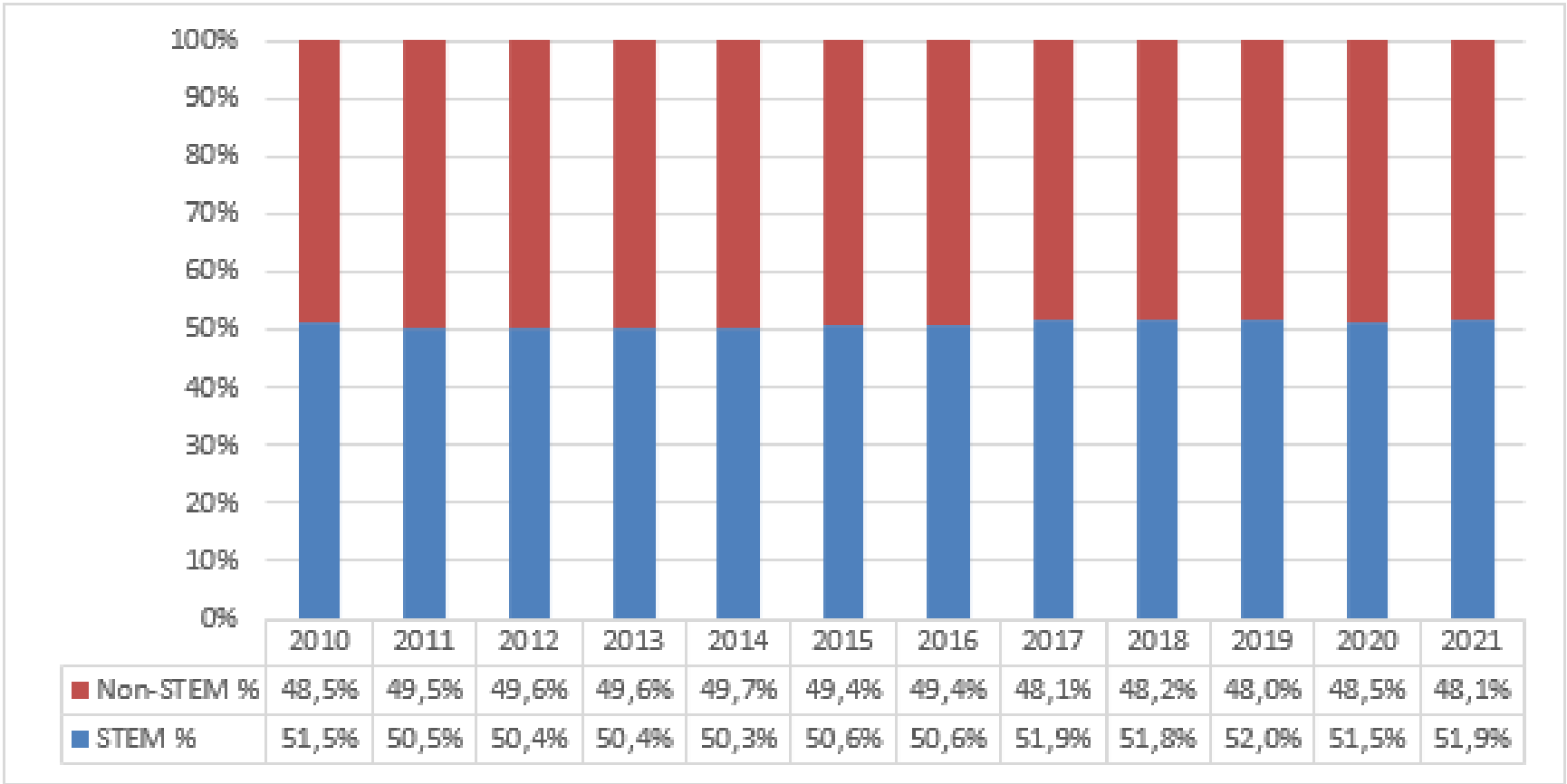
Proportion of permanent academic female professors to total professors by race

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	%									
African female	2,31	2,85	3,39	4,12	4,53	5,10	5,78	6,06	6,18	6,63
Coloured female	1,27	1,44	1,57	1,62	1,82	1,75	1,85	1,98	2,17	2,05
Indian female	1,94	2,03	2,04	2,02	2,13	2,35	2,59	2,68	3,09	3,22
White female	23,31	23,10	23,23	23,50	23,64	23,80	24,20	24,31	24,75	24,99
Other female	0,26	0,15	0,22	0,38	0,36	0,41	0,54	0,54	0,55	0,62

Source: NRF Information Portal

Table highlights a demographic imbalance amongst professors in South African public universities, despite an increase in the percentage of African and female permanent academic staff. In 2020, female professors made up 37.51% of all permanent professors including associate professors, up from 27.82% in 2011. White female professors are currently the majority followed by African female professors. However, there is an increasing upward trend in the number of permanent female professors for all races.

% STEM and NON-STEM Staff



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Non-STEM %	48,5%	49,5%	49,6%	49,6%	49,7%	49,4%	49,4%	48,1%	48,2%	48,0%	48,5%	48,1%
STEM %	51,5%	50,5%	50,4%	50,4%	50,3%	50,6%	50,6%	51,9%	51,8%	52,0%	51,5%	51,9%

- In 2010, staff in the STEM fields constituted 51,5% of all staff and by 2021 this percentage was 51,9%

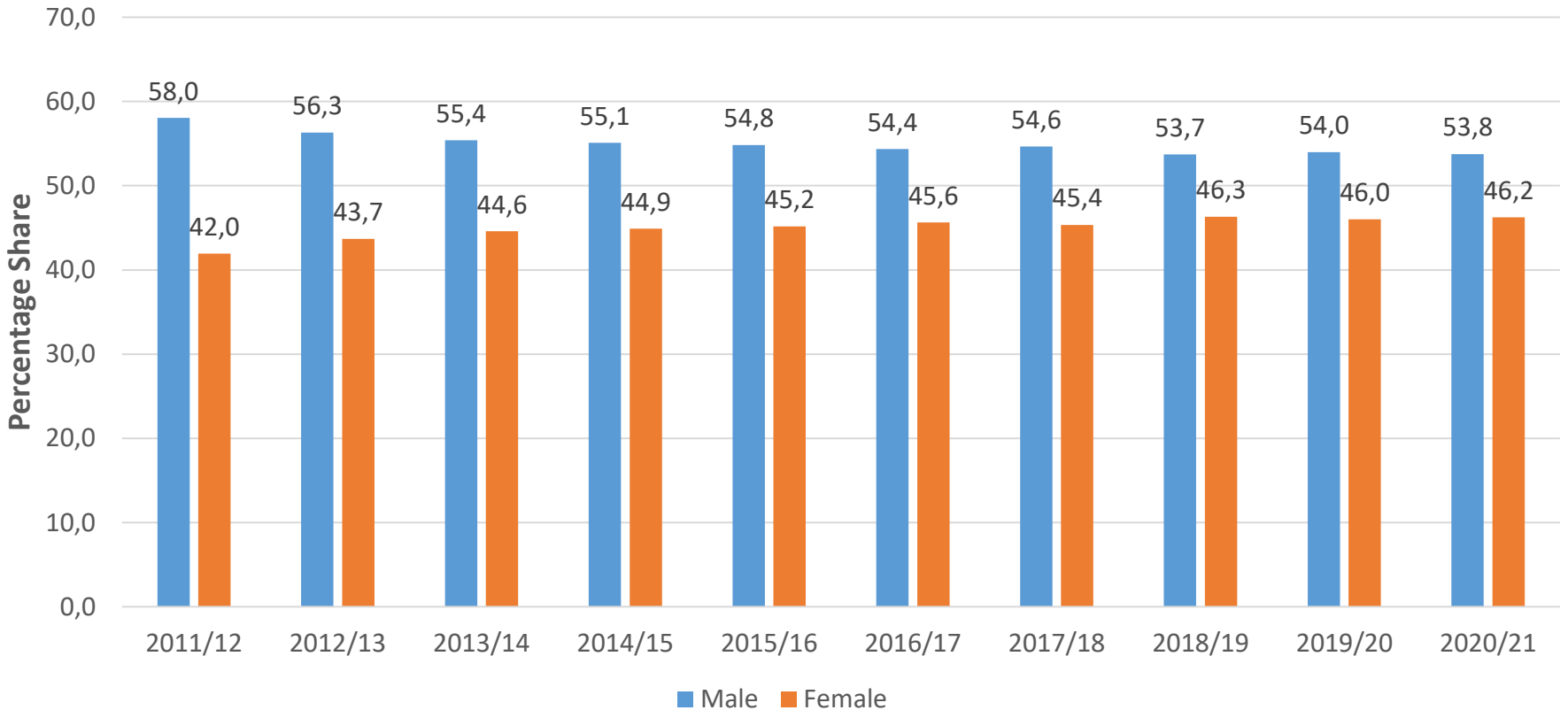
Share of academic staff with doctorate qualifications

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	% Share of academic staff with doctorate qualification									
20 – 29	**7,9**	**7,9**	**7,8**	**7,6**	**7,3**	**7,4**	**7,0**	**6,5**	**6,2**	**5,8**
Male	3,2	3,3	3,3	3,2	3,1	3,3	3,1	2,9	2,8	2,6
Female	4,7	4,6	4,5	4,4	4,2	4,1	3,9	3,6	3,4	3,2
30 – 39	**27,1**	**26,7**	**26,2**	**26,2**	**26,5**	**26,5**	**27,0**	**27,3**	**27,5**	**27,7**
Male	13,8	13,5	13,3	13,2	13,1	12,9	12,9	13,0	13,1	13,3
Female	13,3	13,1	12,9	13,0	13,4	13,6	14,2	14,3	14,4	14,4
40 – 49	**30,3**	**30,5**	**30,7**	**30,6**	**30,6**	**30,7**	**30,3**	**30,2**	**29,9**	**29,8**
Male	16,8	16,9	16,9	16,7	16,3	16,3	16,0	15,7	15,5	15,1
Female	13,6	13,6	13,9	13,9	14,3	14,3	14,3	14,5	14,5	14,6
50 – 59	**27,3**	**27,1**	**26,9**	**27,0**	**26,5**	**26,3**	**26,2**	**26,4**	**26,5**	**26,3**
Male	16,3	16,0	15,7	15,5	15,0	14,7	14,6	14,6	14,6	14,3
Female	11,0	11,1	11,2	11,5	11,5	11,5	11,6	11,7	11,9	12,0
60+	**7,3**	**7,8**	**8,3**	**8,6**	**9,0**	**9,1**	**9,5**	**9,6**	**10,0**	**10,4**
Male	5,2	5,5	5,7	5,8	5,9	5,9	5,9	5,9	5,9	6,2
Female	2,1	2,3	2,7	2,7	3,1	3,2	3,6	3,7	4,1	4,2

Source: NRF Information Portal

The proportion of academic staff aged over 60 has been constantly increasing, while the percentage of staff aged between 20 to 29 has decreased significantly from 7.9% in 2011 to 5.8% in 2020, regardless of gender. Although the number of staff between 30 to 39 has increased, the growth rate is less than that of staff aged over 60. Therefore, there is a need to improve programs such as the New Generation of Academics Programme that provide support to young academic staff.

Researchers by gender



Source: HSRC and DST "National Survey of Research & Experimental Development"

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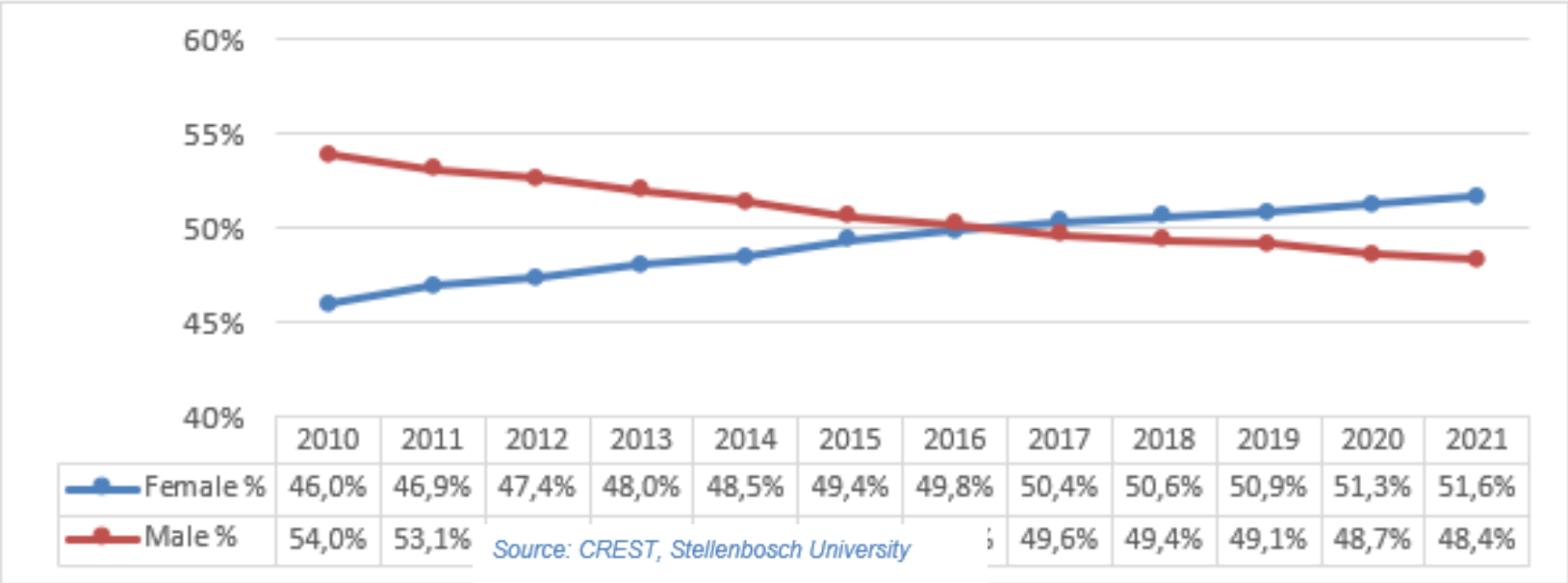
Academic staff by gender

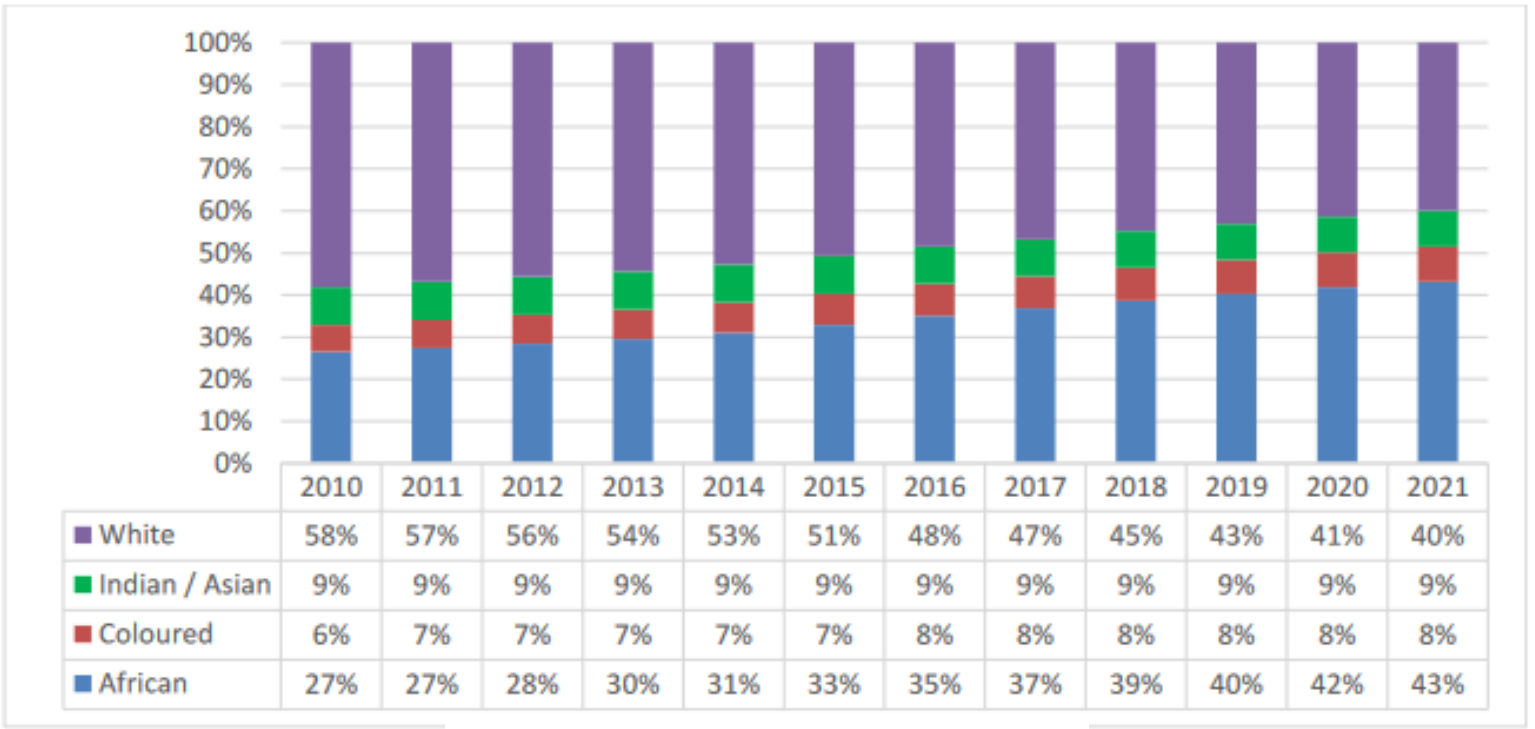


	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Female %	46,0%	46,9%	47,4%	48,0%	48,5%	49,4%	49,8%	50,4%	50,6%	50,9%	51,3%	51,6%
Male %	54,0%	53,1%						49,6%	49,4%	49,1%	48,7%	48,4%

Source: CREST, Stellenbosch University

The DHET launched the Staffing South Africa's Universities Framework in 2015 to improve the quality of future academics and staff capacity. The initiative has various programs, such as the New Generation of Academics Programme, Nurturing Emerging Scholars Programme, and Existing Academic Capacity Enhancement Programme. According to the figure, the gender gap between male and female researchers has gradually decreased, indicating a promising development towards near-gender parity.

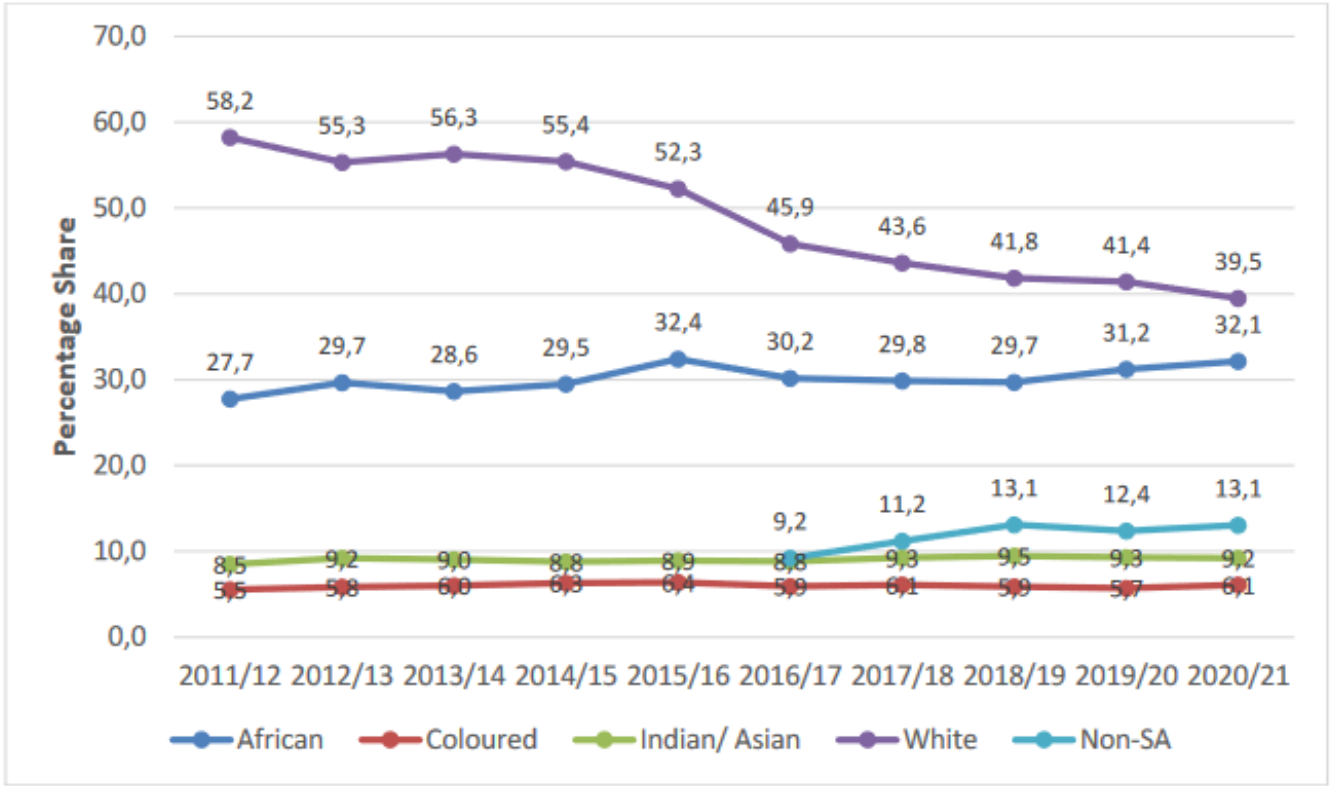
Proportion of permanent academic staff by race



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
White	58%	57%	56%	54%	53%	51%	48%	47%	45%	43%	41%	40%
Indian / Asian	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%
Coloured	6%	7%	7%	7%	7%	7%	8%	8%	8%	8%	8%	8%
African	27%	27%	28%	30%	31%	33%	35%	37%	39%	40%	42%	43%

Source: NRF Information Portal

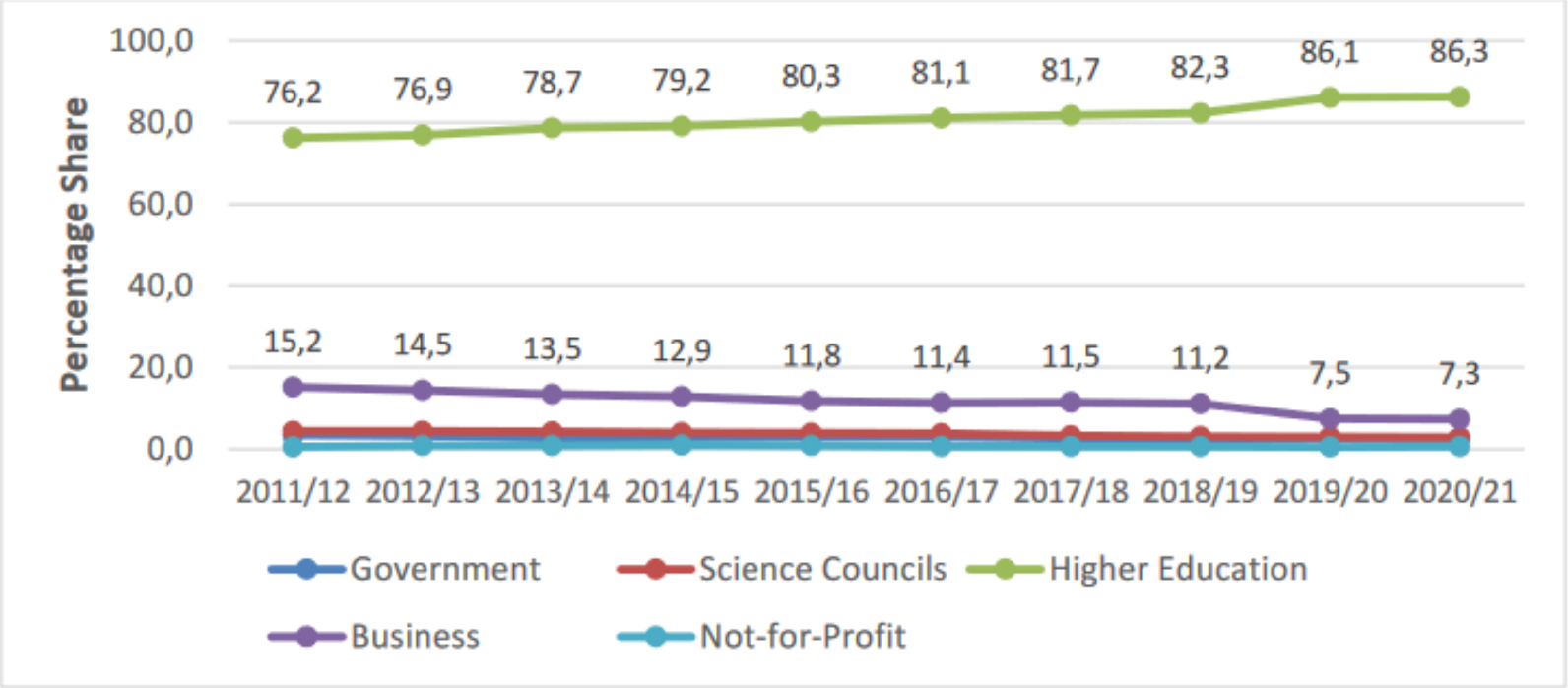
Researchers by race



Source: HSRC and DSI 2020/21 National Survey on Research and Experimental Development

The researchers' profile is progressively transforming, as indicated by an increase in proportion of the designated groups.

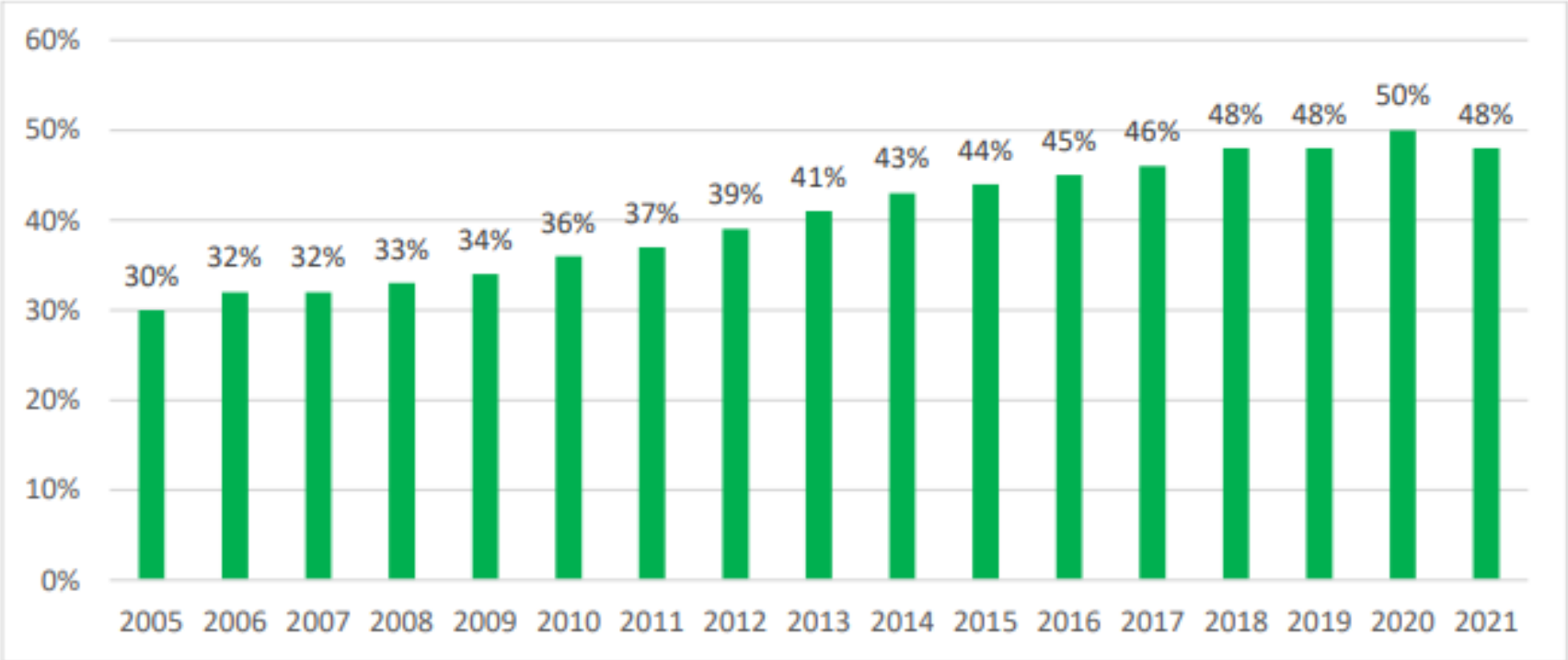
Researchers by employment sector



Source: HSRC and DSI 2020/21 National Survey on Research and Experimental Development

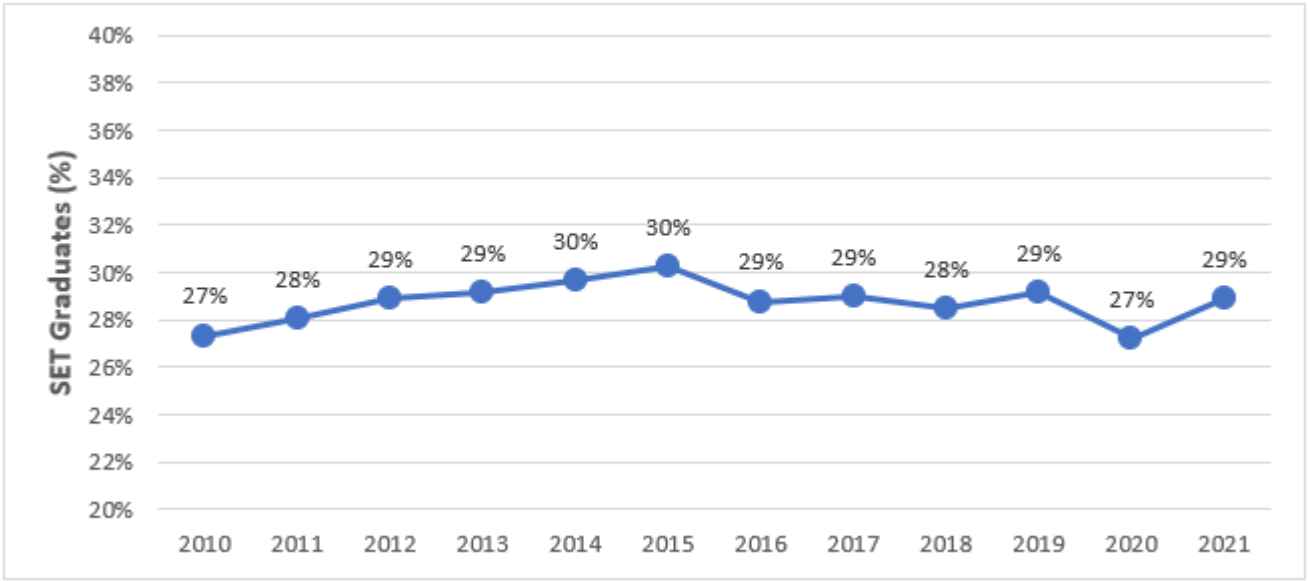
- Most South African researchers are based in the higher education sector (86,3% in 2020/21).
- The business sector's share of total researchers in the country reduced from 15,2% in 2011/12 to 7,3% in 2020/21
- science councils experiencing a decline in the number of researchers since 2017/18, falling from 3.9% to 2.9% in 2020/21

Percentage staff with doctoral qualifications



The target of having 75% of academic staff achieve a doctoral qualification by 2030 is unlikely to be achieved as less than half of academic staff had a doctorate in 2021

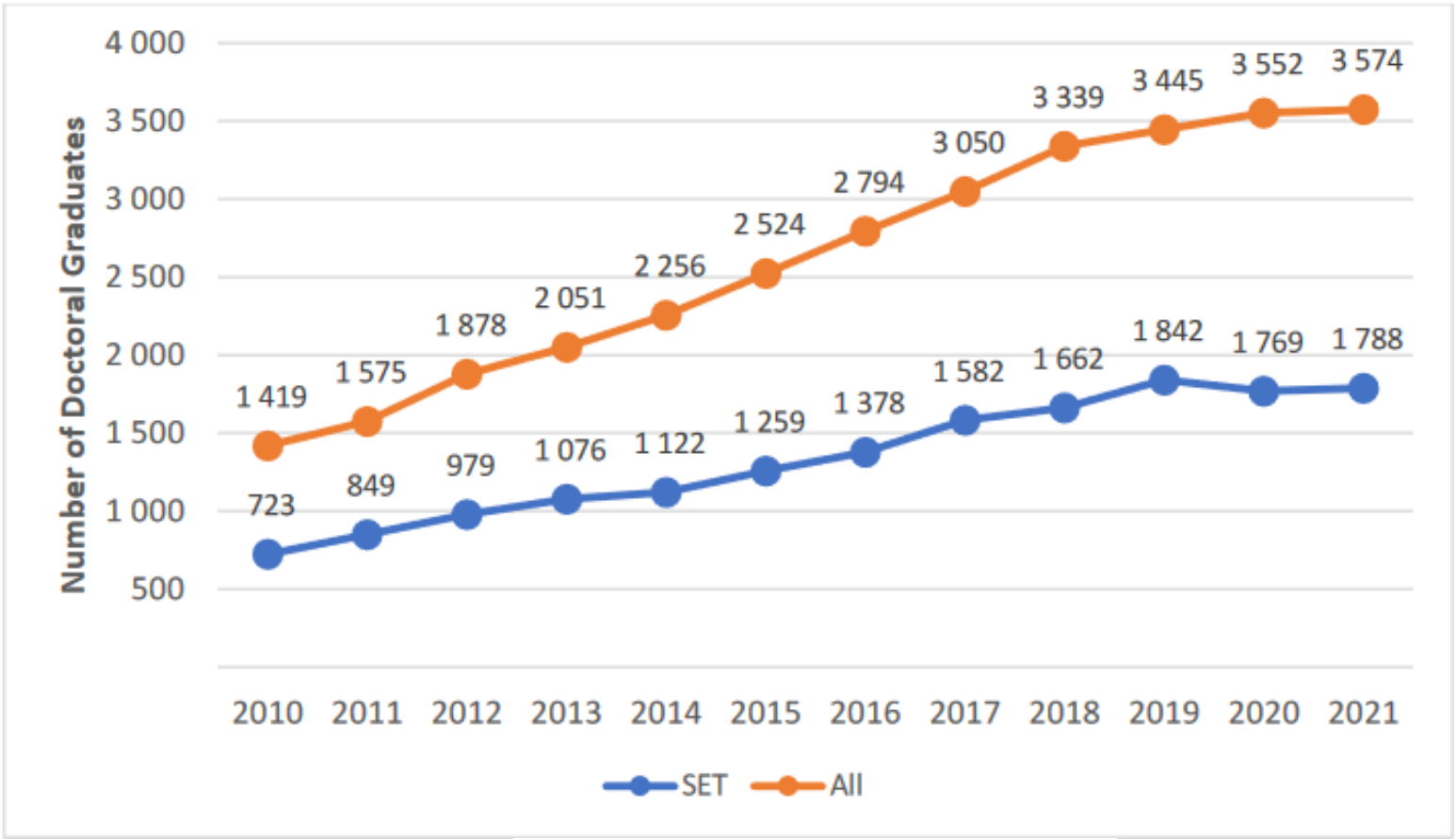
SET graduates as a percentage of all graduates in South African public universities



Source: CREST, Stellenbosch University

The goal of increasing the number of SET graduates has been mentioned in national policy documents since 1994. Nevertheless, the country still lacks sufficient SET skills for the economy. The percentage of SET graduates has remained the same as it was in 2012.

Number of doctoral graduates



Source: CREST, Stellenbosch University

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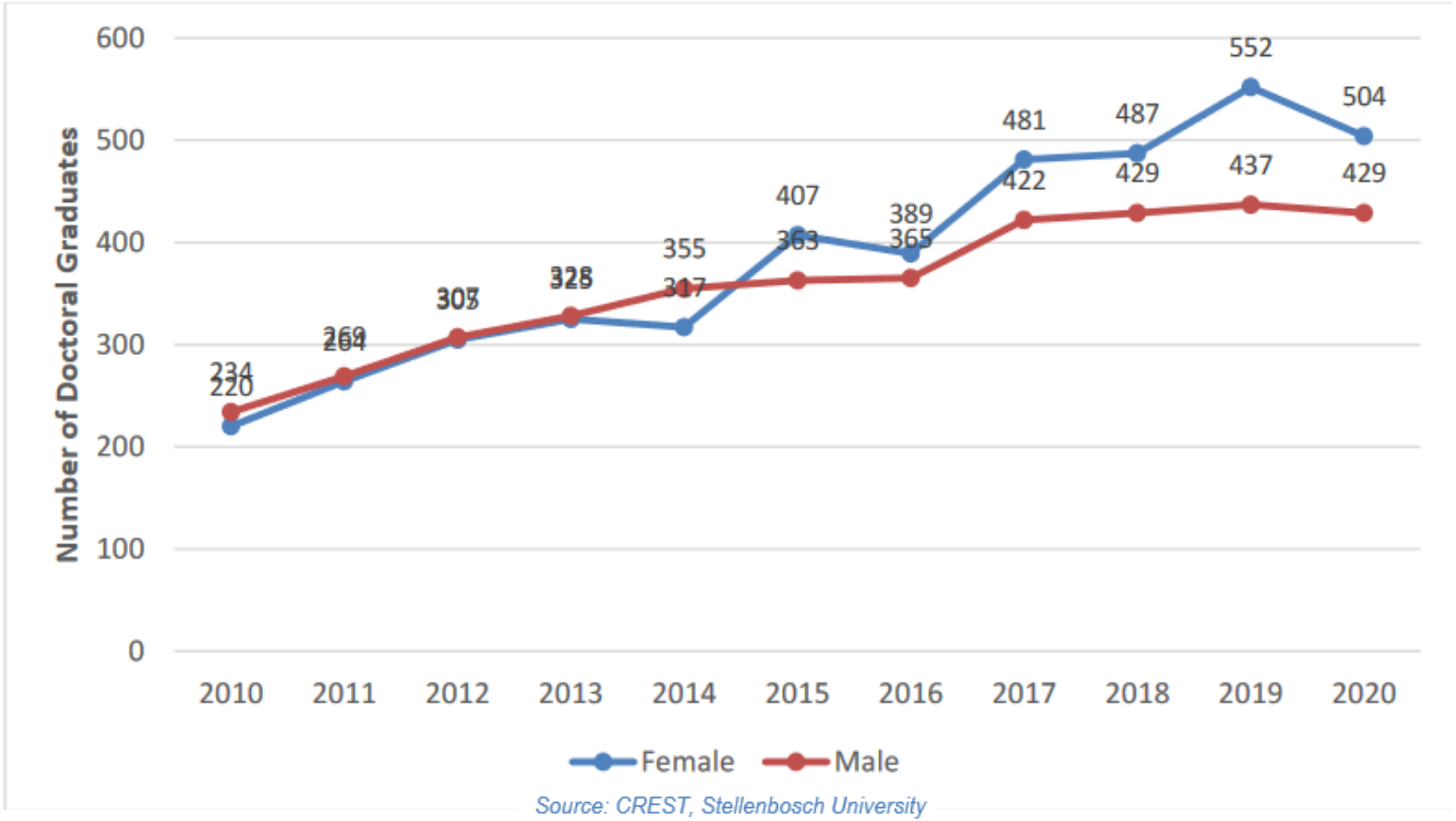
Number of doctoral graduates by gender



Source: CREST, Stellenbosch University

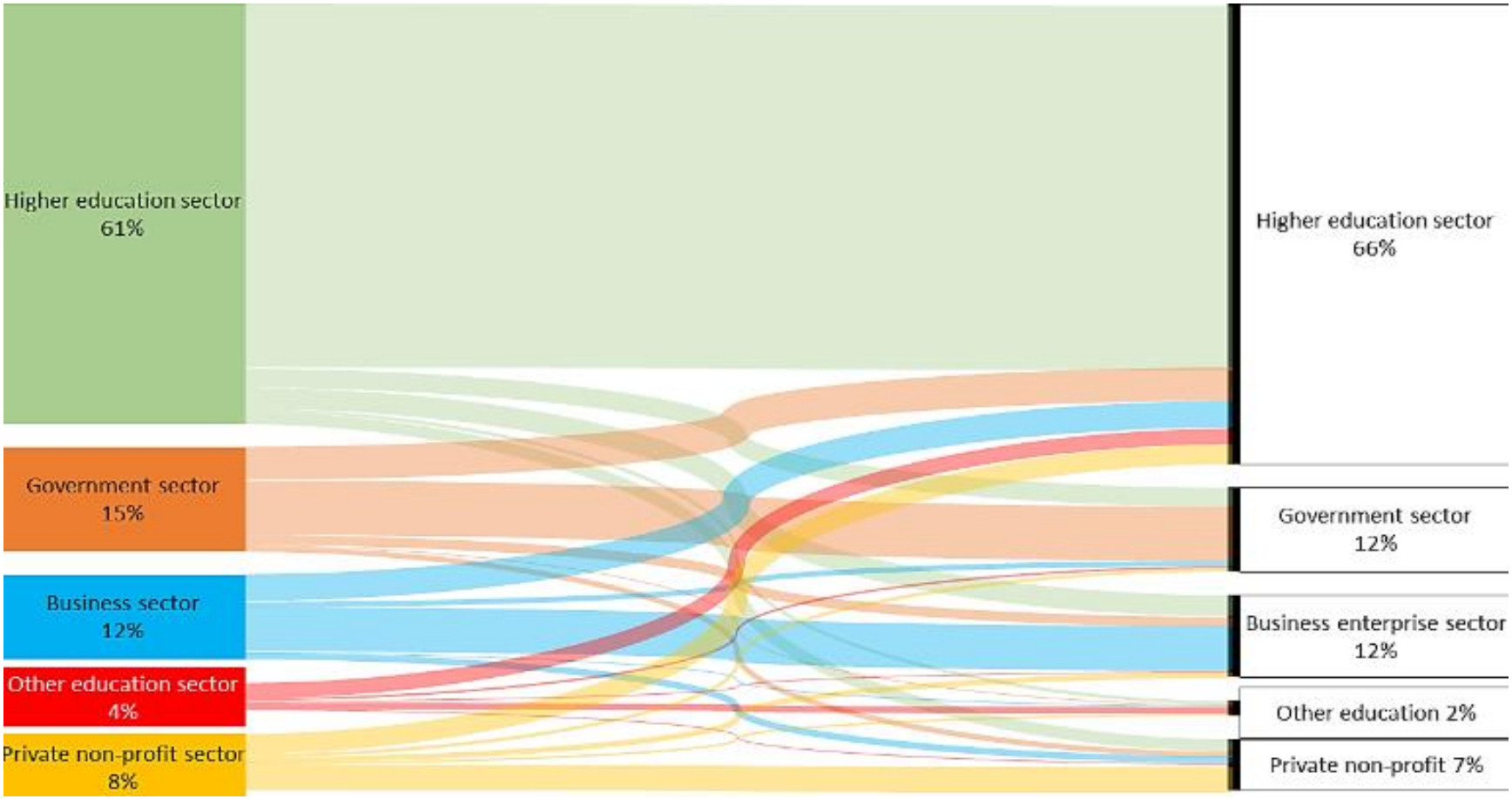
Doctoral graduates in STEM by race

	African		Coloured		Indian/Asian		White		Total
	N	%	N	%	N	%	N	%	
2010	79	17%	29	6%	38	8%	307	68%	453
2011	85	16%	32	6%	55	10%	358	68%	530
2012	126	21%	38	6%	54	9%	393	64%	611
2013	142	22%	45	7%	59	9%	405	62%	651
2014	175	26%	43	6%	58	9%	393	59%	669
2015	190	25%	51	7%	91	12%	432	57%	764
2016	214	28%	47	6%	97	13%	394	52%	752
2017	273	31%	54	6%	84	9%	484	54%	895
2018	326	36%	49	5%	97	11%	436	48%	908
2019	362	37%	61	6%	77	8%	483	49%	983
2020	358	39%	45	5%	88	10%	433	47%	924
Total	**2 330**	**29%**	**494**	**6%**	**798**	**10%**	**4 518**	**56%**	**8 140**

Source: CREST, Stellenbosch University

There has been a positive development in the STEM field with an increase in the number of black doctoral graduates. The share of black doctoral students in STEM fields rose from one-third in 2010 to 44% in 2020

Mobility of doctoral graduates



Source: CREST, Stellenbosch University

Figure illustrates the differences between the graduates' sectors of employment at the time of the research and their sector of employment at the time of their doctoral studies.

Mobility between sectors of employment (from time of doing doctoral studies to current employment)

Sector of employment during PhD	Sector of current employment									
	Higher education		Government/ public		Business enterprise		Other education		Private non-profit	
	Number	%	Number	%	Number	%	Number	%	Number	%
Higher education	2 185	86,3%	113	4,0%	129	5,1%	20	0,8%	74	2,9%
Government/ public	199	33,5%	325	54,7%	62	10,4%	6	1,0%	35	5,9%
Business	162	35,0%	36	7,8%	268	57,9%	8	1,7%	37	8,0%
Other education	94	54,0%	12	6,9%	9	5,2%	43	24,7%	8	4,6%
Private non-profit	122	39,0%	21	6,7%	30	9,6%	13	4,2%	153	48,9%

Source: CREST, Stellenbosch University

Geographic mobility of SA Graduates

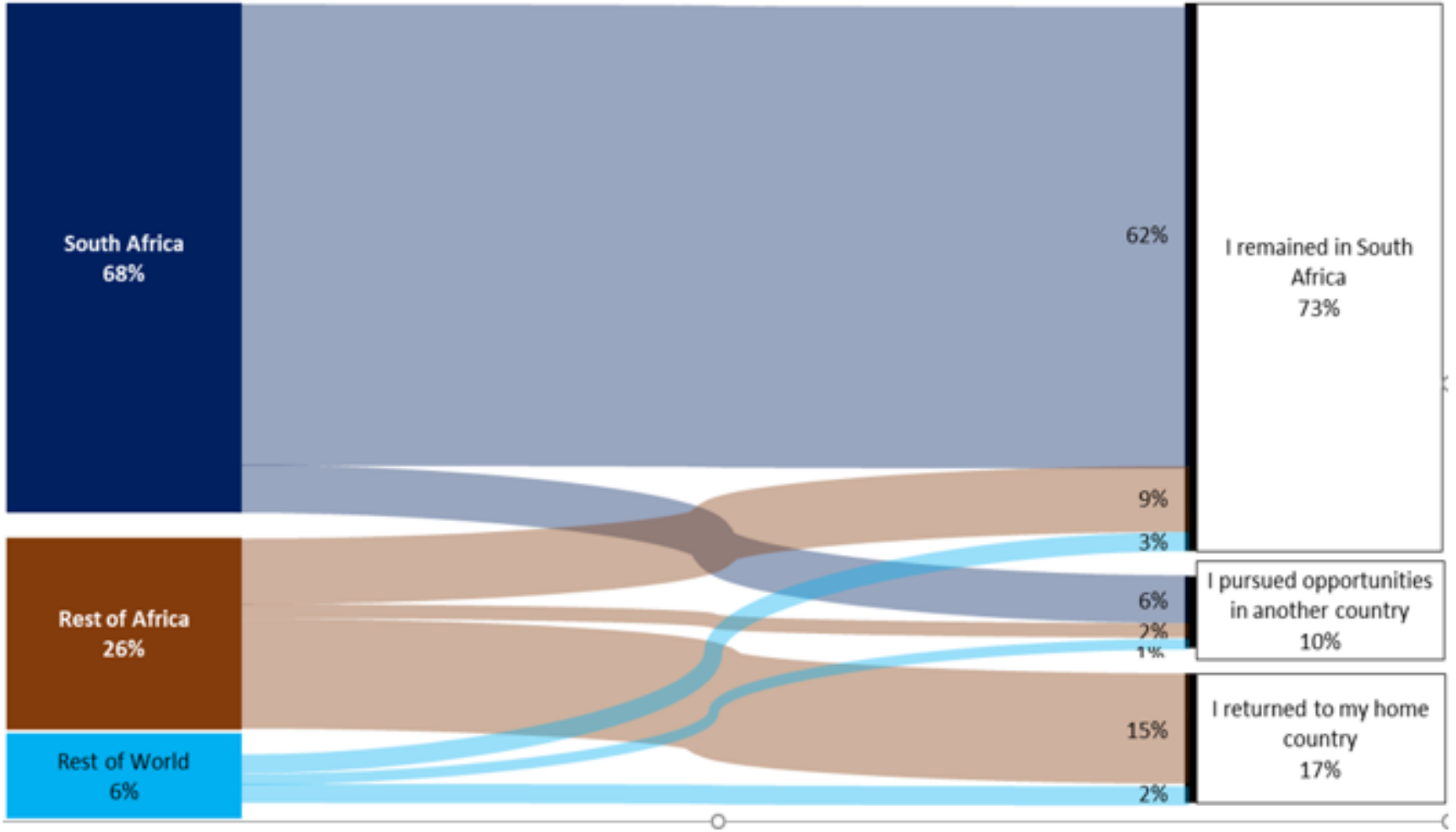


Figure provides a visual representation of the geographic mobility of doctoral graduates within the first year after completing their studies, categorized by their nationality during doctoral studies.

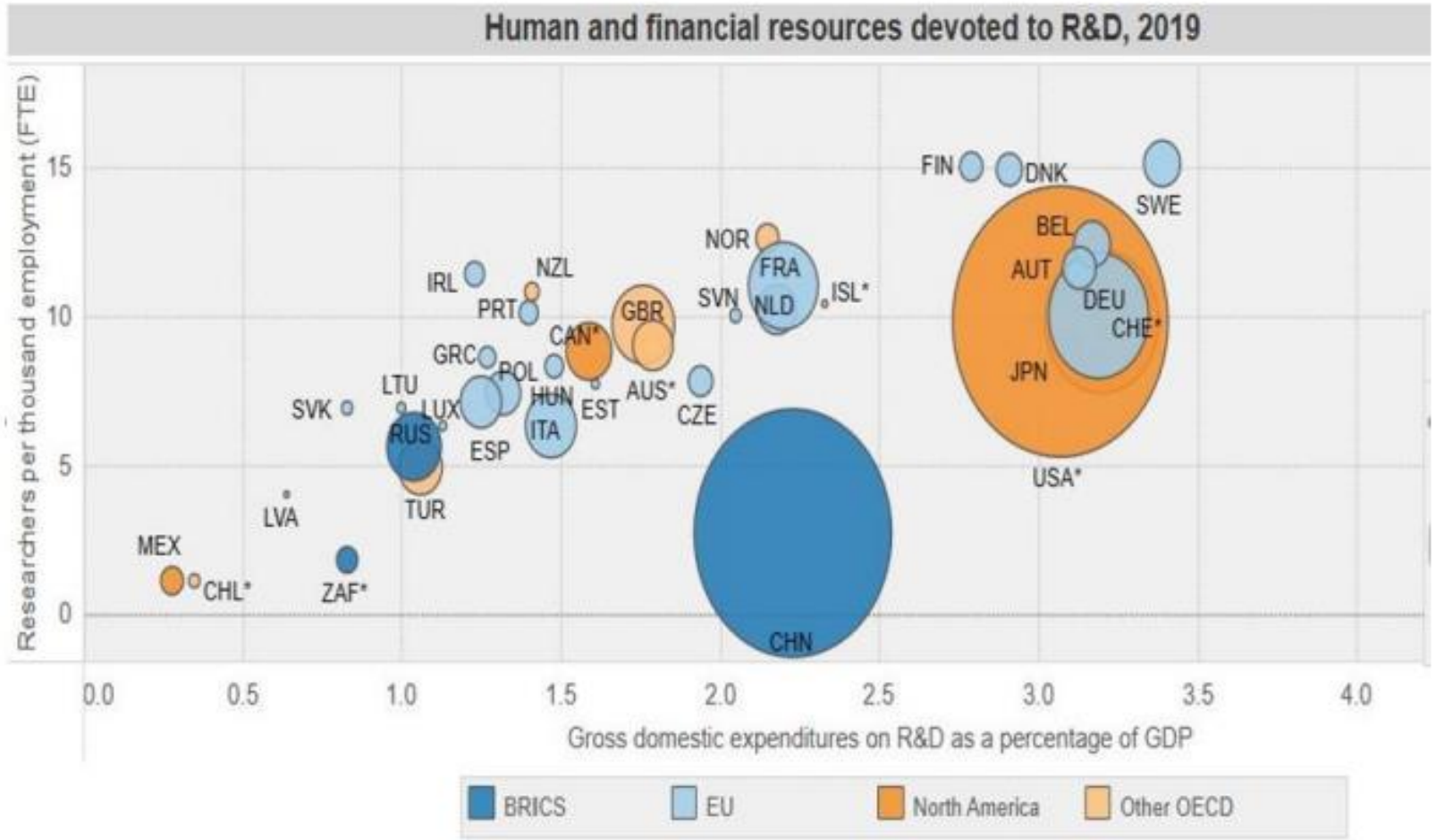
What is to be done?

Due to the challenge of replacing permanent academics who remain in their positions for an average of 40 years, South African universities ("large tankers") are seen as difficult to change course. Consequently, the percentage of staff in STEM fields has not changed significantly. To change this trend, a comprehensive organizational redesign to establish more medical schools, engineering faculties, and larger science faculties must occur. The establishment of the Oliver Tambo University of Science and Technology in Johannesburg is an example of this needed intervention.

Also, New Generation of Academics Programme, Nurturing Emerging Scholars Programme, and Existing Academic Capacity Enhancement Programme need to be upscaled.

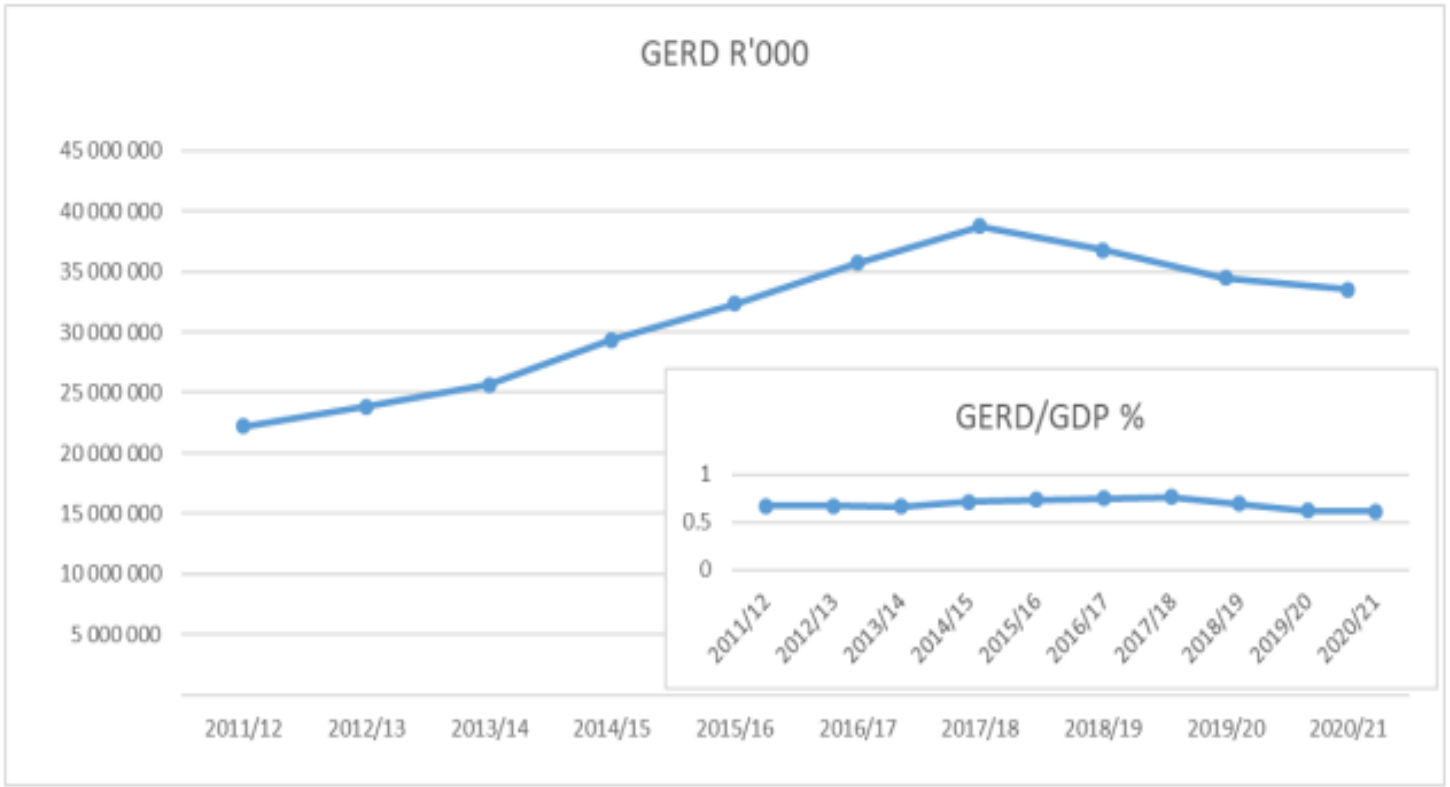
Investment and financing of NSI

R&D investment across the world



Source: OECD, 2020 Research and Development Statistics

Domestic investment in R&D



Source: HSRC and DSI, 2020/21 National Survey of Research and Experimental Development

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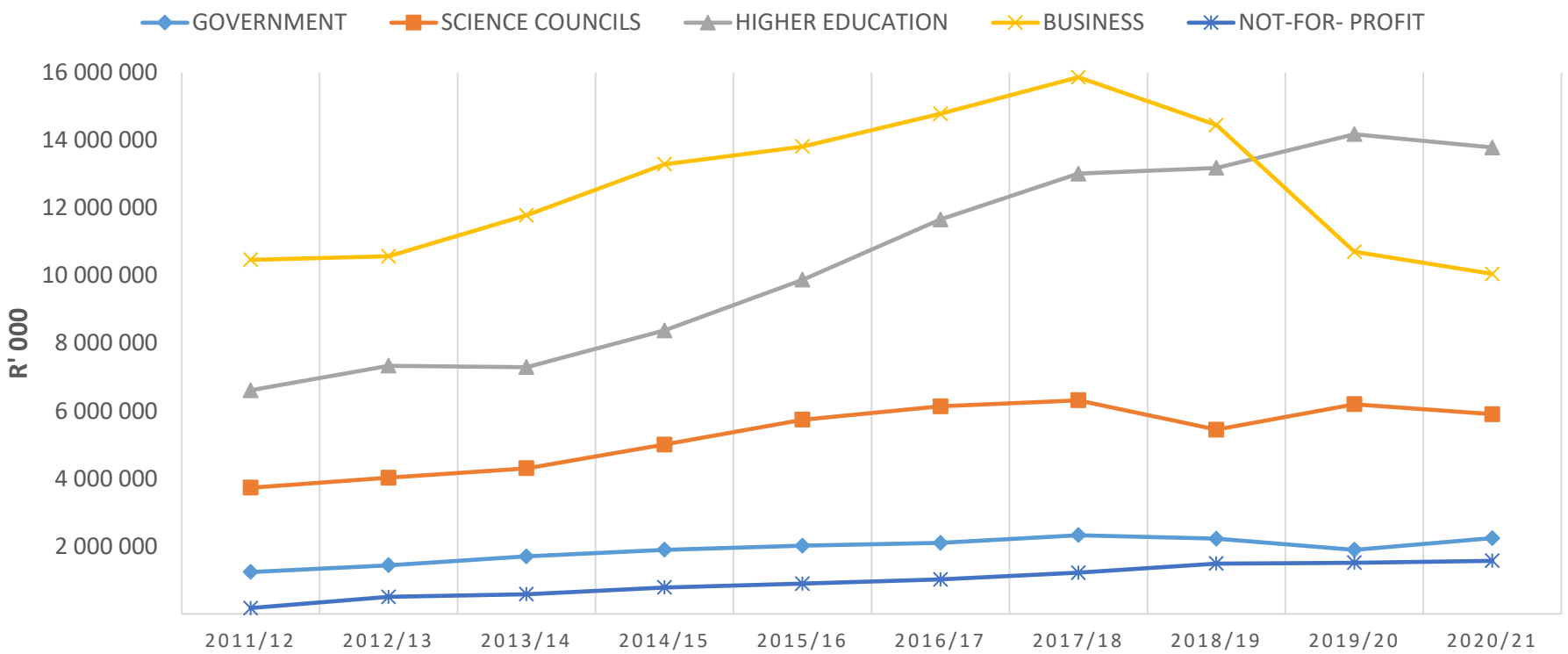
R&D expenditure by sector



Source: HSRC and DST "National Survey of Research & Experimental Development"

- BERD on a downward spiral.
- HERD on the steady increase.

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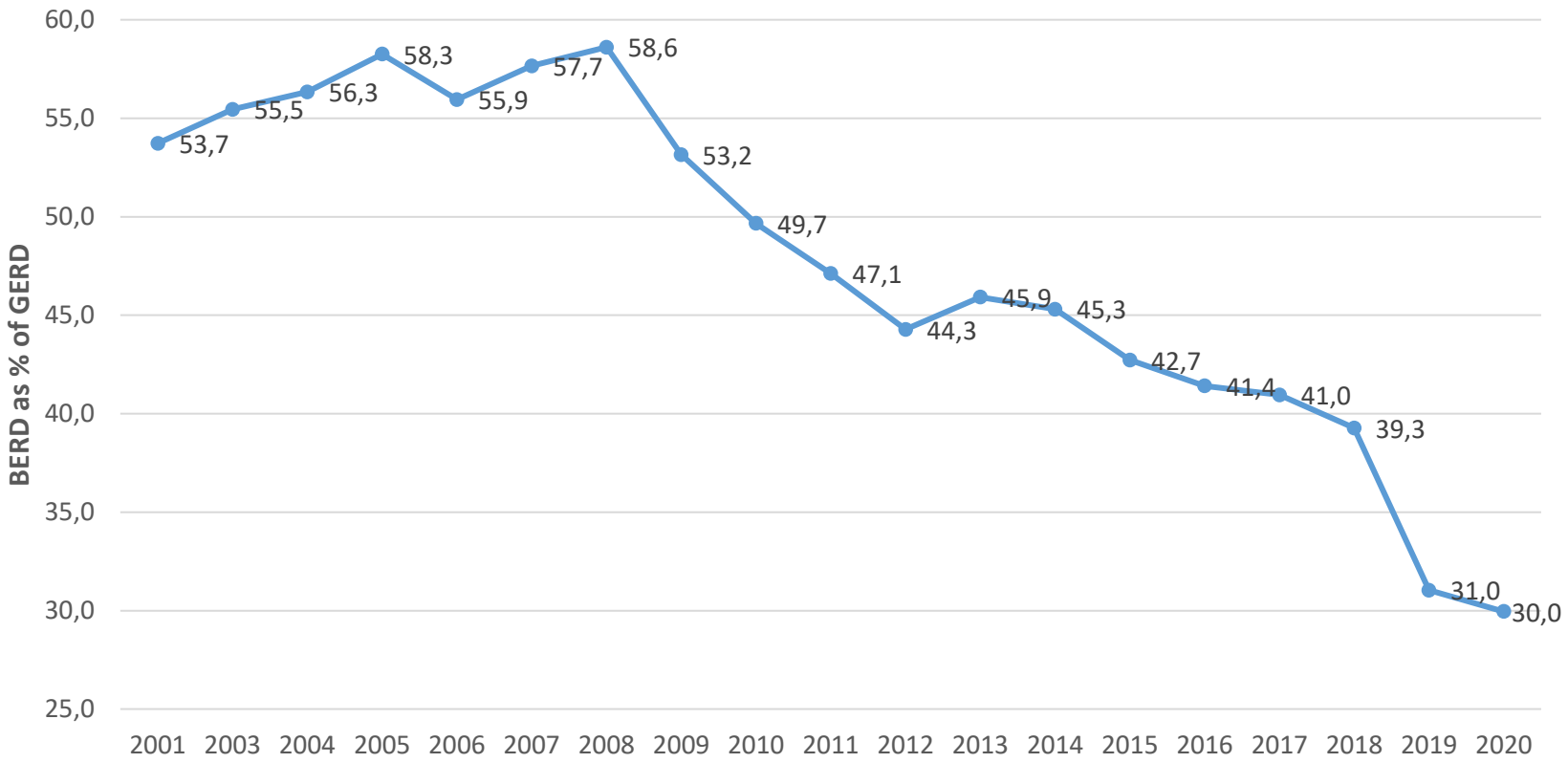
BERD decline

- Business used to be a major contributor prior to a global economic recession



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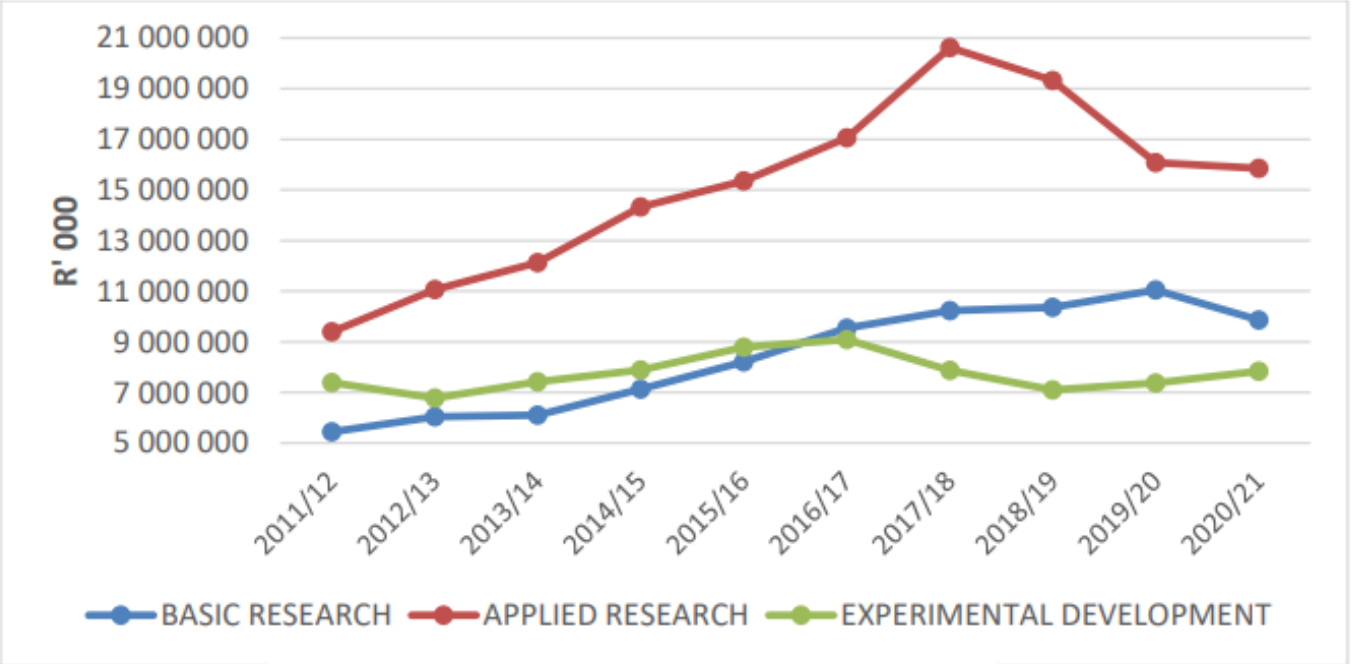
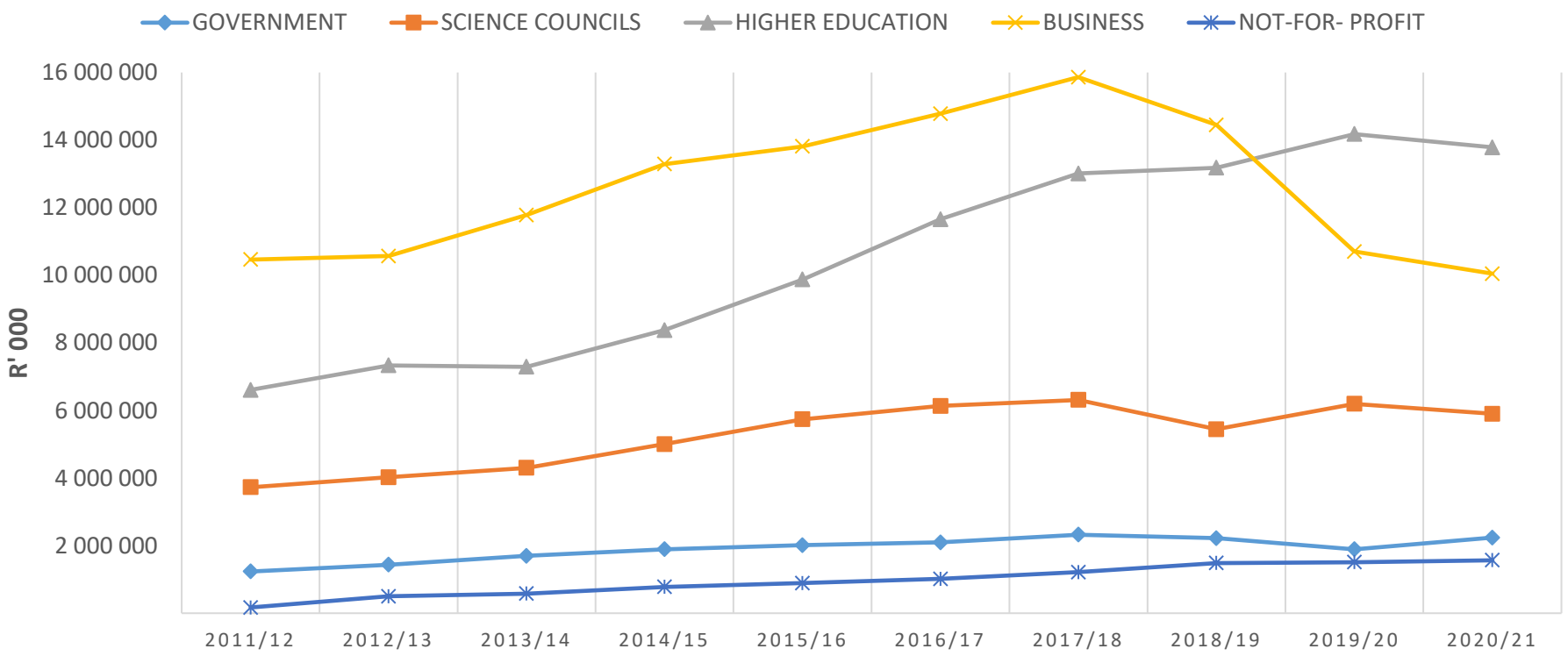
Expenditure by research type



Source: HSRC and DSI 2020/21 National Survey of Research and Experimental Development

Applied research has consistently been the largest recipient of expenditures, its share increased to until 2017/18

R&D expenditure by sector



Source: HSRC and DST "National Survey of Research & Experimental Development"

- BERD has been declining
- R&D expenditure increase in higher education over the entire decade

Business funded R&D by sector

Year	Total	Government	Science councils	Higher education	Business	Non-profit
Constant 2015 Rand values (R' 000)						
2011/12	10 675 007	1 670	83 317	622 909	9 927 581	39 531
2012/13	10 772 761	13 538	159 765	679 801	9 890 302	29 302
2013/14	11 805 910	1 956	466 490	654 578	10 623 546	59 340
2014/15	12 646 438	306	235 253	934 373	11 409 923	66 582
2015/16	12 576 499	41 109	326 648	770 448	11 384710	55 585
2016/17	13 132 872	1 178	451 759	847 716	11 767978	64 239
2017/18	14 242 899	460	314 540	602 417	13 264 539	60 492
2018/19	12 393 817	3 935	176 217	385 170	11 757 152	61 343
2019/20	7 636 368	34 815	156 285	424 208	6 970 281	51 381
2020/21	7 002 702	0	240 322	423 485	6 273 979	58 915

Source: Data Supplied by CeSTII, Human Sciences Research Council

- The business sector in South Africa primarily funds R&D in higher education and science councils, but there have been significant declines in funding for both sectors since 2016/17
- There was an 8% increase in business-sector funding of R&D in science councils in 2020/21

Funding of main research fields

Main research field	2011/12 R'000	2020/21 R'000	Changes (%)
Division 1: Natural sciences, technology	**18 924 485**	**25 894 833**	36,8
Mathematical sciences	636 153	799 796	25,7
Physical sciences	338 098	911 291	169,5
Chemical sciences	1 273 588	1 127 071	-11,5
Earth sciences	409 212	1 061 388	159,4
Information. computer and communication technologies	2 852 251	3 640 785	27,6
Applied sciences and technologies	2 114 322	1 367 857	-35,3
Engineering sciences	3 775 247	4 332 003	14,7
Biological sciences	1 350 716	1 530 697	13,3
Agricultural sciences	1 710 860	2 654 666	55,2
Medical and health sciences	3 819 180	7 404 019	93,9
Environmental sciences	439 719	440 186	0,1
Material sciences	166 411	328 498	97,4
Marine sciences	38 726	296 576	665,8
Division 2: Social sciences and humanities	**3 284 707**	**7 646 499**	132,8
Social sciences	2 790 339	6 597 460	136,4
Humanities	494 368	1 049 039	112,2
Total	**22 209 192**	**33 541 332**	51,0

Table displays changes in funding for the main research fields in South Africa from 2011/12 to 2020/21, with marine sciences exhibiting the highest growth but starting from a small base, and earth sciences, social sciences, and humanities showing growth above 100%. However, investments in applied sciences and technologies, as well as chemical sciences, declined during the same period.

Foreign funded R&D in the business sector

Years (R'000)	Constant 2015 Rand values (R'000)
2011/12	1 925 097
2012/13	1 400 577
2013/14	1 364 505
2014/15	1 497 504
2015/16	1 532 766
2016/17	1 251 645
2017/18	420 866
2018/19	341 490
2019/20	953 652
2020/21	758 296

- Foreign funding for R&D in the South African business sector has significantly declined since 2015/16, with particularly large drops in 2017/18 and 2018/19. There was a significant increase in 2019/20 but a 20% decrease in 2020/21.
- In real terms, foreign-funded R&D in the business sector in 2020/21 was less than half of what it was in the first half of the decade.

Proportional business sector R&D expenditure by sector

	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Agriculture, hunting, forestry and fishing	2,7	3,1	3,5	3,5	3,2	2,5	3,9	6,6	6,6	4,5
Mining & quarrying	14,7	14,2	10,1	8,8	7,2	6,9	12,1	6,4	6,4	9,2
Manufacturing	32,9	32,2	33,9	32,2	27,8	28,2	21,9	32,3	32,3	28,8
Electricity, gas and water supply	3,6	3	4,1	3,2	3,7	4	4,9	7,1	7,1	7,1
Construction	0,1	0,1	0	0	0	0	0,1	0,0	0	0
Wholesale and retail	1,7	0,9	0,6	0,3	0,4	0,5	0,7	0,8	0,8	0,6
Transport, storage and communication	4,4	3,8	4,8	6,5	10,4	6,2	7,7	4,7	4,7	2,7
Financial intermediation, real estate and business services	37	40,1	40,3	42,8	44,3	48,8	44,3	37,7	37,7	42,3
Community, social and personal services	2,8	2,6	2,7	2,7	2,9	2,8	4,4	4,3	4,3	4,7
Total	100	100	100	100	100	100	100	100	100	100

Table 2.9 highlights a consistent rise in the share of R&D expenditure by the business sector located in financial intermediation, real estate, and business services over the years. The share of these sectors in the business sector's R&D expenditure was around one-third in 2010/11 and nearly half in 2016/17. There was a slight decline in the following years, but it increased again to 42.3% in 2020/21, a significant rise from the previous year's share of 37.7%.

R&D expenditure in the manufacturing sector

	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
High technology	**18,0**	**18,9**	**19,6**	**15,7**	**12,8**	**15,3**	**14,0**	**15,4**	**15,6**	**19,6**
Radio, television, instruments, watches and clocks	18,0	18,9	19,6	15,7	12,8	15,3	14,0	15,4	15,6	19,6
Medium technology	**69,5**	**67,7**	**66,4**	**71,2**	**73,7**	**73,8**	**72,7**	**65,1**	**68,5**	**69,4**
Petroleum products, chemicals, rubber and plastic	38,9	32,8	33,1	40,8	40,5	41,3	37,8	25,3	33,7	37,9
Other non-metal mineral products	2,0	1,4	1,4	1,1	0,6	0,9	0,6	1,4	0,6	1,2
Metals, metal products, machinery and equipment	11,1	16,8	16,4	13,5	14,9	12,6	13,0	16,6	15,9	14,6
Electrical machinery and apparatus	8,7	9,0	6,7	6,7	8,6	11,1	14,2	11,8	7,3	10,4
Transport equipment	8,7	7,7	8,8	9,1	9,1	7,8	7,1	10,0	11,0	3,3
Low technology	**12,5**	**13,4**	**14,1**	**13,1**	**13,5**	**10,9**	**13,3**	**19,5**	**16,0**	**13,1**
Food, beverages and tobacco	8,0	9,2	9,0	8,1	8,5	8,0	10,2	15,7	13,1	9,4
Textiles, clothing and leather goods	0,0	0,1	0,8	0,8	0,2	0,2	0,5	0,4	0,3	0,6
Wood, paper, publishing and printing	2,3	1,5	1,6	1,6	2,2	2,1	2,0	2,4	2,3	2,7
Furniture & other Manufacturing	2,3	2,7	2,6	2,6	2,7	0,6	0,6	1,0	0,3	0,3

Source: HSRC and DSI 2022/24 National Survey of Research and Experimental Development

The percentage share of high-technology manufacturing in total manufacturing R&D increased between 2018/19, 2019/20, and especially in 2020/21. However, the increase in 2020/21 was only slightly higher than at the start of the decade, with no clear trend of increase. On the other hand, the share of low-technology sectors grew for most of the decade, except for a decline in 2019/20 and 2020/21, where it dropped. Consequently, in 2020/21, the share of low-technology sectors in total manufacturing R&D declined slightly compared to the beginning of the decade.

Venture capital investments (1)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Investments per year Value (R' millions)	288	183	273	372	933	968	1 067	1 230	1 390	1 310
Investments per year – number of deals	8	19	67	69	116	147	134	162	167	186

Source: SAVCA 2022 Venture Capital Industry Survey. Covering the 2021 calendar year

Table reveals a steady increase in the value of VC investments and the number of deals in South Africa over the last decade, with a faster growth rate since 2015.

Although this growth rate slowed in 2020, the investment value continued to rise. However, in 2021, the number of deals increased significantly by 11.4%, but the nominal value of investments decreased by 5.8%.

Venture capital investments (2)…

- VC activity in Africa has experienced significant growth, particularly in 2021, with both the value and the number of deals almost doubling and quintupling, respectively. South Africa was the leading country for VC deals, accounting for over one-fifth from 2014 to 2020.

- However, in 2021, South Africa's share of VC deals declined to 17%, with Nigeria becoming the leading country for the number of deals. Additionally, Nigeria was the leading country for VC deal value in 2021, with South Africa's share at 15%.

- In the first half of 2022, Egypt, Kenya, Nigeria, and Ghana all exceeded South Africa in VC deal value.

Comparison of infrastructure and access of South Africa with BRICS

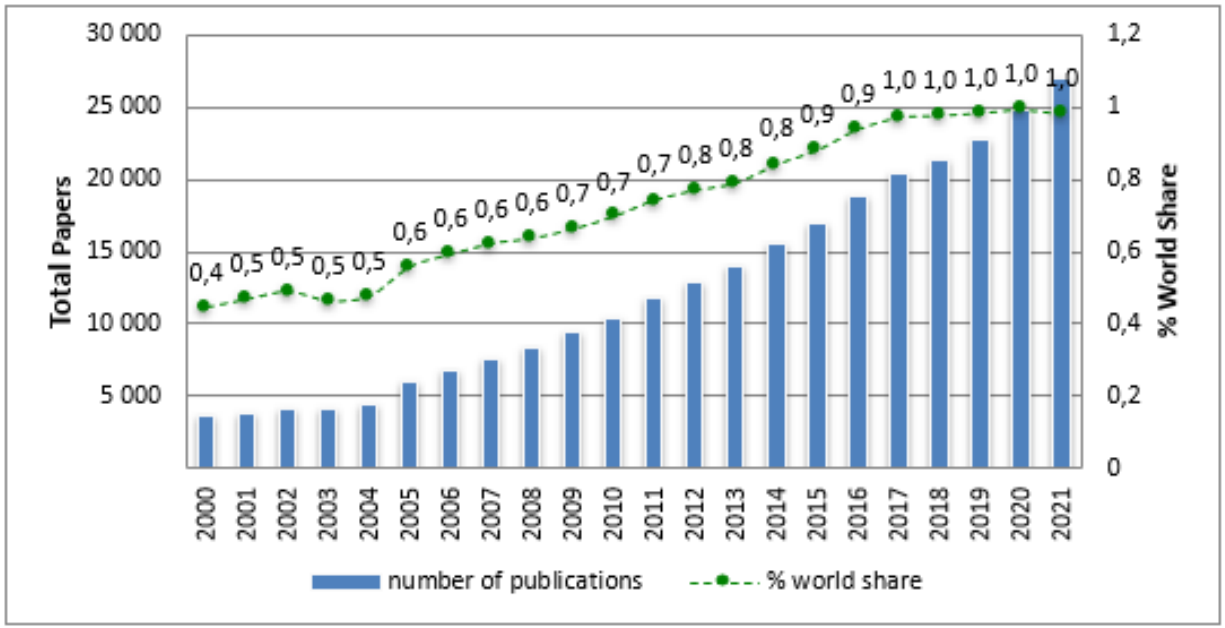
Country	Network coverage	Mobile phone ownership (individuals also owning a mobile phone)	ICT access at home		Mobile and fixed telephone subscriptions	Mobile and fixed broadband subscriptions	
			Households with Internet access at home	Household with computer at home	Mobile-cellular subscriptions per 100 inhabitants (2021)	Active mobile-broadband subscriptions per 100 inhabitants (2021)	Fixed broadband subscriptions per 100 inhabitants (2021)
SA	100%	78%	63%	23%	169	116	3
Brazil	90%	89%	83%	45%	102	96	19
Russia	99%	98%	84%	73%	169	108	24
India	99%	-	24%	11%	82	54	2
China	100%	-	-	-	122	105	38

Source: ITU[1]

Table indicates that in South Africa, network coverage and mobile cell ownership are at 100%, which is among the highest in the BRICS countries.

...Knowledge production and utilisation outputs

SA's scientific publications % world share



Source: SA Web of Science

- Figure represents South Africa's annual growth in scientific articles throughout the years.
- The number of scientific articles has grown from 3,693 in 2000 to 27,052 in 2021. However, the country's world share of scientific publications has leveled off around 1% in the last five years, despite the continued increase in publications.
- Other countries such as China and India are increasing their scientific output at a faster pace than South Africa.

scientific output per country

Country	Number of articles and review articles
China	650 118
United States	584 018
United Kingdom	195 789
Germany	161 889
India	154 186
Italy	119 624
Japan	113 880
Canada	107 986
Australia	106 451
Spain	103 589
France	100 643
Korea, Republic Of	88 304
Brazil	84 797
Russian Federation	70 644
Islamic Republic of Iran	66 367
Turkey	62 549
Netherlands	61 167
Paland	50 907
Switzerland	47 064
Saudi Arabia	45 516
Sweden	42 846
Taiwan, Province of China	38 789
Belgium	34 320
Pakistan	33 589
Egypt	32 283
Denmark	29 392
Portugal	27 388
Malaysia	27 218
Mexico	27 124
South Africa	27 062

Source: CREST, Stellenbosch University

- Table compares South Africa's scientific output with 29 countries above it in the 2021 rankings.
- South Africa has now secured the second position among all African countries in terms of scientific output, with Egypt publishing 5,000 more articles in 2021.

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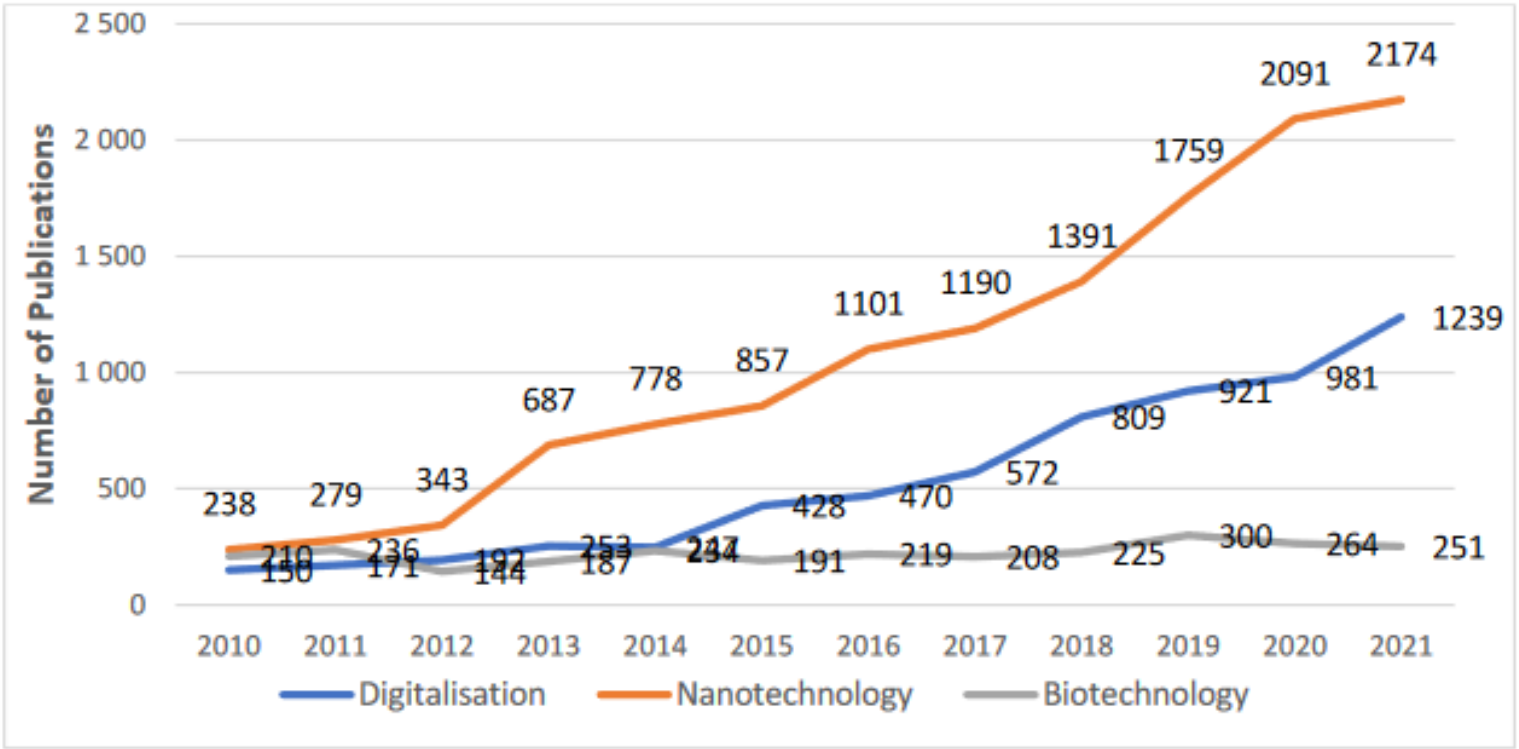
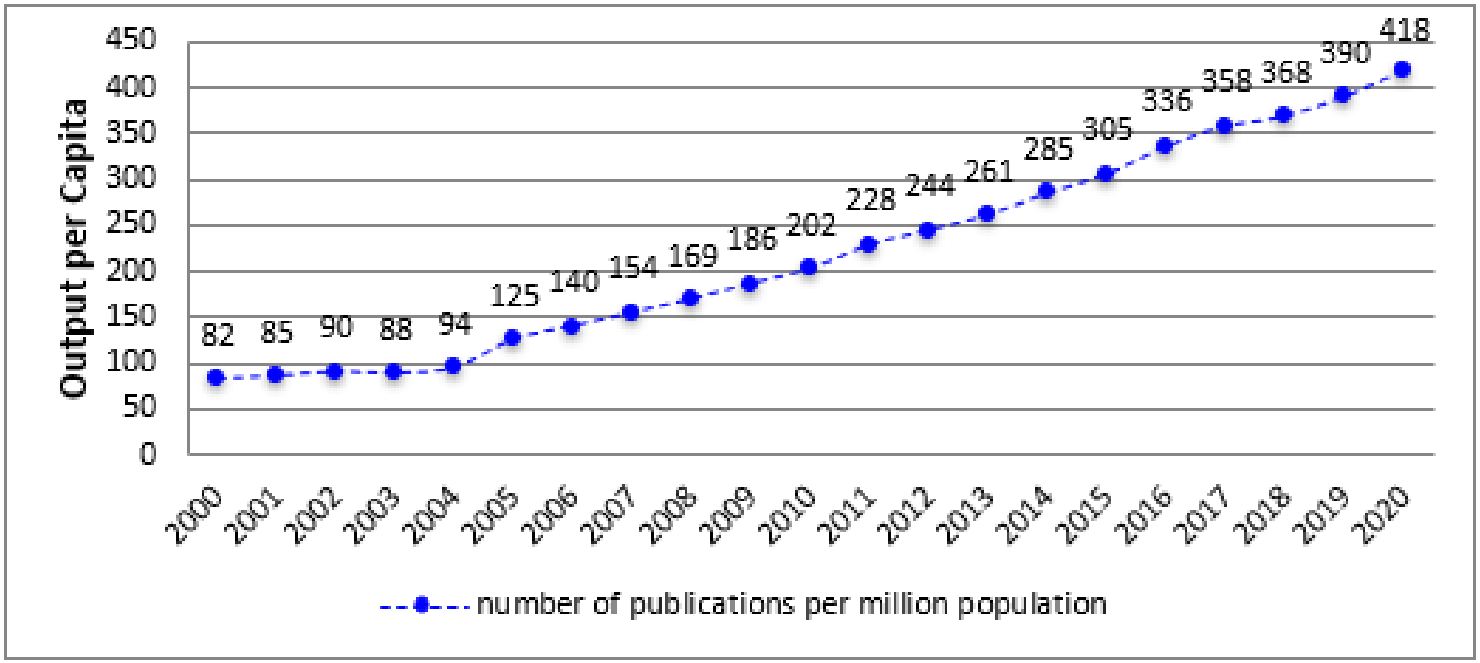
Number of publications by fields of specialisation



Source: Web of Science Core Collection

Figure shows that, of the three technologies, nanotechnology and digitalization seem to be showing the highest growth based on academic publications, with biotechnology stagnant

SA PUBLICATION OUTPUT PER MILLION POPULATION



Source: CREST, Stellenbosch University

Figure demonstrates that the science system in South Africa has become increasingly productive when the number of publications is adjusted per million of the population.

Percentate share of publications by females

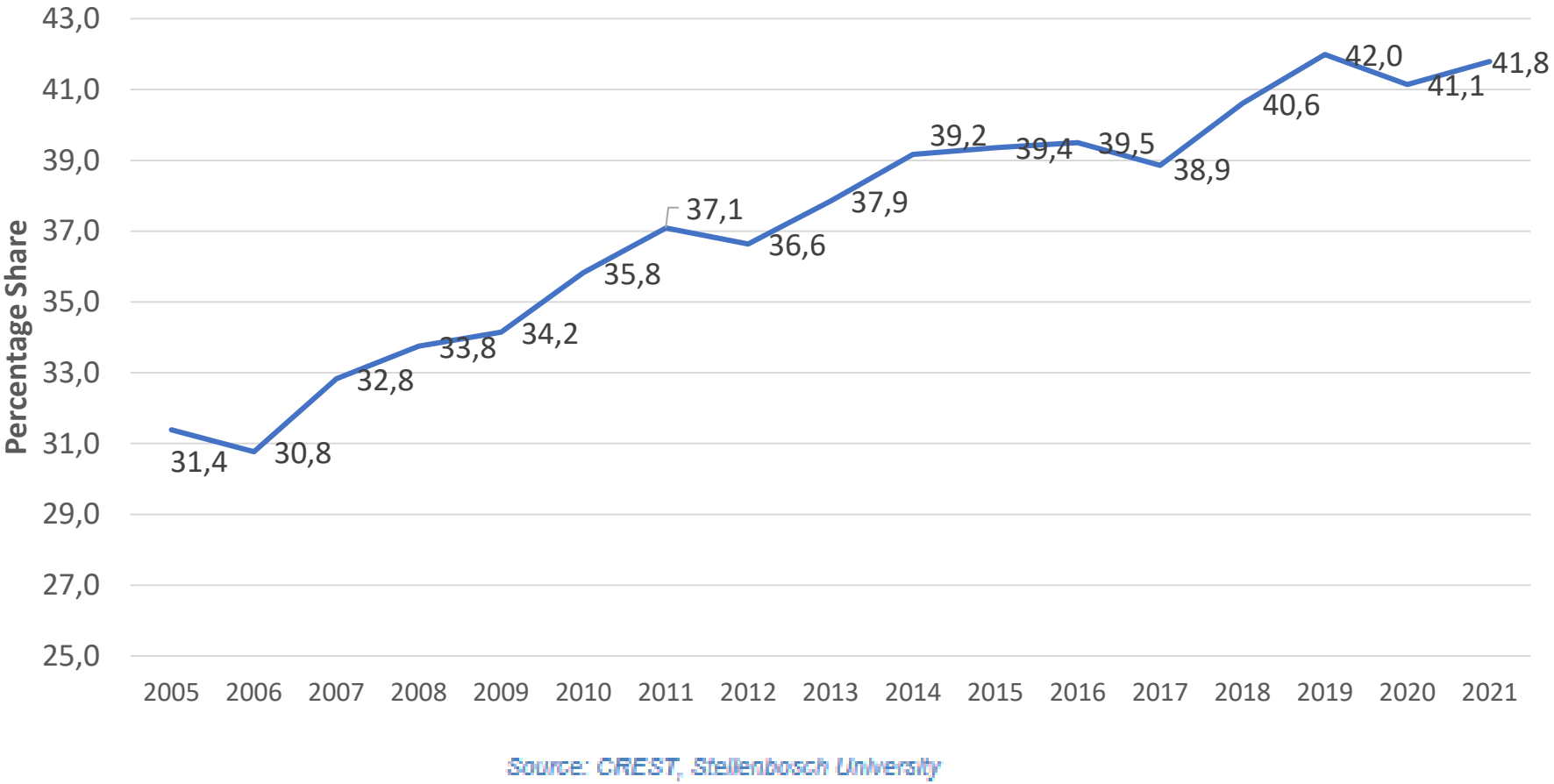
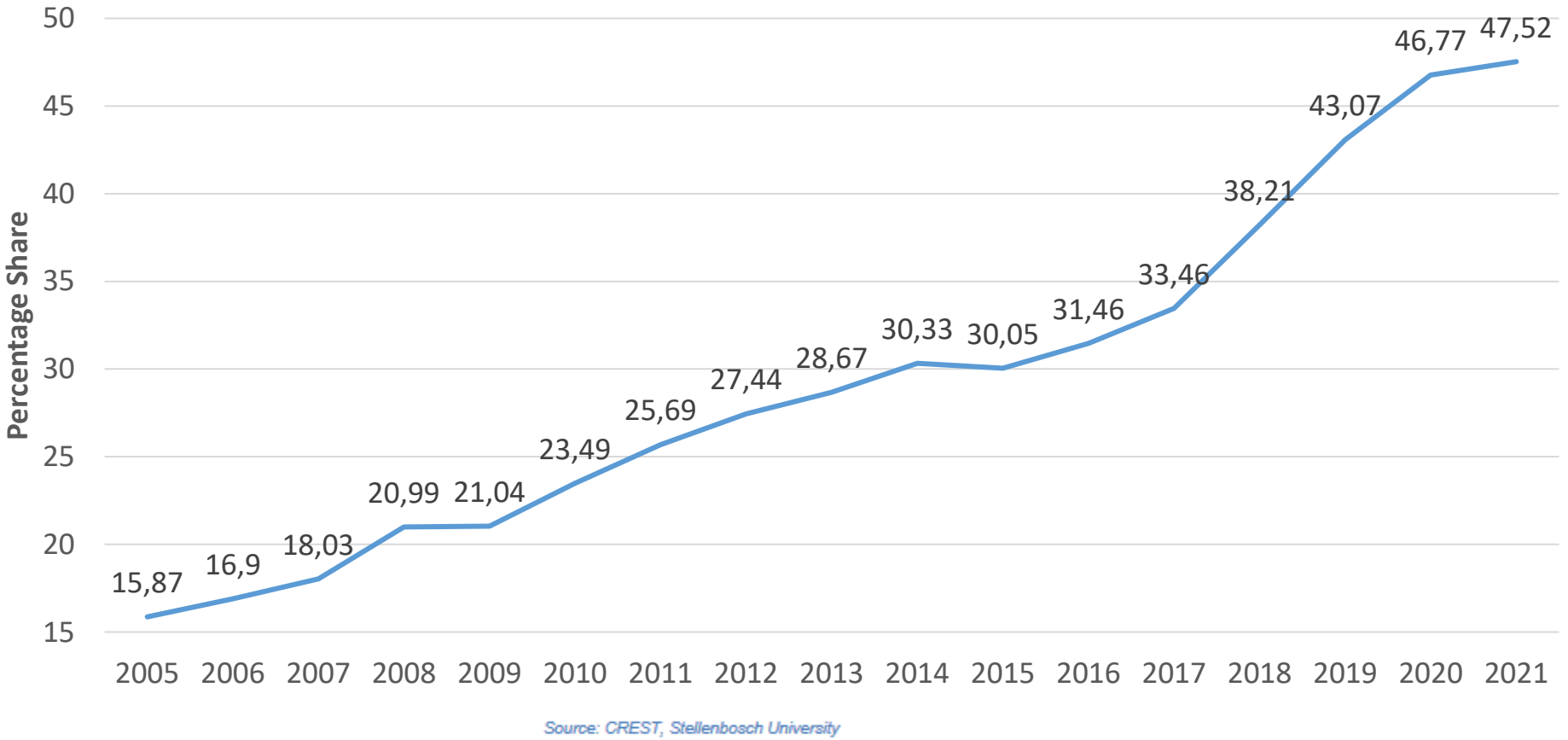


Figure indicates that female authors have increased their contribution to university publications during the reporting period, increasing their percentage by ten points, from 31% in 2005 to approximately 42% in 2021

% share of publications by SA designated groups



Source: CREST, Stellenbosch University

Post doctoral fellows and staff had ~ threefold increase in contribution over the 17-year period

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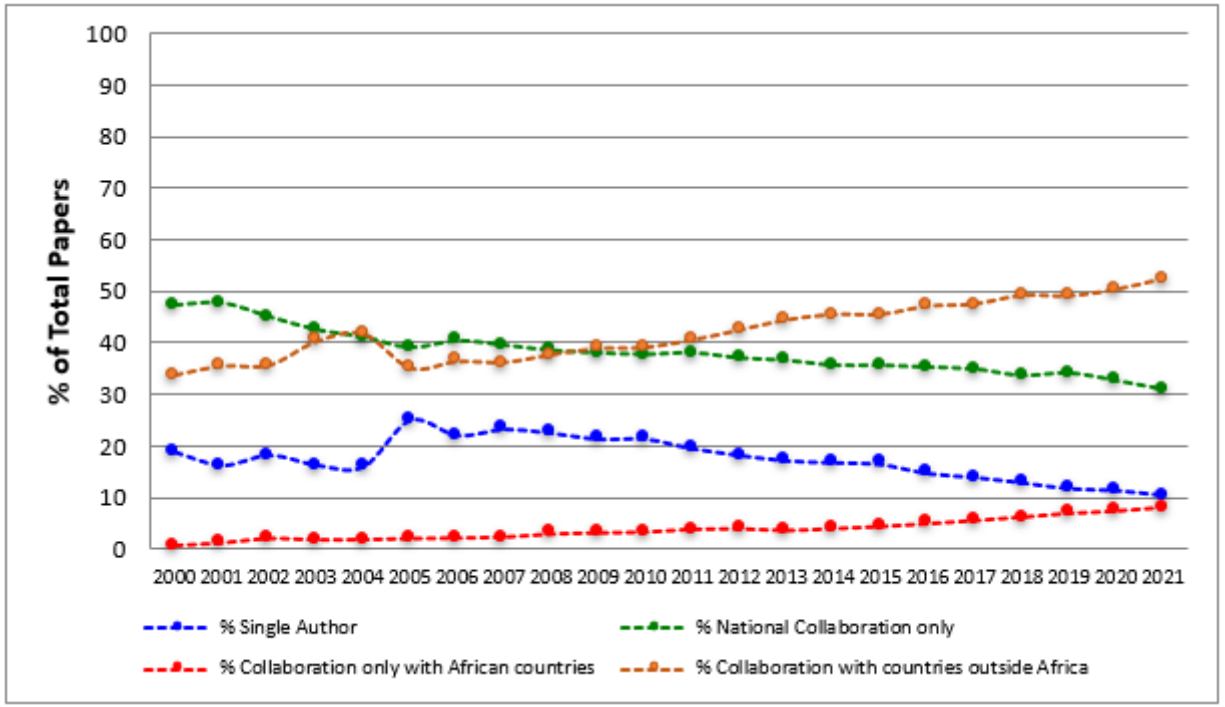
Research collaborations



- The figure indicates a gradual decrease in single-authored papers across all fields, from around 20% in 2000 to 10% in 2021, which is not surprising.
- The majority of single-authored papers are concentrated in philosophy, history, and mathematics.
- Furthermore, the percentage of collaborations taking place within South Africa has also decreased.

Trends in citations impact

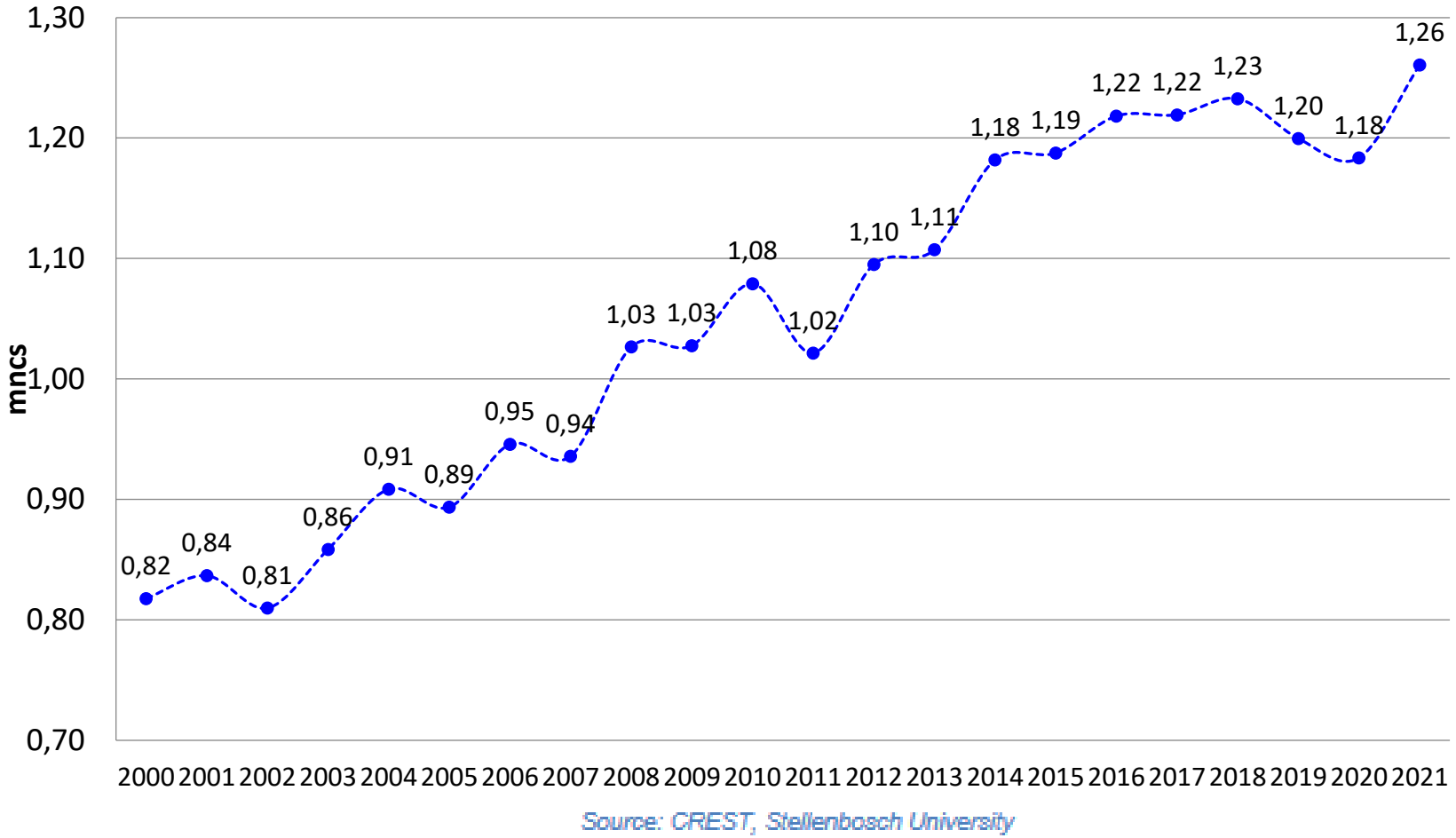


Figure shows citation impact of publications in 2021 calculated to ~25% (1,26) higher than the average citation values for all world publications in the same fields

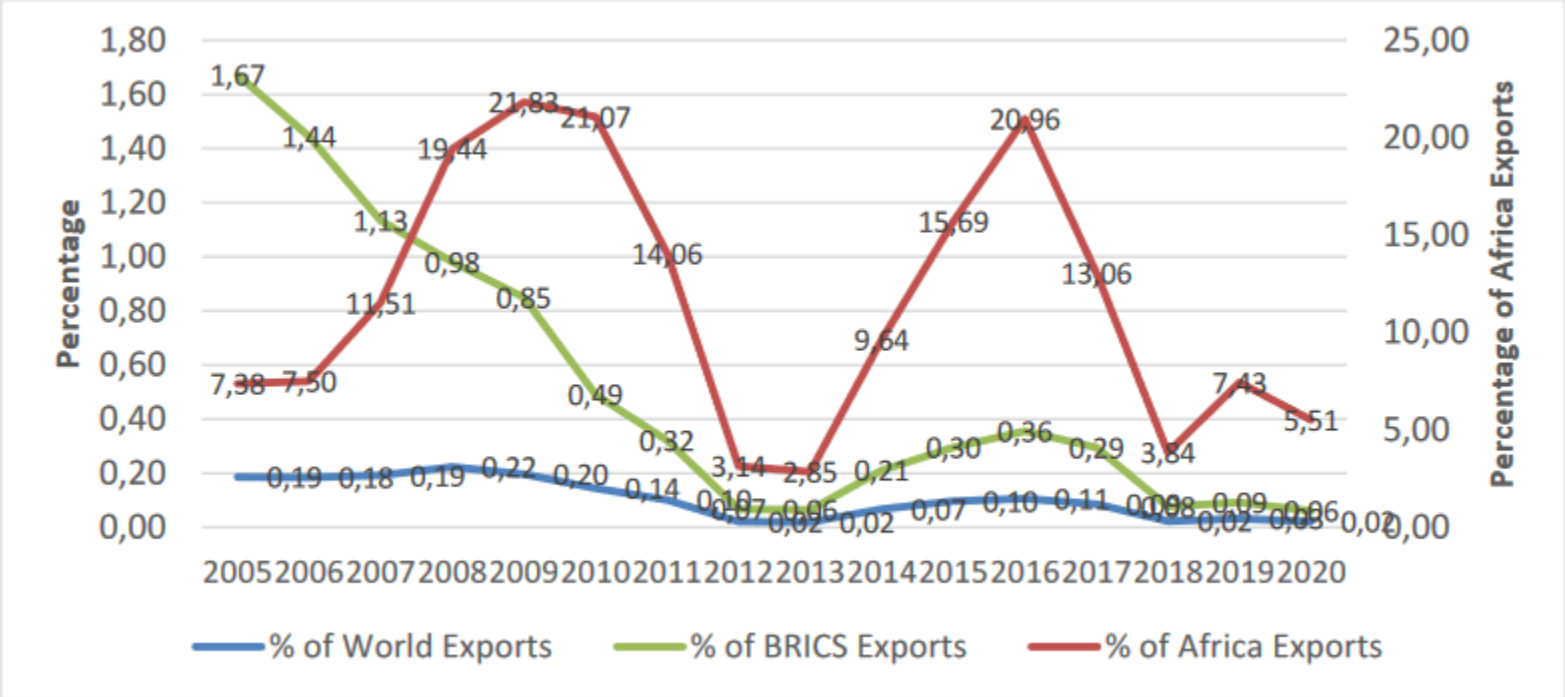
Number of patent grants

Years	Number of Patent Grants
2011	53
2012	65
2013	54
2014	50
2015	59
2016	70
2017	50
2018	73
2019	69
2020	80
2021	51

Source: EPO database

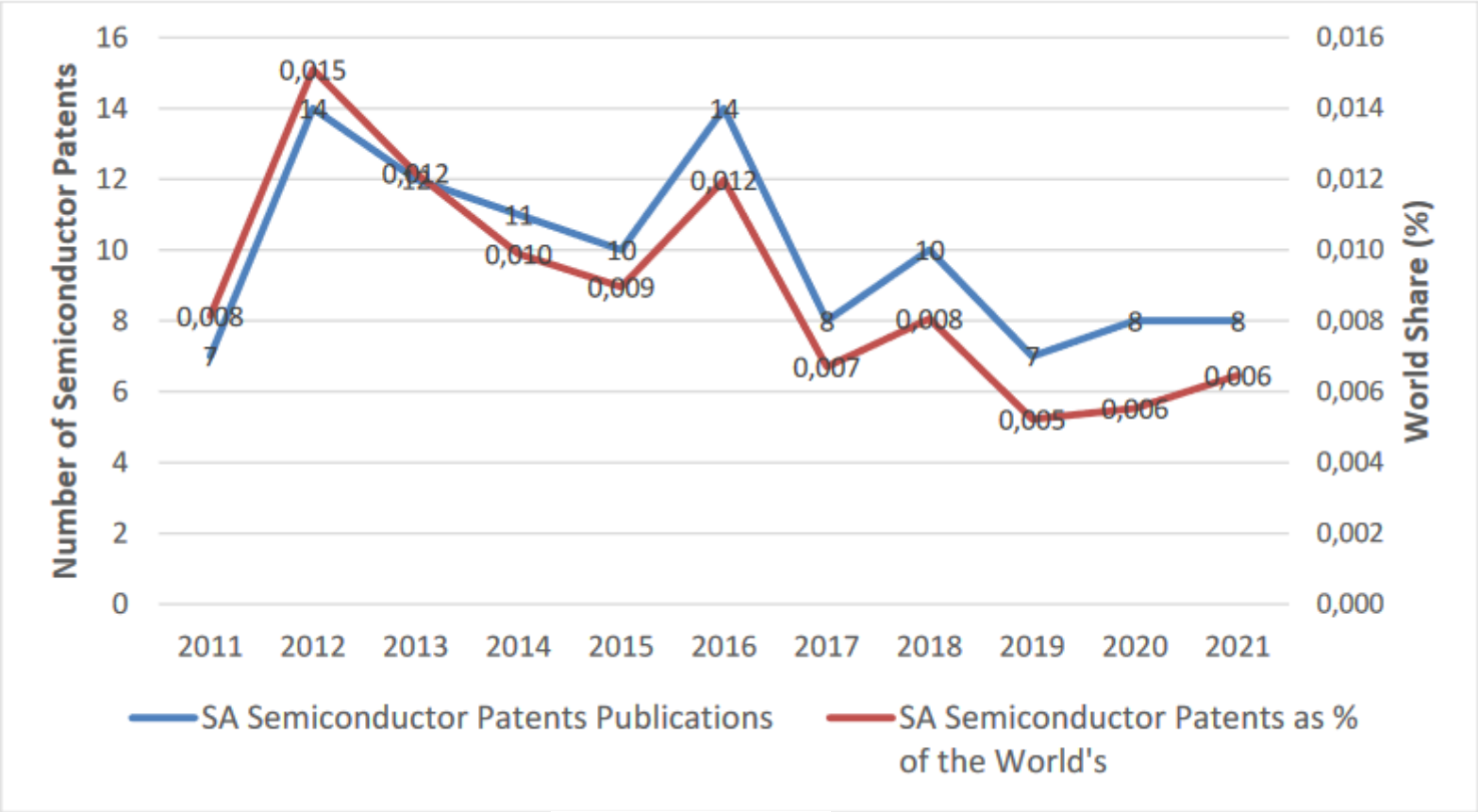
In 2021, the number of SA patents granted at the EPO declined 36% as compared with 2020 (general decline of 18.6% for all countries)

Percentage of Africa exports



Source: OCE Data

SA semiconductor patents



Source: WIPO Patentscope

South Africa's world share of semiconductor patents decreased from a high point of 0,015% in 2012 to 0,006% in 2021

South African Patent Grants at the USPTO Number and Share of Total

Year	Total	South Africa (count)	South Africa %
2015	298 407	166	0.056
2016	303 051	181	0.060
2017	318 829	182	0.057
2018	307 760	145	0.047
2019	354 430	182	0.051
2020	352 010	155	0.044

BRICS by Number of Utility Patents at USPTO

	Number of Foreign Utility Patents		Percentage Share	
	2019	2020	2019	2020
BRICS	25 816	28 162	13.8	15.0
China	19 209	21 428	10.3	11.4
India	5 378	5 861	2.9	3.1
Russia	622	677	0.3	0.4
Brazil	425	494	0.2	0.3
South Africa	182	152	0.09	0.08

Payments and Receipts for IP 2011-2021

	Payments	Receipts
	($ billion)	$0
2011	2, 1 2	139 891
2012	2,02	135 297
2013	1,94	135 485
2014	1,73	136 803
2015	1,64	126 114
2016	1,83	139 258
2017	1,88	157 684
2018	1,54	182 504
2019	1,36	150 760
2020	1,20	126 359
20.21	1,45	135 304

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World Bank' World Development Indicators•

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CHARGES FOR THE USE OF INTELLECTUAL PROPERTY RECEIPTS

	2016	2017	2018	2019	2020	2021
Current $US '000						
Argentina	168 807	356 98	321 051	284 486	209 592	212 632
Brazil	650 834	642 57	825 475	641 114	634 292	705 262
South Africa	139 258	157 84	182 504	150 761	126 359	135 304
Current $US Billion						
Middle income	4,17	8,67	10,14	11,18	13,61	17,25
South Africa Share of middle income	3,3	1,8	1,8	1,4	0,9	0,8

Source: World Bank World Development Indicators

- SA receipts from the sale of IP were lower in 2021 than in 2016 (-3%)
- Compared with all middle-income countries, South Africa's share of receipts has declined significantly and consistently: from 3,3% in 2016 to 0,8% in 2021.

NUMBER OF PATENTS GRANTED AT EUROPEAN PATENTS OFFICE

Years	Number of Patent Grants
2011	53
2012	65
2013	54
2014	50
2015	59
2016	70
2017	50
2018	73
2019	69
2020	80
2021	51

Source: EPO database

In 2021, the number of SA patents granted at the EPO declined 36% as compared with 2020 (general decline of 18.6% for all countries)

Innovation and socioeconomic impacts

Venture capital investments

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Investments Value (R millions)	288	183	273	372	933	968	1 067	1 230	1 390	1 310
Investments Number of deals	8	19	67	69	116	147	134	162	167	186

Source: SAVCA 2022 Venture Capital Industry Survey. Covering the 2021 calendar year

- There is an increase in the value of VC investments and the number of deals in South Africa over the last decade, with a faster growth rate since 2015
- In 2021, the number of deals increased significantly by 11.4%, but the nominal value of investments decreased by - 5.8%

South Africa Share of VC in Africa declining

- Number of Deals.

2014-2020 SA share 21%.

2021 SA share 17%.

- Value of Deals

First half of 2022: Egypt; Kenya; Nigeria; Ghana – all exceed SA.

Manufacturing, medium and high-technology manufacturing value added

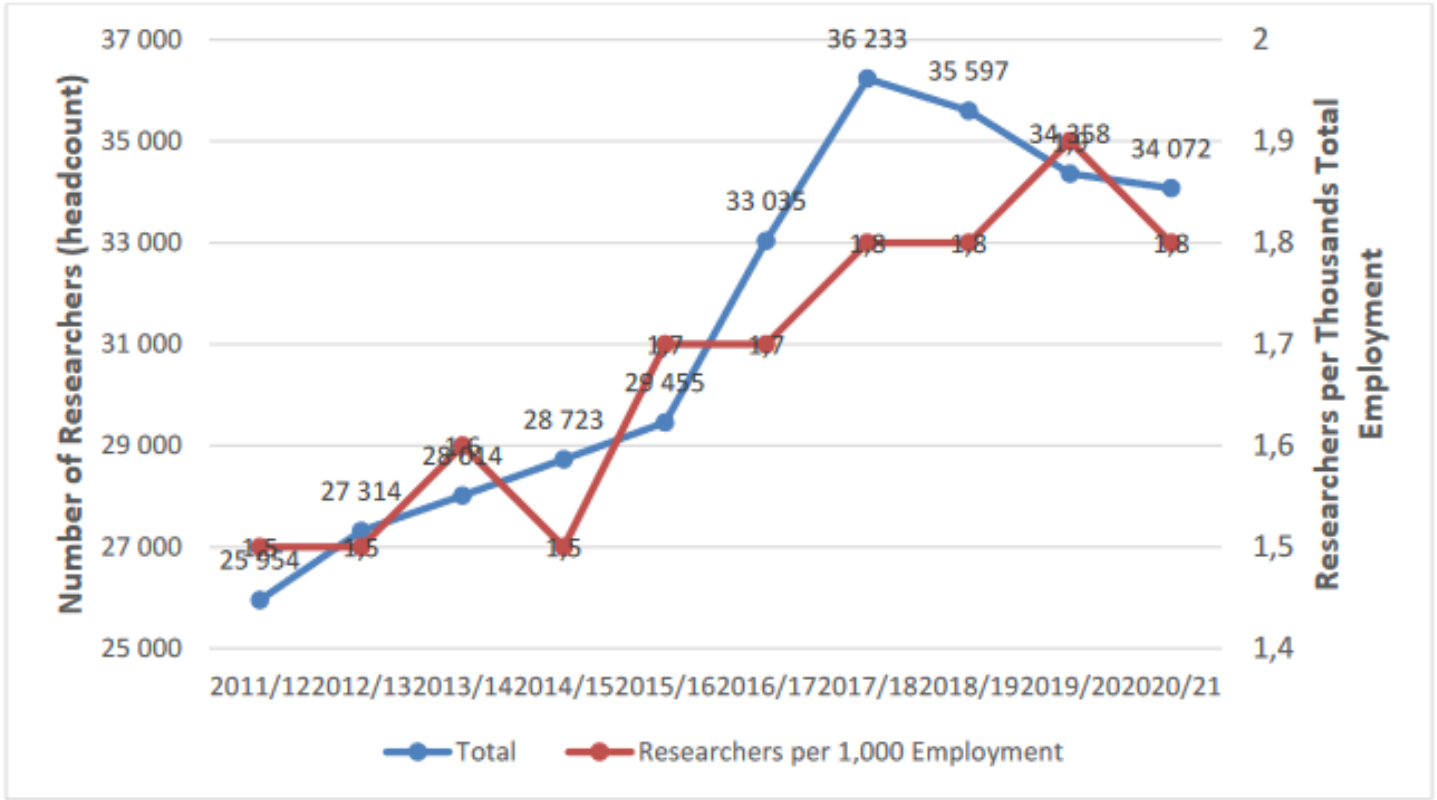
	Gross value added, rand million: constant 2015 prices										
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Manufacturing	541 829	552 595	558 021	554 420	553392	555 880	554 833	565 726	557 941	488 409	520303
MHT	157731	157 117	158 051	157 823	157 937	159 868	155 966	155 028	147 827	125 030	133 324
MHT less motor vehicles	138 059	138 750	137025	136 458	136 014	138 376	134 715	131 941	124 611	108 555	117 981
MHT (% share)	29,11	28,43	28,32	28,47	28,54	28,76	28,11	27.39	26,50	25.6	25,62
MHT less motors (%)	25,48	24,75	24,56	24,61	24,58	24,89	24,28	23.31	22,33	22,23	22,68

Sources:Quantec & Stats SA

Manufacturing output, measured by Gross Value Added (GVA), in 2021 increased by 4,5%.

This followed a decline of 12% in 2020. Manufacturing GVA in 2021 was still lower than a decade ago.

No of researchers per thousands total employment



Source: HSRC and DSI 2020/21 National Survey on Research and Experimental Development

After a period of growth in the total number of researchers (by headcount), there has been a downward trend since 2018/19 (from 36 233 in 2017/18 to 34 072 in 2021/22).

Medium and high-tech sectors value added % share

% Share of gross value added : Constant 2015 prices											
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Basic Chemicals	12,95	11,40	11,71	12,27	12,49	14,21	13,39	13,03	11,89	13,54	13,28
Other chemical products	20,10	19,72	20,31	20,40	20,39	20,68	19,87	18,45	16,91	18,91	18,55
General purpose machinery	12,13	12,31	11,28	10,38	9,41	9,13	9,75	9,95	10,66	10,89	11,19
Special purpose machinery	13,32	13,66	13,89	13,62	13,28	12,64	13,71	13,92	14,27	14,11	14,23
Household appliances	1,91	1,99	1,94	2,01	1,87	1,68	1,76	1,83	2,04	1,98	2,08
Office, accounting,Computing machinery	0,88	0,87	0,87	0,91	0,84	0,74	0,77	0,78	0,86	0,78	0,78
Electric motors, generators, transformers	1,51	1,77	1,82	2,00	2,01	2,23	1,95	2,04	1,99	1,95	1,68
Electricity distribution and control apparatus	1,31	1,26	1,32	1,18	1,23	1,20	1,31	1,27	1,32	1,11	1,22
Insulated wire and cables	1,45	1,43	1,41	1,36	1,34	1,36	1,44	1,45	1,48	1,40	1,42
Other electrical equipment	3,00	3,03	3,44	3,31	3,82	3,59	3,14	3,10	3,31	3,69	3,66
Radio, television and communication apparatus	1,08	1.19	1,26	1,54	1,43	1,65	1,60	1,43	1,69	1,60	1,79
Professionl equipment	3,03	3,10	3,08	3,29	3,25	3,30	3,73	3,74	3,58	3,73	3,74
Motor vehicles	12,47	12,96	13,30	13,54	13,88	13,44	13,63	14,89	15,70	13,18	11,51
Parts and Accesories	10,75	10,61	10,61	9,82	10,23	9,81	9,17	9,50	9,09	8,44	10,42
Other transport equipment	4,11	4,69	4,33	4,38	4,52	4,33	4,80	4,61	5,30	4,51	4,56

Different sectors within MHT, percentage shares of GVA have been stable over the last decade.

Special-purpose machinery increased its share after 2016

PROVINCIAL EMPLOYMENT IN HIGH-TECHNOLOGY SECTORS

	Year		Change in employment	% Change
	2012	2021		
Eastern Cape	948	872	-76	-8,01
Free State	502	552	50	9,96
Gauteng	10 842	11 968	1 126	10,38
KwaZulu-Natal	2 674	2 797	123	4,59
Limpopo	474	531	57	12,02
Mpumalanga	677	742	65	9,60
Northern Cape	160	236	76	47,5
North West	508	519	11	2,16
Western Cape	3 522	3 803	281	7,97

Source: Quantec

- Employment in high-technology sectors increased in all the provinces except for the Eastern Cape.
- In 2021, Gauteng had the highest employment in high technology sectors (11 956) followed by the Western Cape (3 803) and KwaZulu-Natal (2 797).

Medium and high tech sectors's share of employment

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Basic chemicals	6.81	7.38	7.45	6.94	6.35	5.90	6.05	6.06	5.85	5.76	5.57
Other chemical products	14.55	14.77	15.32	15.34	15.96	15.92	16.58	17.24	15.92	16.19	15.65
General purpose machinery	12.75	12.86	12.96	12.70	12.04	11.96	12.33	12.57	12.65	12.83	12.59
Special purpose machinery	15.31	14.83	14.83	15.27	15.28	14.97	15.75	16.12	16.56	16.86	16.59
Household appliances	1.84	1.85	1.84	2.01	1.93	1.96	1.93	1.68	1.61	1.83	1.84
Office, accounting, computing machinery	1.67	1.60	1.46	1.26	1.17	1.24	1.25	1.16	0.96	0.94	0.93
Electric motors, generators, transformers	3.70	3.57	3.94	4.45	4.46	4.35	3.92	3.96	3.94	4.62	5.20
Electricity distribution and control apparatus	1.78	1.81	1.57	1.64	1.91	1.89	1.93	1.87	1.84	1.75	1.77
Insulated wire and cables	1.43	1.48	1.44	1.40	1.38	1.36	1.29	1.17	1.19	1.16	1.15
Other electrical equipment	5.30	5.10	4.98	4.68	4.59	4.53	3.03	3.87	4.31	4.07	4.11
Radio, television and communication apparatus	1.81	1.73	1.82	1.95	1.92	1.94	1.92	1.79	1.71	1.73	1.79
Professional equipment	3.05	3.09	3.02	3.05	3.00	3.15	3.33	3.33	3.41	3.38	3.33
Motor vehicles	11.93	12.25	12.25	12.26	12.39	12.81	13.15	12.65	12.88	12.47	12.65
Parts and accessories	13.63	13.47	13.13	12.90	13.29	13.45	13.00	12.02	12.53	12.36	12.88
Other transport equipment	4.45	4.21	4.00	4.16	4.31	4.57	4.56	4.49	4.63	4.05	3.96

Source: Quantec and Statistics South Africa

- Special-purpose machinery and motor vehicle are two sectors that have had some growth in their shares of manufacturing output also exhibited a small increase in their share of employment over the decade

Medium and High Technology Employment and Employment Share

	MHT employment ('000)	% Share of MHT employment
2011	348	29.8
2012	353	30.3
2013	360	30.8
2014	355	30.6
2015	354	30.2
2016	365	30.7
2017	369	30.7
2018	384	31.4
2019	391	31.7
2020	383	32.5
2021	386	33.0

PROVINCIAL EMPLOYMENT IN HIGH-TECHNOLOGY SECTORS

	Year		Change in employment	% Change
	2012	2021		
Eastern Cape	948	872	-76	-8,01
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Northern Cape	160	236	76	47,5
North West	508	519	11	2,16
Western Cape	3 522	3 803	281	7,97

Source: Quantec

- High-technology employment has increased in all provinces except the Eastern Cape and Western Cape
- Conversely, medium-technology employment has declined in all provinces, while employment in the low-technology sector has dropped in all provinces except for the Northern Cape and the Northwest

Exports as measure of innovation

Why we should consider exports as a/the key indicator of innovation.

Product innovation

- New exporters
- New products
- New markets

Process innovation

- Increasing export volumes of existing products

Manufacturing Exports Characteristics 2010–2021

	Number of Exporters	Number of Products	Number of Destinations	Number of Transactions
2010	30 826	3 529	217	778 606
2011	31 677	3 527	221	862 942
2012	36 865	3 518	216	939 991
2013	38 605	3 502	215	959 266
2014	38 799	3 505	223	990 823
2015	39 354	3 506	215	1 006 994
2016	39 499	3 501	216	1 006 221
2017	37 849	3 488	224	1 011 669
2018	35 170	3 487	221	1 013 427
2019	33 266	3 484	224	997 123
2020	33 631	3 470	217	875 225
2021	35 071	3 478	220	922 487

The Diversity of South African Exports: Number of Products in Which SA is Competitive 2010–2020

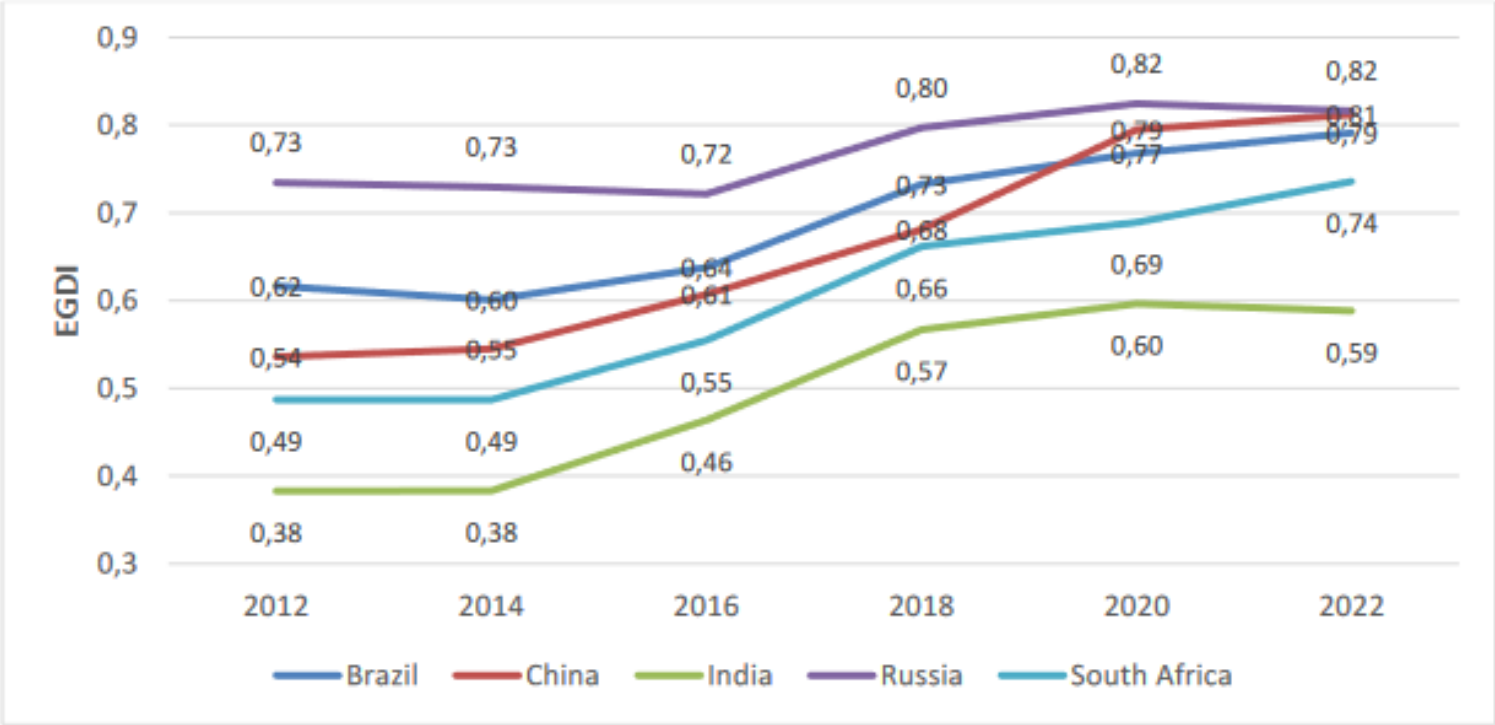
	Manufactured Products	All Products
2010	197	312
2011	184	293
2012	201	317
2013	199	307
2014	194	303
2015	191	301
2016	175	281
2017	177	280
2018	169	275
2019	156	255
2020	134	225

PRODUCTION

- Very slow increase in MHT
- Sectoral composition – decreasing share of manufacturing
- Technology composition (manufacturing) – increasing share of low technology

No indication of any sub-sectors where there is significant and sustained growth

E-GOVERNMENT DEVELOPMENT INDEX



Source: United Nations e-Government Knowledgebase

South Africa's ranking in the E-Government Development Index rose from 0,49 in 2012 to 0,74 in 2022

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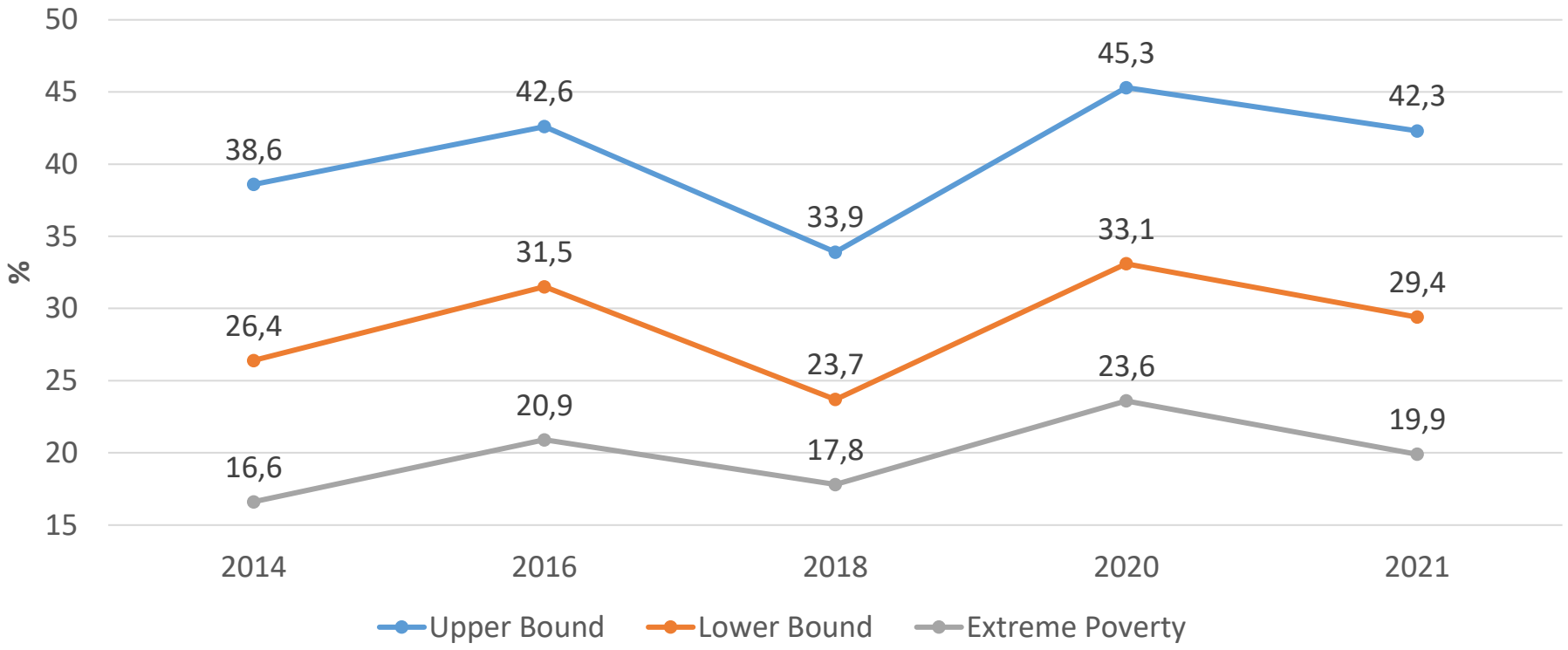
POVERTY TRENDS IN SOUTH AFRICA



Source: Statistics South Africa "General Household Survey

SA although being a middle-income country, it still faces many socio-economic challenges, including poverty, inequalities and rising unemployment

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Concluding remarks

- Consistent picture of decline in both inputs and outputs
- Slow growth to approximately 2015/16 and a decline thereafter
- Latest data suggest that the rate of decline is accelerating.
- Recent declines may well have been overstated.
- Decline is evident before COVID – approximately since 2015/16
- By contrast with SA, OECD countries increasing commitments to R&D - by 5% per annum pre-COVID; 1.5% during COVID.

Knowledge gaps

Lack of knowledge about both established firms and start-ups

What accounts for:

- Strong performance of start-ups
- Heterogeneity among established firms

New sources of evidence/data:

- South African Revenue Service and National Treasury Firm-Level Panel (SARS-NT panel) data

Areas requiring urgent attention

- Investment in postgraduate students
- young Academics with doctoral qualifications
- Transformation of the professoriate
- Business investment in R&D
- Decline of employment of researchers in science councils

Enkosi
Ha khensa
Re a leboga
Ro livhuwa
Siyabonga
Siyathokoza
Thank you
Dankie
Obrigado
Спасибо
धन्यवाद
谢谢

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