SOUTH AFRICAN SCIENCE, TECHNOLOGY AND INNOVATION INDICATORS

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NACi
NATIONAL ADVISORY COUNCIL ON INNOVATION

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LIST OF ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
BoP	Balance of Payment
CO_2	Carbon Dioxide
FDI	Foreign Direct Investment
FTE	Full-Time Equivalent
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
HEI	Higher Education Institutions
HIV	Human Immunodeficiency Virus
HSRC	Human Sciences Research Council
ICT	Information and Communication Technology
IP	Intellectual Property
IT	Information Technology
JSE	Johannesburg Stock Exchange
MNC	Multinational Corporation
NACI	National Advisory Council on Innovation
NDP	National Development Plan
NRDS	National Research and Development Strategy
NRF	National Research Foundation
NSC	National Senior Certificate
NSI	National System of Innovation
OECD	Organisation for Economic Corporation and Development
PDI	Previously Disadvantaged Individual
PhD	Doctor of Philosophy
R&D	Research and Development
ROI	Return on Investment
SA	South Africa
SADC	Southern African Development Community
SET	Science, Engineering and Technology
SNA	System of National Accounts
SSA	Sub-Saharan Africa
STI	Science, Technology and Innovation
TFP	Total Factor Productivity
TIMSS	Trends in International Mathematics and Science Study
UNCTAD	United Nations Conference on Trade and Development
US	United States of America

FOREWORD

On behalf of the National Advisory Council on Innovation (NACI) I am delighted to present the annual report on the 2016 South African Science, Technology and Innovation (STI) Indicators. This publication is part of our contribution to building the monitoring, evaluation and learning capability necessary for assessing the health of the National System of Innovation (NSI).

The 2016 STI indicators report is based on the analysis of NSI performance during the period between 1996 and 2016. Coincidentally, government is leading a process of reviewing the current 1996 White Paper on Science and Technology and developing the new White Paper on Science Technology and Innovation (STI). Therefore, the 2016 STI indicators report can provide necessary input into the current policy development process.

The 2016 STI indicators report identifies areas of progress but also points to the lack of progress in certain areas of the NSI. First, the NSI human capital pipeline remains constrained. The percentage of matric learners who passed mathematics and physical science with at least 50% remains low. The proportion of matric female learners passing mathematics and physics with at least 60% has been declining from 2008 to 2016. Unsurprisingly then, the undergraduate percentage SET enrolment has remained stagnant between 2005 (29.4%) and 2015 (29.7%). Notwithstanding, at the postgraduate level, the proportion of science engineering and technology (SET) enrolment as percentage of total student enrolments has increased between 2005 and 2015.

Second, there has been notable progress in the expansion and transformation of research capacity. The percentage of female researchers (full time equivalent) increased from 2001/02 (38.4%) to 2014/15 (44.1%). The proportion of female academic staff with doctoral degrees increased between 2005 (30.4%) and 2014 (39.1%) and the proportion of black (African, Coloured and Indian) female academic staff with also increased albeit slightly.

Third, the international benchmarking of mobile cellular subscriptions indicates that South Africa is doing well in diffusing ICT access through mobile cellular devices per 100 people. This is an important step if South Africa seize the opportunities and benefits of digitisation and the fourth industrial revolution or new production revolution.

Fourth, the R&D intensity or business expenditure on R&D in the agricultural sector increased from 0.29% in 2003/04 to 0.66% in 2014/15. This is welcomed given the declining R&D intensity in manufacturing and other key industrial sectors on the one hand; and the importance of strengthening research and innovation related to food security on the other hand.

Fifth, there has been notable progress in knowledge generation. South Africa's world share of publications increased from 0.39% in 1996 to 0.69% in 2015.

On behalf of the NACI Council and Secretariat we sincerely hope that all NSI stakeholders (including policy makers, the private sector and nongovernment organisations), will find this STI indicators report informative and useful. We especially hope that the data will serve as a source of acknowledgement for the work done in the areas where South Africa has shown progress and where we have not, it will spur us all to focus our efforts to address the challenges.

Prof. Cheryl de la Rey
NACI Chairperson

CONCEPTUAL FRAMEWORK

The conceptual framework for South African STI Indicators report is the logical indicator framework proposed by the 2002 National Research and Development Strategy (NRDS). This framework (**Figure 0.1**) is useful as Quality of Life and Wealth Creation, enabled by Business Performance through innovation, are the ultimate goals of the NSI. Technological Innovation is at the core of this framework; and it is enabled by local science and technology activities (e.g. Science, Engineering and Technology Human Capital pipeline and Research System Capacity); but it is also supported by Imported Know-How.

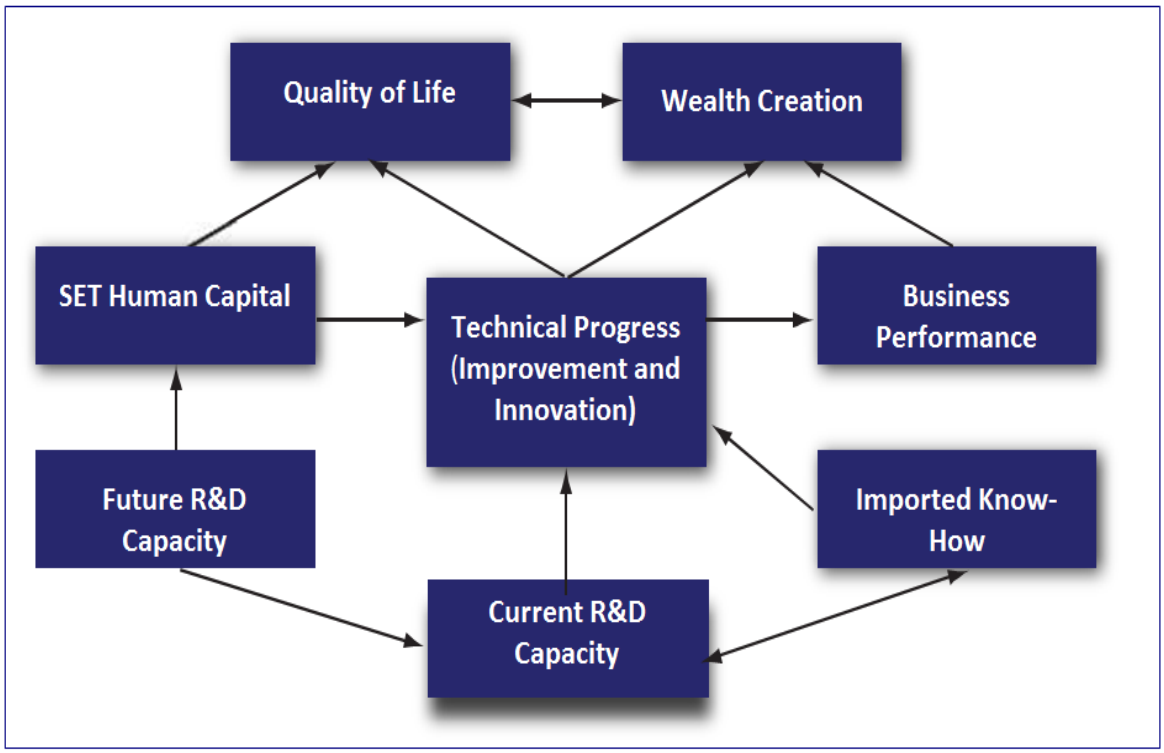


Figure 0.1: Logical Indicator Framework

Source: Department of Science and Technology "2002 National R&D Strategy"

KEY HIGHLIGHTS

The performance of the innovation system for the country during the period 1996 to 2015 is summarised in **Table 0.1**. As shown, there are visible improvements overall with regard to future and current science, engineering and technology (SET) capacity. A similar trend is observed for current R&D and innovation capacity although there is stagnation with regard to the country's share of publications in 'engineering and technology' research field. The number of internet users per 100 people is increasing, although this is lagging behind the number of mobile cellular subscriptions per 100 people (142 during 2011 – 2015).

Table 0.1: Performance of South Africa`s NSI between 1996 and 2015

Performance Indicator	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015	Trend
Future R&D and Innovation Capacity											
HEI SET Enrolments (%)	-		-	-	28.3	29.1		28.8	29.6	29.9	↑
HEI Female SET Enrolments (%)	-		-	-	44.5	45.5		45.5	45.8	46.2	↑
SET Human Capital											
HEI SET Graduations (%)	-		-	-				30.1	30.6	30.7	↑
Female SET Graduations (%)	-		-	-	49.2	50.0		50.0	50.2	50.6	↑
Current R&D and Innovation Capacity											
Total R&D Expenditure, SNA (billion R)	3.59		21.2	36.4	65.6	80.9		15.9	16.6	18.9	↑
Number of Scientific Publications	4 969		25 453	28 624	46 977	75 270		14 890	16 260	17 246	↑
Country Share of Publications in Engineering and Technology (%)	15.2		14.1	13.6	12.9	13.9		14.8	13.9	15.0	→
Technical Progress (Improvement and Innovation)											
Internet users per 100 people	0.8		3.0	7.2	11.7	44.6		46.5	49.0	51.9	↑
% Share of SA Non-residents Patents Granted	34.6		46.1	31.1	34.3	59.2		67.1	66.6	61.9	↑
% Share of SA Non-residents Industrial Designs Registered	15.3		45.6	38.8	52.1	69.5		71.4	79.6	69.5	↑
% Share of SA Non-residents Trademarks Registered	21.4		21.7	28.6	26.2	27.2		31.8	28.5	29.8	→
Imported Know-How											
Technology payments as % of GDP	-		-	-	4.03	4.95		5.10	5.37	6.98	↑
FDI inflow as % of GDP	0.55		1.02	1.91	1.85	1.32		2.26	1.64	0.56	↓
Business Performance and Key Industrial Sectors											
High technology exports as % of World high-tech exports	0.10		0.09	0.07	0.09	0.09		0.09	0.10	0.08	→
SA TCI service exports as % of World TCI service exports	-		-	-	0.12	0.13		0.14	0.13	0.12	→
Wealth Creation											
SA GDP as % of World GDP	0.5		0.5	0.5	0.5	0.5		0.5	0.5	0.4	→
Ratio of current account balance to GDP (%)	-1.1		-0.9	-1.3	-3.8	-4.6		-5.9	-5.3	-4.3	↓
Quality of Life											
Life expectancy at birth (years)	-		-	-	-	-		61.0	61.6	62.1	↑
CO2 emissions (metric tons per capita)	9.14		8.94	8.69	9.69	-		8.86	-	-	→

The declining inflow of foreign direct investment (FDI) as percentage of gross domestic product (GDP) resulted in a low South African FDI inflow compared with other selected regions/ economies during 2011 – 2015 (**Table 0.2**). Although the country's high technology exports as a percentage of the world high technology exports shows stagnation, as a proportion of SADC, Sub-Saharan Africa and the rest of Africa, it was very large (at 77.07%, 56.91% and 33.41% respectively during 2011 – 2015).

Overall, relative to the rest of the world, South Africa is not doing well in terms of quality of life indicators: carbon dioxide emissions are relatively high and so is the HIV prevalence rate. Technology payments are relatively high but conversely technology receipts are low as a share of the world.

The South African innovation system remains the strongest in the African continent although other countries are deservedly starting to catch-up in some key areas such as inflow of FDI.

Table 0.2: NSI Benchmarking, South Africa`s Performance on Key STI Indicators as Percentage of Selected Regions/ Economies (2011 – 2015 or a recent period)

Performance Indicator	SADC	SSA	Africa	BRICS	DC[1]	UMIE[2]	G20	World
Future R&D and Innovation Capacity								
-	-	-	-	-	-	-	-	-
SET Human Capital								
Researchers (FTE)	96.17	28.50	15.64	1.20	-	0.75	0.47	0.30
Current R&D and Innovation Capacity								
R&D Expenditure	88.80	38.29	21.37	1.30	-	1.11	0.31	0.28
Technical Progress (Improvement and Innovation)								
Mobile Cellular Subscriptions	32.47	12.17	0.38	2.84	-	2.97	-	<0.01
Technology Receipts	79.50	50.83	45.24	4.80	-	-	0.04	0.04
Imported Know-How								
Technology Payments	88.67	50.83	63.32	5.08	-	-	0.68	0.58
Foreign Direct Investment	27.66	11.45	9.21	1.83	0.71	1.24	0.61	0.33
Business Performance and Key Industrial Sectors								
High Technology Exports	77.07	56.91	33.41	0.42	0.18	0.33	0.13	0.09
Telecommunications, Computer and Information Service Exports	56.54	19.52	10.32	0.76	0.52	1.54	0.44	0.13
Wealth Creation								
Gross Domestic Product	55.9	23.6	16.3	2.3	-	-	0.6	0.5
Quality of Life								
CO_2 Emissions	89.52	67.38	41.59	4.19	-	-	1.9	1.6

[1]DC = Developing Countries
[2]UMIC = Upper Middle Income Economies

1. FUTURE R&D AND INNOVATION CAPACITY

The country's future competitiveness in terms of research and innovation depends largely on a healthy SET human capital pipeline. Each developmental stage is dependent on the preceding one, hence holistic and integrated SET human capital development is important. This section discusses the results of the recently released International Trends in Mathematics and Science Achievement (TIMSS), national senior certificate (NSC) pass rate for mathematics and physical science, as well as SET enrolments at local public higher educational institutions.

1.1 International Trends in Mathematics and Science Achievement

TIMSS is an assessment of the mathematics and science knowledge of fourth and eighth grade learners from selected countries around the world. South Africa participates at grades five and nine respectively; and it has participated for the first time at grade five in respect of mathematics (TIMSS-Numeracy) specifically. TIMSS uses five 'international benchmarks' to scale the scores[1], namely: Advanced (above 625 points), High (550 to 625 points), Intermediate (475 to 550 points), Low (400 to 475) and Not Achieved (less than 400). For those scoring below 400, it means that they did not demonstrate the minimum competency in the subject.

Table 1.1 summarises the performance of South Africa for TIMSS 2015 as compared with the TIMSS 2011 performance.

Table 1.1: Summary of South African Performance on TIMSS

International Benchmark	Grade 5	Grade 9			
	Mathematics	Mathematics		Science	
	2015	2011	2015	2011	2015
Advanced (>625)	1%	1%	1%	1%	1%
High (550-625)	4%	2%	3%	3%	4%
Intermediate (475-550)	12%	6%	10%	7%	9%
Low (400-475)	22%	18%	21%	14%	18%
Not Achieved (<400)	61%	73%	66%	75%	68%
Average SA Scores	**376**	**352**	**372**	**332**	**358**

Source: Human Sciences Research Council

[1] Reddy, V., Visser, M., Winnaar, L., and Arends, F., Juan, A Prinsloo, C.H. and Isdale, K. 2016. TIMSS 2015: highlights of Mathematics and Science achievement of Grade 9 South African Learners. Human Sciences Research Council

For mathematics at grade five level, about 61% of learners did not achieve the minimum competency. The story at grade nine level is similar with only 34% of learners achieving above the minimum competency level in mathematics and 32% in science. This is an improvement from 2011 when 27% of learners who participated achieved the minimum competency in mathematics. For science it was 25%.

For science at grade nine, 68% of learners did not achieve the 400 acceptable benchmark. This represents an improvement from 75% in 2011 but, as with mathematics, does not represent a score high enough to enable dramatic improvements in the country's STI in the future. For both mathematics and science only 10% or less of learners achieved the Intermediate level benchmark (475 – 550 score) except for grade five mathematics where 12% attained this level. The Human Sciences Research Council (HSRC) summarised the South African performance on TIMSS as an improvement from 'very low' (from 1995 to 2003) to 'low' (in 2015).

Figure 1.1 shows TIMSS scores for public schools (fee paying and no-fee paying) as well as for independent schools. It is clear that while there has been a solid improvement in 2015, the learners from no-fee paying public schools on average are not achieving the TIMSS international benchmark either for mathematics (grade five and nine) or science. According to the HSRC, the learner performance is influenced by conditions at home, in communities and at school.

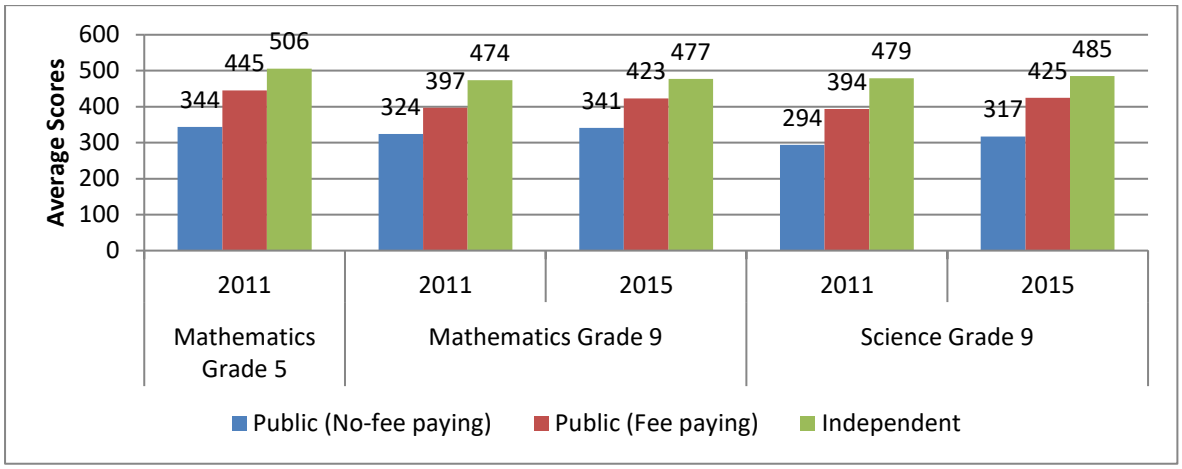


Figure 1.1: Summary of South African TIMSS Scores per School Type

Source: Human Sciences Research Council

The provincial TIMSS performance (**Table 1.2**) confirms the influence of socio-economic conditions on learners' performance. For TIMSS-Numeracy (grade five), Western Cape

learners on average achieved a relatively high score (441), followed by Gauteng (420). For grade nine, the scores for Gauteng are relatively high for both mathematics and science followed by the Western Cape.

Table 1.2: Summary of South African Performance on TIMSS by Province

Province	Grade 5	Grade 9			
	Mathematics	Mathematics		Science	
	2015	2003	2015	2003	2015
Eastern Cape	343	250	346	222	328
Free State	373	291	367	280	351
Gauteng	420	303	408	301	405
KwaZulu-Natal	367	278	369	254	352
Limpopo	344	244	361	216	339
Mpumalanga	384	287	370	266	348
Northern Cape	373	341	364	357	356
North West	355	280	354	260	335
Western Cape	441	414	391	421	388

Source: Human Sciences Research Council

As shown in **Figure 1.2**, from 2003 to 2015, the provinces that had the largest improvement in TIMSS average scores for grade nine science were Limpopo (increase of 123 points), followed by Eastern Cape (106), Gauteng (104) and KwaZulu-Natal (98). In mathematics, Limpopo also had the largest improvement (117) followed by Gauteng (105), Eastern Cape (96) and KwaZulu-Natal (91).

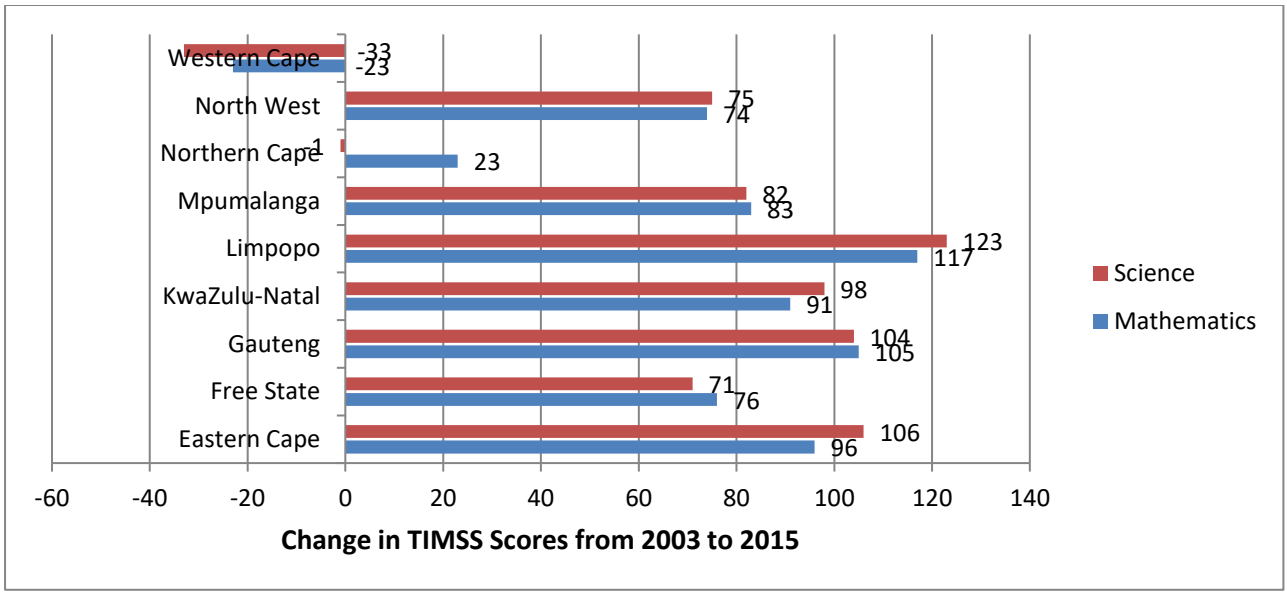


Figure 1.2: Change in Provincial Grade Nine TIMSS Scores, 2003 to 2015

Source: Human Sciences Research Council

1.2 NSC Pass Rate for Mathematics and Physical Science

The percentage of learners passing NSC mathematics with at least 40% from amongst those who wrote the exam decreased from 25.9% in 2008 to 21.4% in 2012 but this trend was then reversed in 2013 reaching a high of 28.0% (**Figure 1.3**). This percentage declined again to 19.6% in 2014 and to 18.5% in 2015. Encouragingly, there has been a slight improvement in 2016 for the proportion of learners passing mathematics with more than 40%, 50% and 60%. The percentage of learners passing mathematics with at least 50% is still very low (12.8%) and this performance reflects a similar pattern to that of TIMSS 2015.

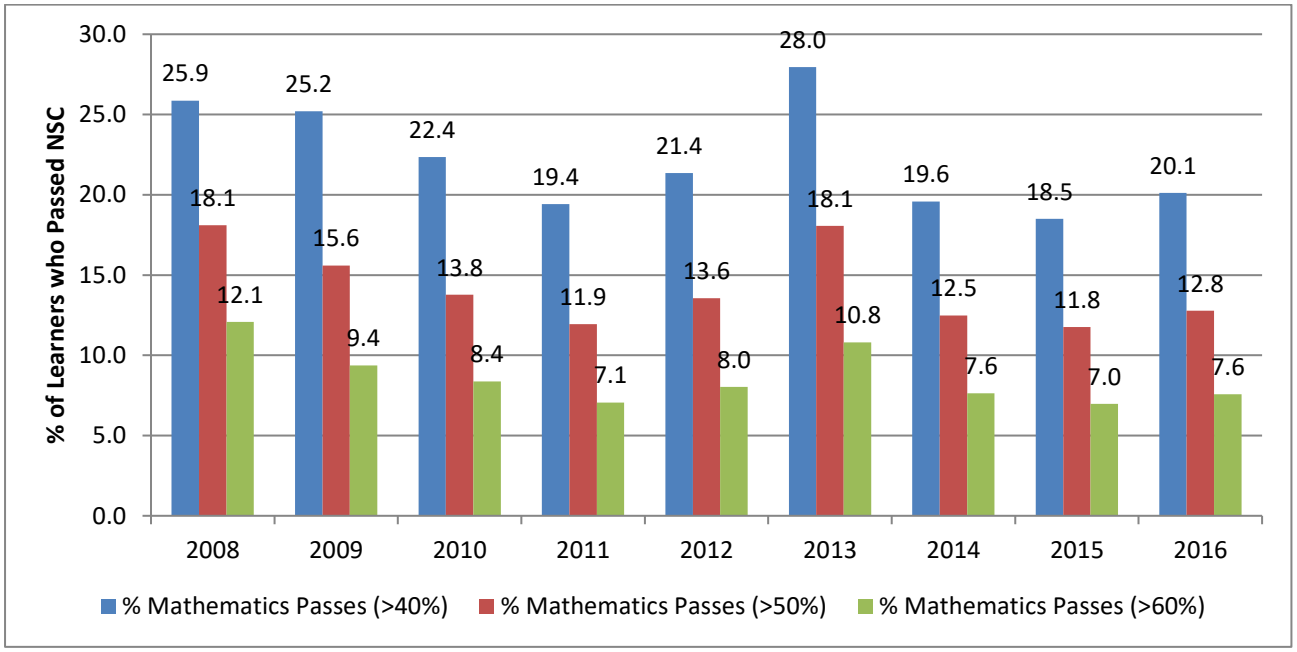


Figure 1.3: Trends in Proportion of Learners Passing NSC Mathematics

Source: Department of Basic Education

The performance of NSC passes in physical science shows trends that are different to those of mathematics between 2008 and 2015.The percentage of learners passing physical science with at least 40%, 50% or 60% increased consistently between 2009 and 2013. Following a decline in performance in 2014 (a phenomenon also observed for mathematics), the proportion of learners passing physical science with at least 40%, 50% or 60% has been on the increase over the past three years.

Despite this slight difference in NSC learner performance trends for both mathematics and science, the percentage of learners passing these subjects with at least 50% remains low. This is an area of concern that requires further improvement according to the National Development Plan (NDP) and Schooling 2025 Action Plan. The NDP emphasises the need

to ensure that at least 90% of learners' master minimum competencies in language and numeracy with 50% pass mark, and this should start from lower grades.

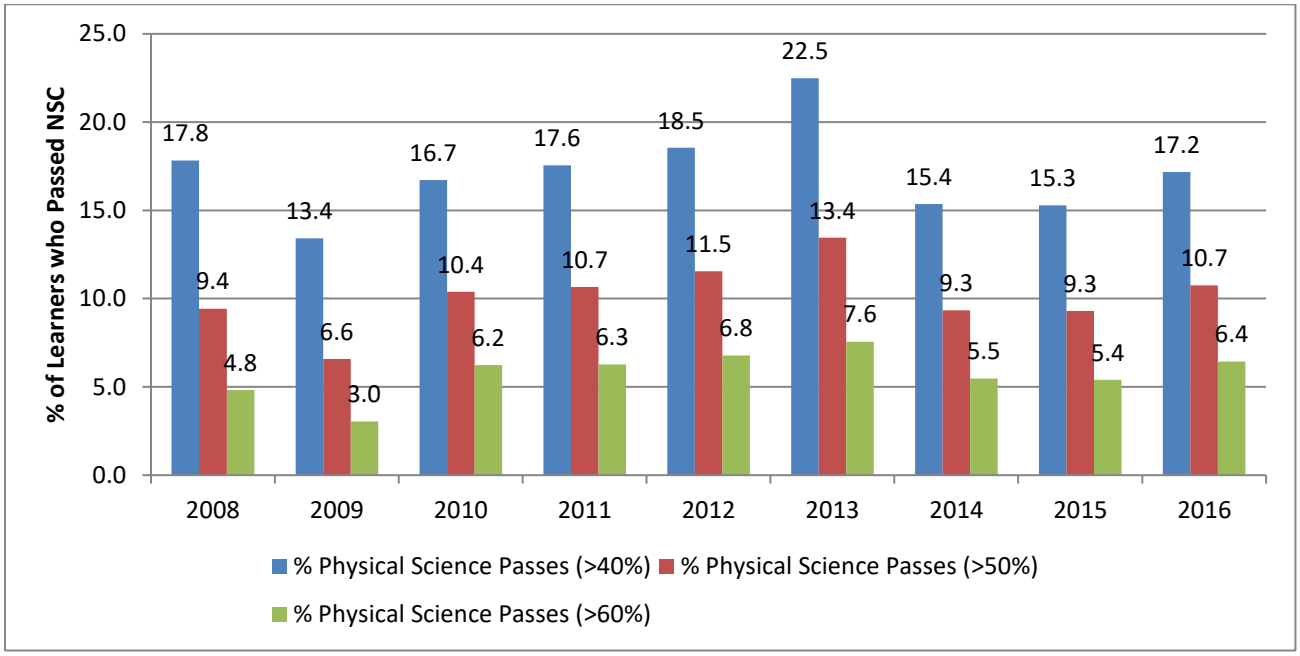


Figure 1.4: Trends in Proportion of Learners Passing NSC Physical Science

Source: Department of Basic Education

In terms of gender, the proportion of female learners passing mathematics NSC with at least 60% has fallen to 43.0% in 2016. The declining trend has continued since 2012 (**Figure 1.5**).

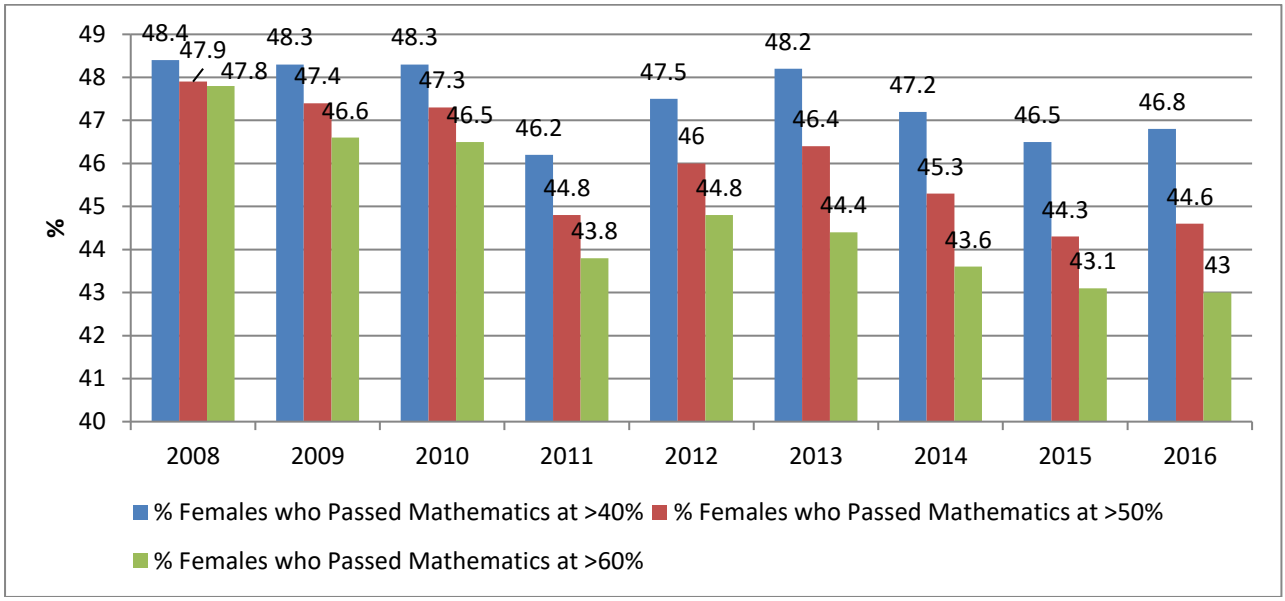


Figure 1.5: Proportion of Learners Passing NSC Mathematics by Gender

Source: Department of Basic Education

Similarly, there is a low proportion of females passing physical science with at least 60% (44.4% in 2016). On the positive side this proportion was slightly higher, at 48.7%, for physical science pass marks of 40% or more. Furthermore, the proportion of female learners passing NSC physical science with at least 40%, 50% or 60% has been on the increase since 2014.

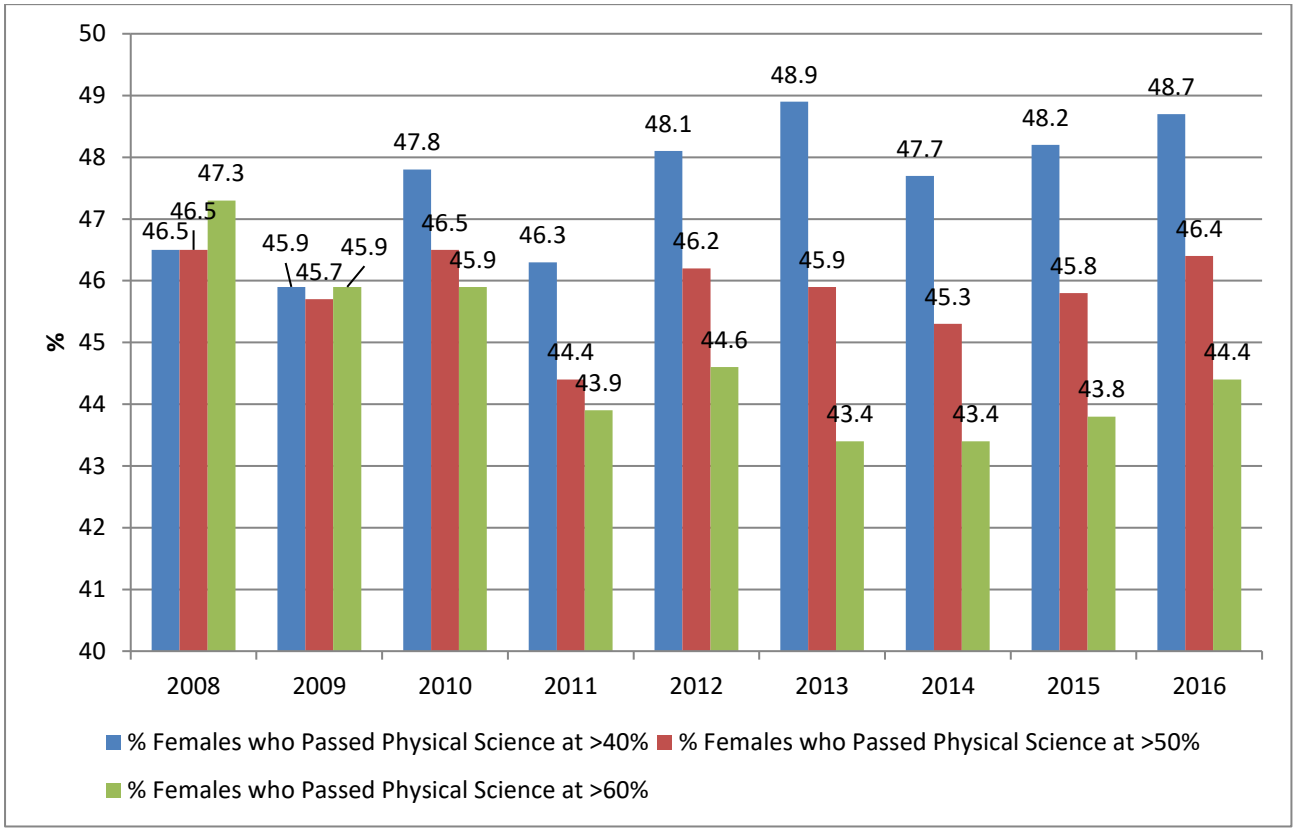


Figure 1.6: Distribution of Learners Passing NSC Physical Science by Gender

Source: Department of Basic Education

1.3 SET Enrolments at Higher Education Institutions (Universities)

As **Table 1.3** shows, over the past decade the percentage of SET enrolments at South African higher education institutions (HEIs) has been stagnant, rising only from 28.7% in 2005 to 29.9% in 2015. This is expected as the proportion of students passing NSC Mathematics with at least 50% has declined from 2008 to 2016. Stagnation in SET enrolment is also taking place with regard to total higher education enrolments which seem to be experiencing capacity challenges. The undergraduate percentage SET enrolment percentage is also stagnant with only a marginal increase, from 29.4% in 2005 to 29.7% in 2015.

At the postgraduate level, a significant increase in SET enrolments as a percentage of total enrolments has taken place rising from 25.6% in 2005 to 28.7% in 2010 and 31.3% in 2015.

The percentage proportion of female SET enrolments is gradually on the increase, rising from 43.5% in 2005 to 46.2% in 2015. Similarly, the proportion of SET enrolments for previously disadvantaged individuals (PDIs) is on the increase, reaching 79.1% in 2015 compared with 7.3% a decade earlier. This suggests some gradual transformation is taking place within the sector, although the pace at which this is occurring is slow given the rise in the share of the population taken up by PDIs over this period.

Table 1.3: Higher Education SET Enrolments

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total HE Enrolments ('000)	735	741	761	800	838	893	938	953	984	969	985
Total SET Enrolments ('000)	211	212	215	225	237	251	264	273	284	287	295
% Total SET Enrolments	28.7	28.5	28.2	28.1	28.3	28.1	28.2	28.7	28.8	29.6	29.9
% Undergraduate SET Enrolments	29.4	29.0	28.2	28.1	28.2	28.0	28.1	28.4	28.8	29.4	29.7
% Postgraduate SET Enrolments	25.6	27.0	28.3	28.2	28.3	28.7	28.4	30.0	29.3	31.0	31.3
% Female SET Enrolments	43.5	43.8	44.1	44.6	45.1	44.9	44.8	45.2	45.5	45.8	46.2
% PDI`s Total SET Enrolments	71.3	72.3	73.1	74.6	75.4	76.2	76.9	77.4	78.2	78.6	79.1

Source: Department of Higher Education and Training

The disaggregation of SET enrolment by PDIs is shown in **Table 1.4** and **Figure 1.7**. African students' proportion of SET enrolments is on the increase whereas there has been a decline for Coloureds, Indian and White students.

Table 1.4: Percentage Proportion of Public Universities' SET Enrolment by Race and Gender

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
African	57.2	58.5	60.1	61.7	62.7	63.6	64.7	65.7	66.6	66.7	67.3
Female	44.4	44.7	44.9	45.2	45.8	45.6	45.4	45.8	46.0	46.2	46.4
Male	55.6	55.3	55.1	54.8	54.2	54.4	54.6	54.2	54.0	53.8	53.6
Coloured	5.8	5.9	5.8	5.9	6.0	6.0	5.8	5.7	5.7	5.7	5.7
Female	46.5	47.6	47.9	49.7	50.5	50.5	49.8	50.2	51.0	51.7	51.5
Male	53.5	52.4	52.1	50.2	49.5	49.5	50.2	49.8	49.0	48.3	48.5
Indian	8.2	7.8	7.3	6.9	6.7	6.5	6.4	6.0	6.0	6.2	6.1
Female	44.7	45.4	45.0	45.5	46.0	46.8	47.1	47.6	48.2	48.4	48.9
Male	55.3	54.6	55.0	54.5	54.0	53.2	52.9	52.4	51.8	51.6	51.1
White	28.6	27.6	26.6	25.2	24.4	23.4	22.6	21.8	20.9	20.4	19.7
Female	40.6	40.6	41.1	41.5	41.8	41.0	41.3	41.6	41.8	42.4	43.4
Male	59.4	59.4	58.9	58.5	58.2	59.0	58.7	58.4	58.2	57.6	56.6

Source: Department of Higher Education and Training

According to the Statistician General[2], although a large number of the students who were enrolled at higher education institutions were black, proportionately this group was under-represented by 1:5 in comparison with the Indian and White students' enrolment if population figures are taken into account. This presents a huge challenge needing to be corrected if a meaningful reduction in inequality by race group is to be diminished.

In terms of disaggregation by gender, White and African female students are still lagging behind in terms of their proportion of total African and White SET enrolments (43.4 and 46.4% respectively in 2015) even if there has indeed been some improvement over the past decade. Coloured female students have a higher proportion of SET enrolments than their male counterparts (51.5%). Indian female students' SET enrolment proportion was 48.9% in 2015.

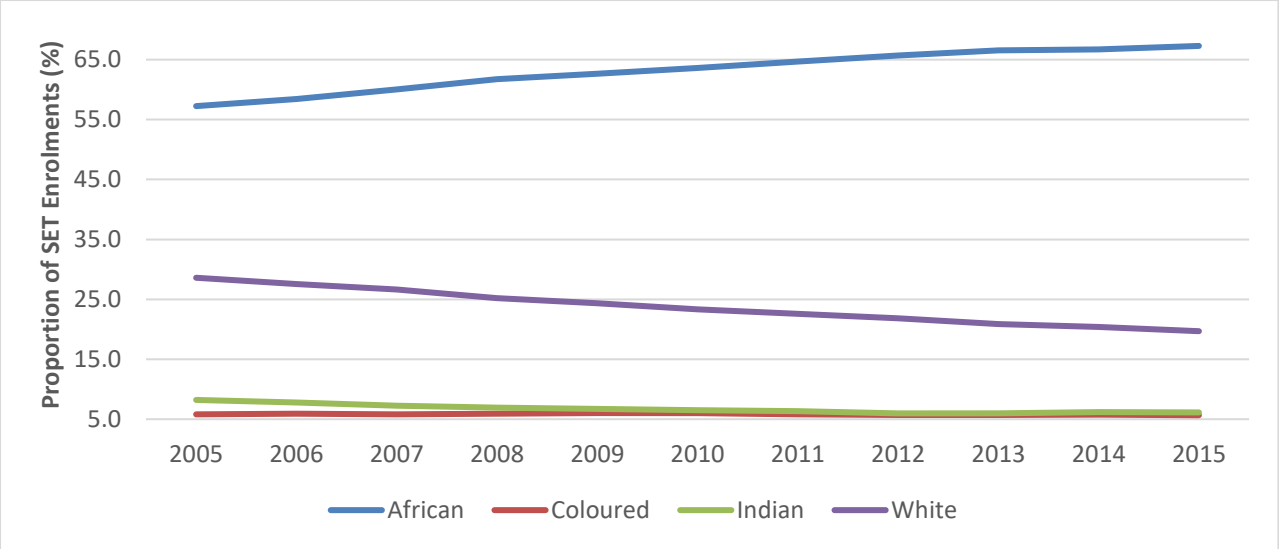


Figure 1.7: Trend in Proportion of SET Enrolments at Public Universities by Race

As shown in **Figure 1.8**, the percentage of SET enrolments at doctoral qualification level as a percentage of all doctoral enrolments is very high (48.8% in 2015) although this has been on a gradual decline since 2012. Humanities' doctoral enrolments are also on the decline. In 2015 they were 29.1% of all doctoral enrolments, down from 39.5% in 2005. On the increase were business and commerce doctoral enrolments followed by enrolments in the education study fields.

[2] Gqirana, T. (2015, November 16). Difference between black and white students failure rate a 'horrow'. *News24.* Retrieved from www.news24.com/SouthAfrica/News/

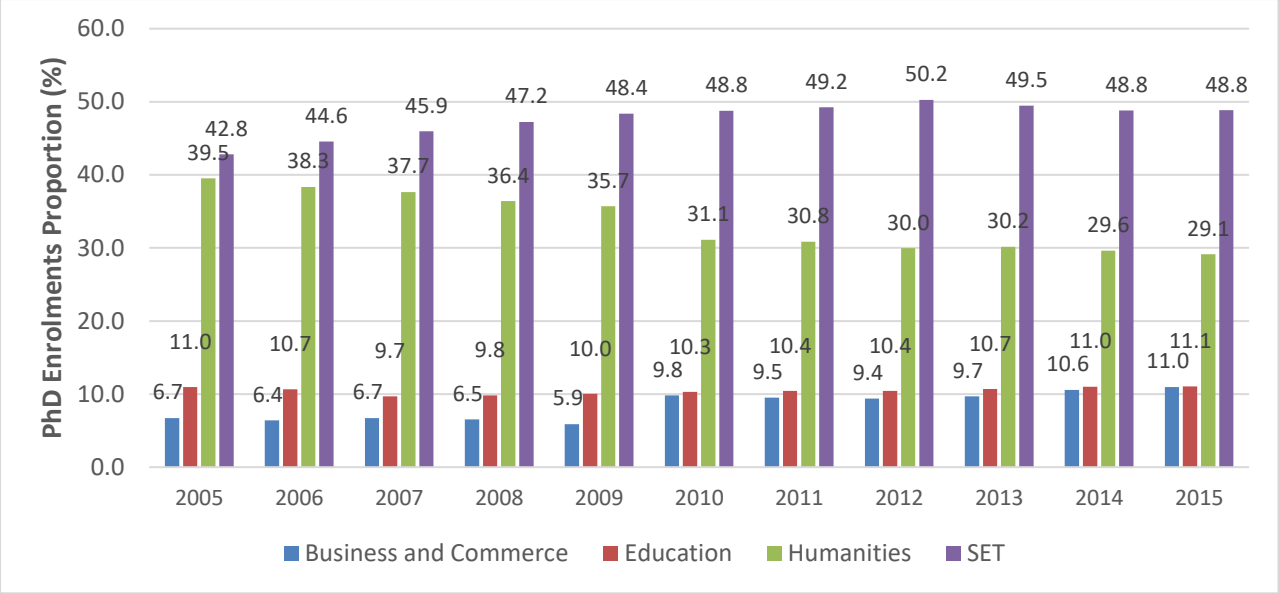


Figure 1.8: Proportion of Higher Education PhD Enrolments by Field

Source: Department of Higher Education and Training

In terms of SET enrolments by nationality, there has been a large increase in the proportion of SET enrolments as a percentage of total public universities' enrolments in respect of other African nationals from outside of Southern African Development Community (SADC), from 40.9% in 2005 to 50.0% in 2015 (**Table 1.6**). This illustrates the growing importance of South Africa`s higher education institutions in helping to develop SET academic expertise within the African continent.

Table 1.6: South African Public Universities' SET Enrolments by Nationality

Nationality	Total Enrolments		% SET Enrolments	
	2005	2015	2005	2015
South Africans	683 473	912 252	28.5	29.5
SADC excl. SA	35 074	52 878	29.9	31.8
Other African Nationals	7 196	12 127	40.9	50.0
Other Foreign Nationals	7 839	6 756	28.3	31.8

Source: Department of Higher Education and Training

2. SET HUMAN CAPITAL

SET human capital capacity is critical to spearhead the research and innovation agenda of the country in an effort to stimulate industrial competitiveness and economic growth through these and the wellbeing of citizens of the country. This section analyses SET graduations and researchers' data.

2.1 SET Graduations

As is the case with the low throughput in terms of the number of graduations at South African universities, SET graduations' throughput is also low. The ratio of SET graduates to that of overall SET enrolments in 2015 was just 1:5, although thankfully this represents a slight improvement from the ratio of 1:6 in 2005. The percentage of SET graduations was slightly higher than that of SET enrolments, with a value of 30.7% in 2015 compared with 28.9% a decade earlier and 27.6% in 2010 (**Table 2.1**).

The percentage proportion of postgraduate SET graduations in 2015 was however slightly lower than that of undergraduates (29.3% compared with 30.3% respectively). This is slightly different from SET enrolments in which the proportion of postgraduate SET enrolments has been higher than that of undergraduates. It suggests greater difficulty in completing postgraduate SET qualifications than in other disciplines. In turn, this could be a function of relative failure in the attainment of decent mathematical and science results at school level. In terms of gender equity, the percentage of female SET graduations has crept upwards from 48.9% in 2005, to 50.2% in 2014 and 50.6% in 2015.

Table 2.1: Public Universities SET Graduation

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total SET Graduations ('000)	33.5	35.5	36.4	39.3	41.5	42.8	46.1	48.8	53.2	55.6	58.1
% SET Graduations	28.9	29.3	29.5	29.9	28.7	27.6	28.6	29.6	30.1	30.6	30.7
% Undergraduate SET Graduations	27.8	28.5	28.8	29.4	28.9	27.9	28.7	29.4	29.4	30.0	30.3
% Postgraduate SET Graduations	24.9	26.1	26.4	27.6	29.4	28.7	28.9	29.1	27.7	28.5	29.3
% Female SET Graduations	48.9	48.7	49.2	49.5	49.3	49.1	49.4	49.4	50.0	50.2	50.6
% PDI`s Total SET Graduations	61.2	62.8	64.1	66.4	67.7	69.2	70.1	71.5	72.8	74.1	74.0

Source: Department of Higher Education and Training

In terms of transformation, the percentage of SET graduations for PDIs has steadily increased from 61.2% in 2005, to 69.2% in 2010 and 74.0% in 2015. One hopes that this is as a result of a general improvement in the relative quality of PDI students entering the higher education environment rather than as a deliberate attempt by such institutions to push through transformation at the expense of quality.

As **Table 2.2** and **Figure 2.1** show, the percentage of African student SET graduations at public universities has been on the increase whereas that of Coloured, Indian and White students is on decline. This pattern is similar to that of SET enrolments and is probably driven by an expanding higher education system with improved access on the part of African students.

In terms of gender, the percentage of female SET graduations is higher for Coloured, Indian and African students (56.0%, 53.2% and 51.5% respectively) than it is for Whites. The percentage SET graduations of female White students relative to White male counterpart is still lagging behind (46.6% in 2015). This is an area requiring further exploration to understand the dynamics taking place as for other race groups gender representivity is higher for female students who account for a higher proportion of the overall population than males.

Table 2.2: Percentage Proportion of Public Universities' SET Graduations by Race and Gender

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
African	46.2	48.5	50.0	52.4	54.0	56.5	57.4	59.6	60.9	62.8	63.0
Female	50.0	50.2	50.4	49.8	50.3	49.9	50.4	51.1	51.1	51.5	51.5
Male	50.0	49.8	49.6	50.2	49.7	50.1	49.6	48.9	48.9	48.5	48.5
Coloured	6.1	6.2	6.3	6.5	6.9	6.6	6.4	6.1	6.1	5.9	5.9
Female	53.6	52.1	55.7	57.7	58.0	58.5	56.2	54.3	57.1	57.0	56.0
Male	46.4	47.9	44.3	42.3	42.0	41.5	43.8	45.7	42.9	43.0	44.0
Indian	9.0	8.2	7.9	7.7	7.0	6.6	6.9	6.6	6.7	6.2	6.1
Female	51.1	52.7	52.6	52.7	52.2	51.7	51.2	51.9	55.1	52.1	53.2
Male	48.9	47.3	47.4	47.3	47.8	48.3	48.8	48.1	44.9	47.9	46.8
White	38.8	37.2	35.8	33.4	32.1	30.3	29.3	27.6	26.4	25.1	24.9
Female	46.4	45.4	45.7	46.0	45.7	45.0	45.5	44.5	44.9	45.3	46.6
Male	53.6	54.6	54.3	54.0	54.3	55.0	54.5	55.5	55.1	54.7	53.4

Source: Department of Higher Education and Training

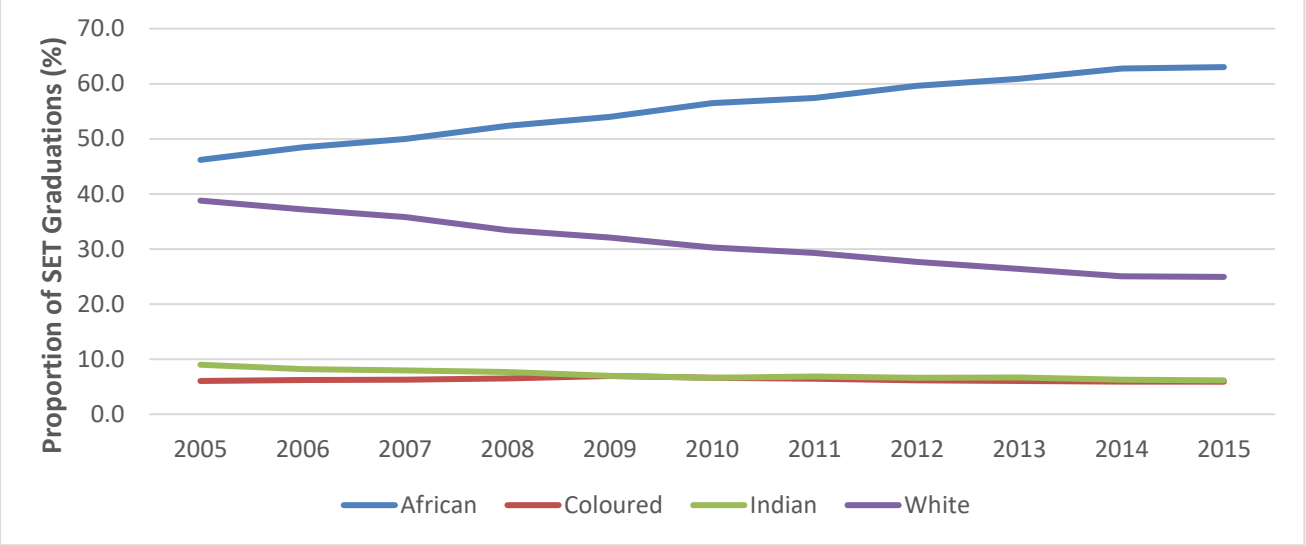


Figure 2.1: Trend in Proportion of SET Graduations at Public Universities by Race

For doctoral qualifications, the percentage of degrees awarded in SET fields of study as a proportion of total doctoral degrees awarded (**Figure 2.2**) is much lower than the percentage of overall doctoral enrolments accounted for by SET doctoral enrolments (**Figure 1.8**). Again this speaks to proportionately greater difficulty in completing SET qualifications once enrolled compared with the case for other disciplines. In 2015, only 30.3% of doctoral degrees were awarded in SET fields.

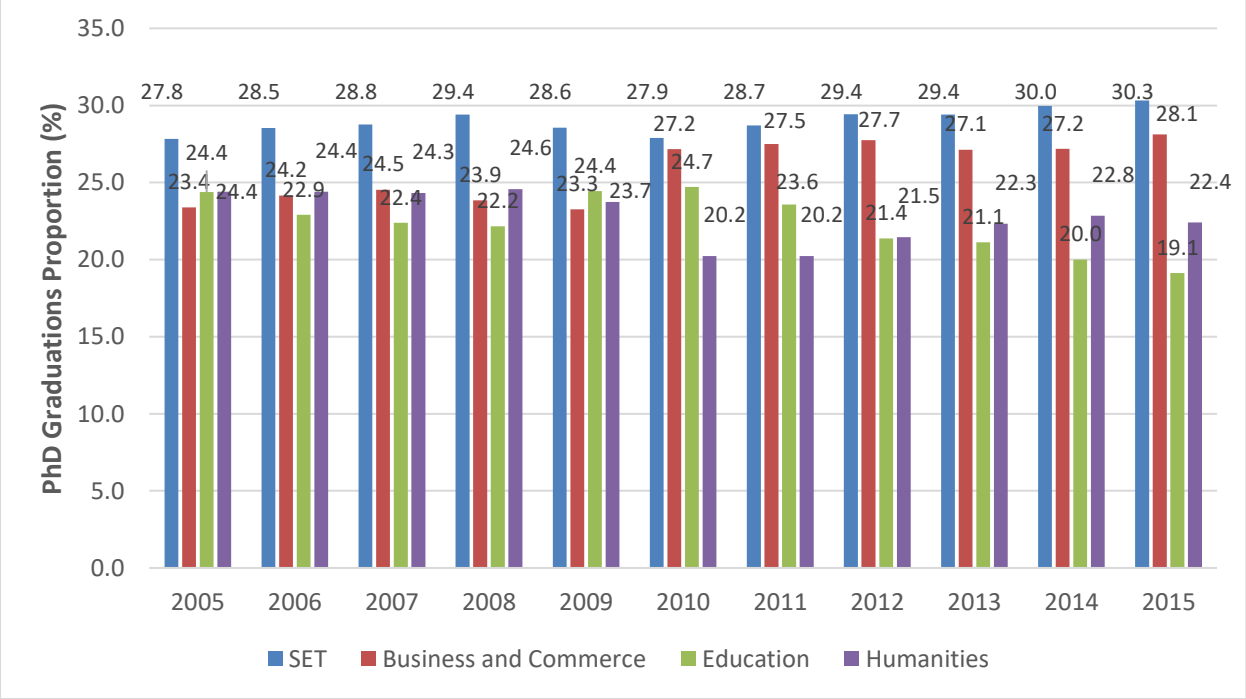


Figure 2.2: Proportion of Doctoral Degrees Awarded by South African Universities by Field of Study

Source: Department of Higher Education and Training

There is a relatively high proportion of doctoral degrees awarded in education as well as in business and commerce fields of study (19.1% and 22.4% respectively in 2015). The NDP advocates a large share of SET doctoral graduates in order for South Africa to be a leading innovator. An overall NDP target for doctoral graduates is 100 doctoral graduates per million inhabitants per year by 2030. This translates to an immediate target of 5,000 doctoral graduates per year, the majority of these being on SET fields.

A higher proportion of SET doctoral degrees are awarded to male students than their female counterparts, a trend that goes as far back as 2005 (**Figure 2.3**). In 2015, 717 SET doctoral degrees were awarded to male graduates with only 546 awarded to female graduates.

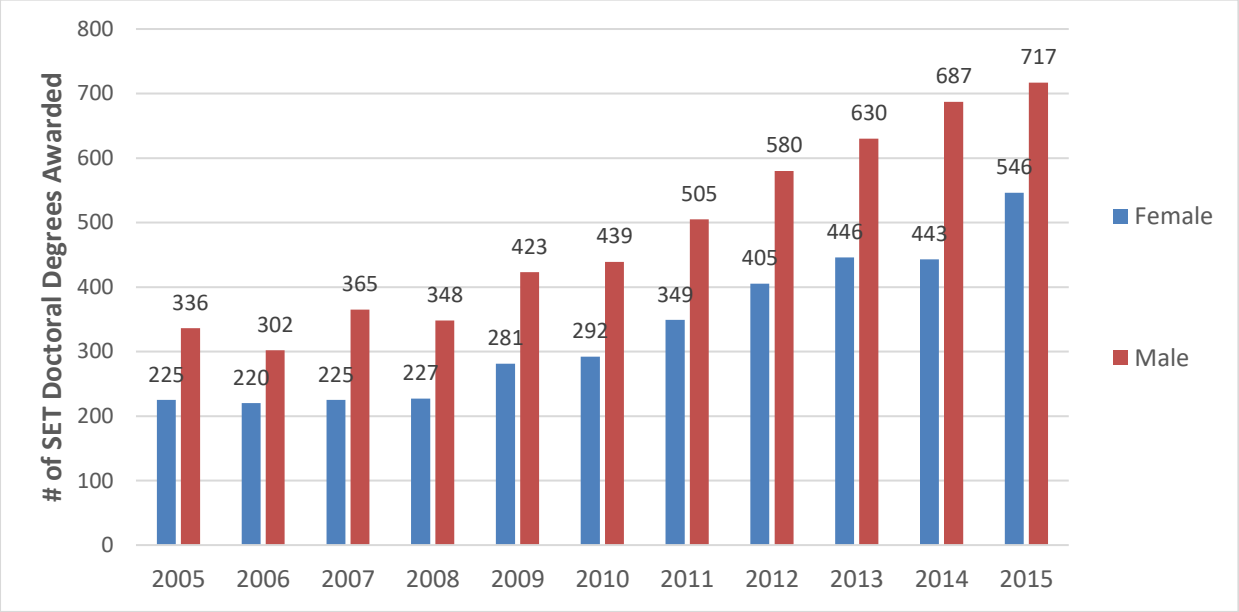


Figure 2.3: Doctoral Degrees Awarded by South African Universities by Gender

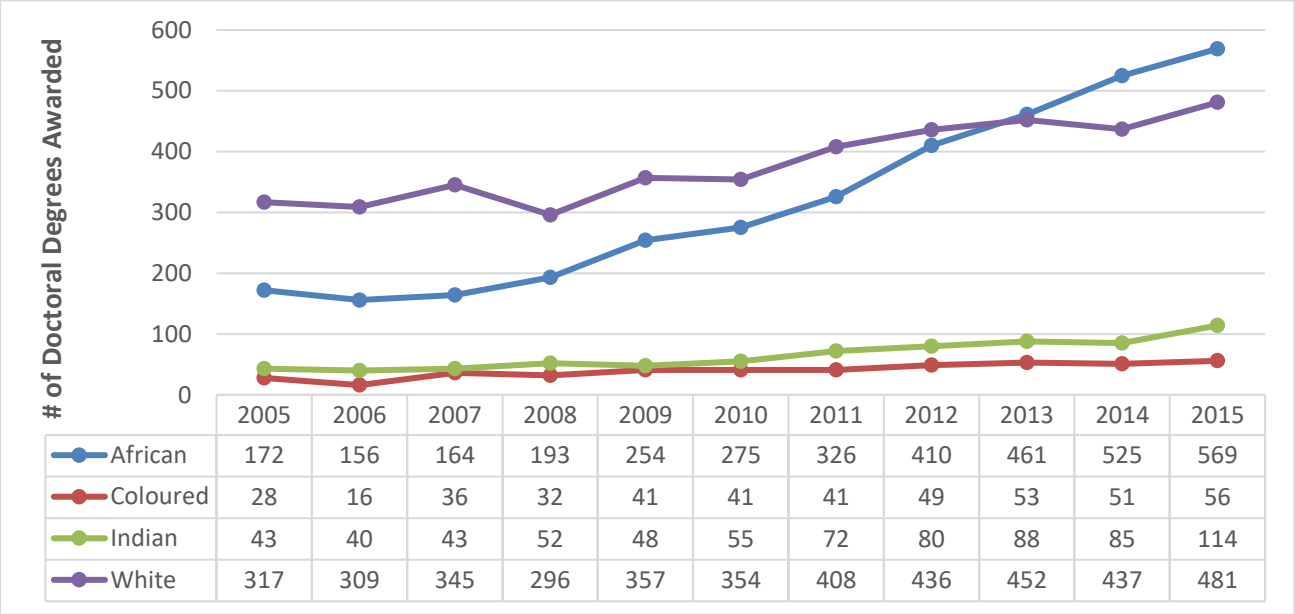
Source: Department of Higher Education and Training

Higher education institutions are continuing a positive trend of transformation at SET doctoral degree level (**Table 2.3** and **Figure 2.4**). In 2015 the number of African graduates receiving doctoral qualifications remained high even though it was slightly lower, at 46.6% of all doctoral qualifications, down from 47.8% in 2014. The figure was substantially higher than it was a decade ago. However, in comparison with the share of Africans in South Africa's total population, of over 80%, this number was still very low.

Table 2.3: Percentage Distribution of SET Doctoral Degrees Awarded by South African Universities by Race

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
African	30.71	29.94	27.89	33.68	36.29	37.93	38.49	42.05	43.74	47.81	46.64
Coloured	5.00	3.07	6.12	5.58	5.86	5.66	4.84	5.03	5.03	4.64	4.59
Indian	7.68	7.68	7.31	9.08	6.86	7.59	8.50	8.21	8.35	7.74	9.34
White	56.61	59.31	58.67	51.66	51.00	48.83	48.17	44.72	42.88	39.80	39.43

Source: Department of Higher Education and Training



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
African	172	156	164	193	254	275	326	410	461	525	569
Coloured	28	16	36	32	41	41	41	49	53	51	56
Indian	43	40	43	52	48	55	72	80	88	85	114
White	317	309	345	296	357	354	408	436	452	437	481

Figure 2.4: Trend in the Number of Doctoral Degrees Awarded

2.2 Researchers

Researchers are an important asset for any research and innovation effort aimed at bringing novel ideas and improving on the existing knowledge domains. As **Table 2.4** and **Figure 2.5** show, the number of researchers per million population was on a gradual increase up until 2007/08 which marked the start of the global economic recession.

This indicator then showed a good improvement again from 2010/11 onwards, although there was a slight decline from 439 to 437 between 2013/14 and 2014/15. The number of researchers per thousand persons employed also declined, from 1.6 in 2013/14 to 1.5 in 2014/15, while the number of researchers per thousand labour force remained constant at around 1.0%. The percentage of female researchers increased significantly from 34.7% in

2001/02 to 38.4% in 2008/09 and to 44.1% in 2014/15. This indicates success in the programme of gender diversification and empowerment of women in the fields of SET.

Table 2.4: South African R&D Researchers (FTE)

	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Researchers per million capita	311	301	376	358	379	389	385	388	363	385	405	439	437
Researchers per thousand employed	1.1	1.1	1.4	1.3	1.3	1.4	1.3	1.4	1.4	1.4	1.5	1.6	1.5
Researchers per thousand labour force	0.8	0.8	1.1	1.0	1.0	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.0
% of female researchers (FTE)	34.7	35.8	37.0	36.2	38.3	38.0	38.4	39.0	40.9	41.7	43.4	43.5	44.1

Source: Department of Science and Technology

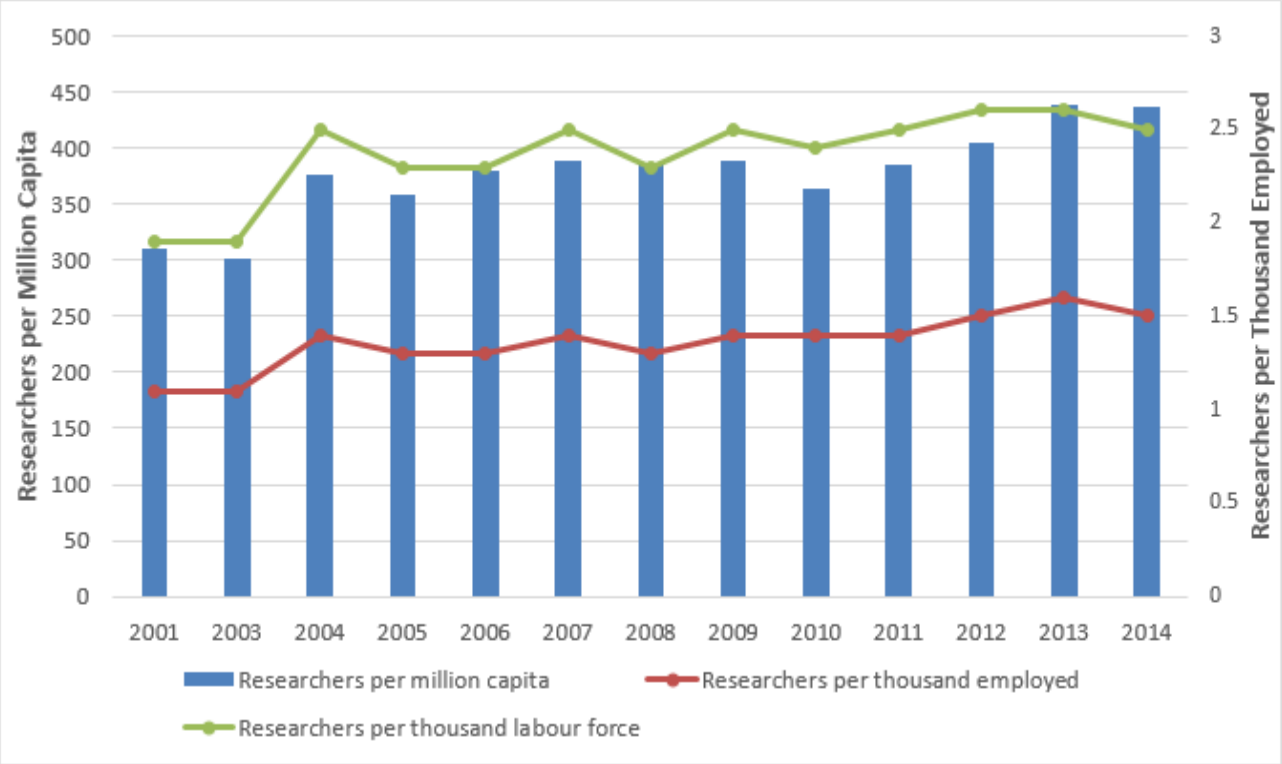


Figure 2.5: Trend in the Number Researchers Involved with R&D

Table 2.5 gives more perspective on the level of South African researchers through international benchmarking. By far the majority of researchers in R&D within the SADC region

are concentrated in South Africa (96.17% in 2013). The level has remained high since 2001. As a proportion of SSA and the whole of Africa, the percentage of South African researchers was 28.5% and 15.6% in 2013 respectively.

In general, the proportion of the country's researchers relative to various regions has been stable. This indicates that South Africa's efforts to improve its research human capital capacity continue at the same pace as those of regional economies. South Africa`s role in research on the continent remains prominent. However, the proportion of the world`s researchers in South Africa is lower than the country`s share of world GDP, at 0.3% compared with 0.4% respectively.

Table 2.5: Benchmarking of South African R&D Researchers (FTE)

	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
SA researchers as % of SADC researchers	94.52	94.46	95.38	95.10	95.38	93.50	92.97	95.30	84.51	89.87	91.90	96.17
SA researchers as % of SSA researchers	29.38	27.82	31.91	29.71	31.65	32.87	29.95	28.56	25.27	26.13	26.72	28.50
SA researchers as % of Africa researchers	29.38	27.82	31.91	27.11	23.61	13.87	14.57	16.47	12.25	12.44	12.53	15.64
SA researchers as % of BRICS researchers	1.06	0.97	1.18	0.93	1.02	0.95	0.89	1.14	0.93	1.13	1.14	1.20
SA researchers as % of Upper Middle Income Economies researchers	0.84	0.77	0.91	0.81	0.81	0.77	0.71	0.89	0.79	0.79	0.75	0.75
SA researchers as % of G20 researchers	0.31	0.29	0.35	0.32	0.33	0.33	0.31	0.34	0.30	0.34	0.35	0.47
SA researchers as % of world researchers	0.28	0.26	0.32	0.29	0.30	0.30	0.29	0.29	0.26	0.27	0.28	0.30

Source: computed by NACI from Unesco Institute for Statistics

As **Table 2.6** shows, the percentage of researchers employed by higher education institutions and the business sector remains much higher amongst Whites (53.4% and 69.5% respectively). On the other hand, the government sector employs a higher proportion of female researchers from all the other race groups although the number of researchers in this sector as a proportion of all researchers was just 4.7%.

It remains of concern that the representation of researchers drawn from previously disadvantaged race groups employed in the business sector is very low in comparison to representation in this sector by Whites. To some extent the same applies in respect of representation in higher education. There are clearly areas in need of focus to effect transformation in terms of increasing the proportion of black graduates in SET areas of research rather than in 'softer' disciplines not focussed on SET.

Table 2.6: Number of Researchers in Headcounts by Population Group and Gender per Sector, 2014/15

	African		Coloured		Indian		White		
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Total**
Business	519	501	169	143	311	269	2 947	1 403	6 261
Higher Education	3 478	2 360	787	824	607	621	5 004	4 944	18 625
Government	284	306	49	64	39	72	243	286	1 343
Science Councils	496	321	61	62	77	98	520	353	1 988
Not-for-Profit	103	100	15	30	15	24	101	118	506

Source: Department of Science and Technology "2014/15 National Survey of Research and Development"

The higher education staff profile (**Table 2.7**) shows that in terms of gender, the majority of staff with doctoral qualifications (PhD's) are male, although there has been a substantial increase in the share of female staff with PhD's over the last ten years.

Encouragingly, there has been an increase in the proportion of African, Coloured and Indian staff with PhD's. In terms of race and gender, there is a higher proportion of White female academic staff with PhD's (25.9% in 2014) than is the case with female staff of other race groups. The majority of staff with PhD's are aged between 40 – 49 and 50 – 59 years.

Table 2.7: Proportion of Higher Education Academic Staff with Doctorate Qualification (FTE)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
No of Staff with PhDs	3 787	4 412	4 321	4 724	4 939	5 190	5 704	5 892	6 326	6 762
Proportion of Female Staff with PhD (%)	30.4	31.3	32.2	34.0	34.3	35.4	36.3	37.2	38.3	39.1
Proportion of Male Staff with PhD (%)	69.6	68.7	67.8	66.0	65.7	64.6	63.7	62.8	61.7	60.9
Proportion of African Staff with PhD (%)	14.8	14.0	14.6	16.3	18.1	18.9	20.6	21.5	22.4	22.6
Proportion of Coloured Staff with PhD (%)	3.2	3.6	4.1	4.3	4.3	4.3	4.6	5.0	5.5	5.5
Proportion of Indian Staff with PhD (%)	5.8	5.5	5.9	5.7	6.5	6.7	7.1	7.3	7.3	7.3
Proportion of White Staff with PhD (%)	75.8	76.0	72.2	71.3	70.4	67.9	65.7	64.0	62.2	60.2
Proportion of African Female Staff with PhD (%)	3.1	3.1	3.3	3.8	4.1	4.6	5.2	5.7	6.3	6.6
Proportion of Coloured Female Staff with PhD (%)	1.0	1.1	1.3	1.6	1.7	1.6	1.8	2.0	2.2	2.3
Proportion of Indian Female Staff with PhD (%)	1.9	1.7	2.0	2.0	2.4	2.5	2.8	2.9	3.2	3.3
Proportion of White Female Staff with PhD (%)	24.3	25.2	24.8	26.0	25.8	26.1	26.1	26.1	26.0	25.9
Proportion of Staff aged 20-29 with PhD (%)	2.0	1.6	1.5	1.5	1.6	1.6	1.7	1.3	1.7	1.6
Proportion of Staff aged 30-39 with PhD (%)	17.4	18.4	18.8	19.3	19.1	20.3	21.0	19.9	20.6	21.0
Proportion of Staff aged 40-49 with PhD (%)	32.8	32.8	32.3	31.5	31.1	30.8	30.9	31.7	31.4	31.8
Proportion of Staff aged 50-59 with PhD (%)	36.6	35.8	34.8	34.3	34.4	32.9	32.3	32.1	31.6	30.7
Proportion of Staff aged 50+ with PhD (%)	11.1	11.5	12.7	12.9	13.7	14.4	14.1	15.0	14.7	14.9

Source: DST "Research Information Management System (RIMS) Database"

Table 2.8 shows that although Whites continue to dominate the list of the National Research Foundation (NRF) rated researchers, there has been some improvement over the last two decades. Unfortunately, the pace of improvement has slowed slightly as shown by **Figure 2.6**. In 1996, the ratio of African NRF rated researchers to their Whites counterparts was 1:28 and this ratio improved to 1:6 in 2012, but only slightly further to 1:5 in 2015. This improvement in NRF rating per race group is also taking place in respect of Coloured and Indian researchers.

Among female researchers by race groups, the number of White female NRF rated researchers increased the most and this group is now better represented in 2015 as compared to 1996. The percentage of White female NRF rated researchers to that of total White NRF rated researchers in 2015, was 34.2%. This constituted a sizeable improvement from 14.7% in 1996. As a proportion of total NRF rated researchers, White female NRF rated researchers increased from 13.2% in 1996 to 25.3% in 2015. The percentage of African, Coloured and Indian female NRF rated researchers to that of total NRF rated researchers increased from 0.4%, 0.2% and 0.2% respectively in 1996 to 2.7%, 1.2% and 2.1% respectively in 2015. The percentage of African male NRF rated researchers to that of total NRF rated researchers increased from 2.8% in 1996 to 12.8% in 2015; conversely, for White male researchers, this percentage declined from 76.7% in 1996 to 48.6% in 2015. There has therefore been considerable gender transformation in the NRF rated researchers over the past two decades.

According to the NRF, "the rating of individuals is based primarily on the quality and impact of their research outputs over the past eight years, taking into consideration the evaluation made by local and international peers". Therefore, to accelerate the share of NRF rating by researchers from the underrepresented groups, appropriate mechanisms need to be put into place to increase the number and quality of researchers from these groups at the qualifying institutions (South African higher education institutions, science councils, etc.).

Table 2.8: National Research Foundation Rated Researchers

	African			Coloured			Indian			White		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
1996	31	5	**36**	16	2	**18**	34	2	**36**	864	149	**1 013**
2000	49	5	**54**	21	2	**23**	40	6	**46**	894	195	**1 089**
2004	78	9	**87**	34	7	**41**	47	14	**61**	1 081	367	**1 448**
2008	135	23	**158**	58	13	**71**	73	18	**91**	1 154	436	**1 590**
2012	273	52	**325**	63	32	**95**	115	39	**154**	1 403	655	**2 058**
2013	319	64	**383**	70	34	**104**	132	53	**185**	1 545	736	**2 281**
2014	382	76	**458**	69	36	**105**	149	59	**208**	1 599	791	**2 390**
2015	436	91	**527**	73	42	**115**	167	70	**237**	1 651	860	**2 511**

Source: National Research Foundation

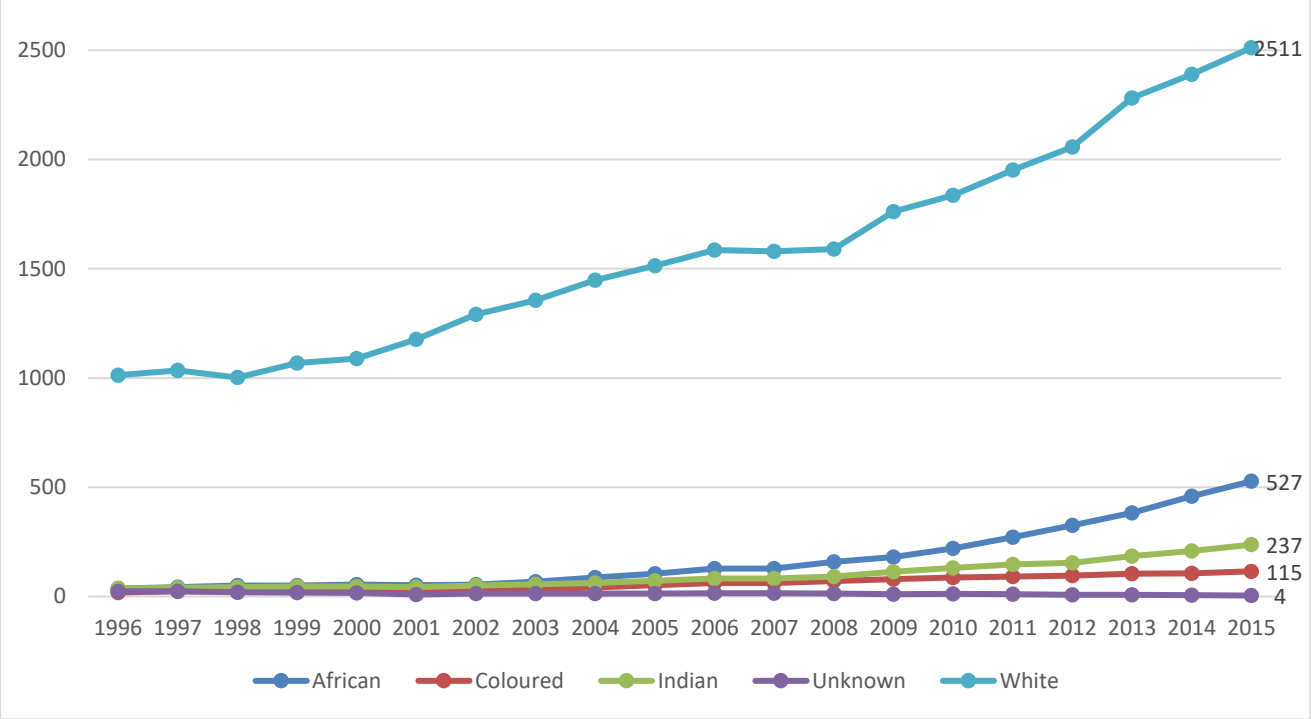


Figure 2.6: Trend in the Number of NRF Rated Researchers

3. CURRENT R&D AND INNOVATION CAPACITY

The research and innovation capacity of the country enhances the absorptive capacity of the country to learn and diffuse imported technologies but also to create novel and incremental solutions that have the potential to improve the socioeconomic landscape of the country. This section analyses R&D expenditure on the input side as well as publications data as part of the R&D outputs.

3.1 Research and Development Expenditure

R&D expenditure has risen substantially from a baseline of R7.5 billion in 2001/02, prior to the launching of the National Research and Development Strategy (NRDS), to R29.3 billion in 2014/15 (**Table 3.1**). In real 2010 – based values, this represents an increase from R14.4 billion to R23.2 billion. The higher education sector has increased its R&D expenditure at a much higher pace than the business sector. In 2007/08 its contribution to gross expenditure on R&D (GERD) was 19.4% while that of the business sector was 57.5%. By 2014/15, the higher education sector's contribution had increased to 28.7% while that of the business sector had decreased to 45.4%. The decline in R&D expenditure by the business sector, especially since the global financial crisis in 2008, is an indication of the manner in which slower economic growth has impacted adversely on the willingness and ability of business to spend on R&D.

Table 3.1: Proportion of R&D Expenditure by Sector

	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	(%)												
Business	53.3	55.4	56.7	58.2	55.8	57.5	58.6	52.9	49.8	47.3	44.4	45.9	45.4
Higher Education	25.3	20.8	20.8	19.1	20.0	19.4	20.0	24.3	26.6	29.7	30.5	28.4	28.7
Government	20	5.0	4.2	5.7	6.1	6.5	5.2	5.2	4.9	5.4	5.9	6.6	6.5
Science Councils		16.8	16.7	14.9	16.4	15.6	14.8	16.7	17.7	16.7	16.7	16.7	17.1
Not-for-Profit	1.3	2.0	1.7	1.4	1.2	1.1	1.0	1.0	1.0	0.9	2.1	2.3	2.7
GERD (R bn, current values)	**7.5**	**10.1**	**12.0**	**14.1**	**16.5**	**18.6**	**21.0**	**21.0**	**20.3**	**22.2**	**23.9**	**25.7**	**29.3**
GERD (R bn, 2010 real values)	**14.4**	**16.3**	**18.2**	**20.3**	**22.3**	**23.1**	**24.0**	**22.3**	**20.3**	**20.8**	**21.2**	**21.5**	**23.2**

Source: Department of Science and Technology "National Survey of research and Development"

As the higher education sector by its nature performs mainly basic research, the relative increase of R&D expenditure in this sector implies that there will be more orientation towards this type of research at an aggregate level for the country. Debate has developed in recent times as to whether the type of research conducted by higher education institutions is sufficiently geared towards satisfying the needs of the business sector and the economy more generally. R&D expenditure of the not-for-profit sector had been stagnant at around R200 million over several years, but there has been a sudden acceleration in recent years with the figure reaching R800 million in 2014/15.

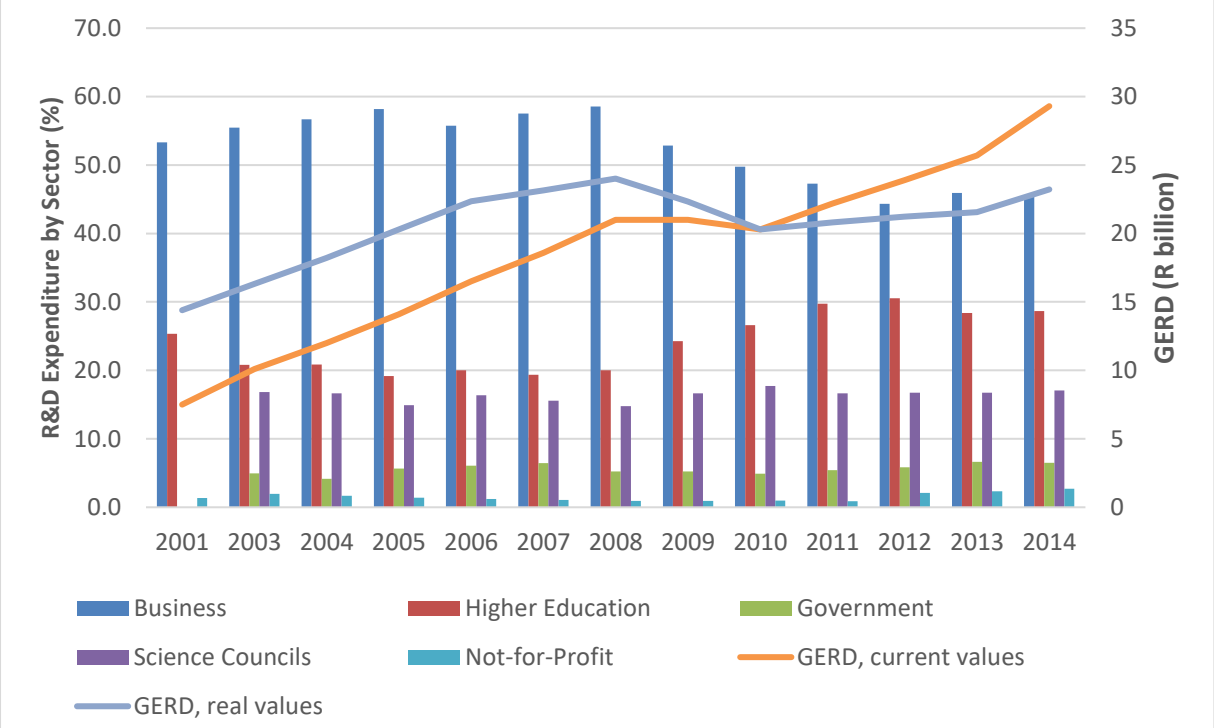


Figure 3.1: Trend in R&D Expenditure by Sector

An alternative way of measuring R&D expenditure is that based on the system of national accounts (SNA). In this framework, R&D is treated as an investment to allow the national accounts to better measure the effects of innovation and intangible assets on economic growth and productivity. Only R&D expenditure that is intended for commercial purposes is included in this framework, hence the exclusion of the higher education sector.

As shown in **Table 3.2** and **Figure 3.2**, the private business enterprise sector accounts for the major proportion of R&D expenditure (69.3% during 2011 - 2015) in the economy followed by the general government sector (at 23.9%) and public corporations (at 6.3%). Total R&D

expenditure based on the SNA in 2014 was 56.7% of the value of general expenditure on R&D measured in accordance with the Frascati Manual.

Table 3.2: R&D Expenditure (per SNA) as Component of Fixed Capital Formation

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
Private Business Entreprises (% of total)	68.4		68.4	69.0	70.0	69.3		70.2	69.6	66.9
General Government (% of total)	23.8		23.8	23.5	23.1	23.9		22.8	23.8	26.9
Public Corporations (% of total)	7.8		7.8	7.5	6.9	6.8		7.1	6.7	6.3
Total SNA R&D Expenditure (million R)	3 587		21 220	36 396	65 597	80 870		15 899	16 620	18 945

Sources: South African Reserve Bank "Online Statistical Query"

The trend in R&D expenditure by private businesses relative to the public sector in the approximate ratio of 2:1 is roughly in line with the corresponding ratio in respect of overall capital investment. This suggests that the decision to embark upon R&D is influenced by similar factors to those determining capital investment more generally. This is unfortunate because one would like to see increased R&D expenditure breaking the mould a reluctance on the part of the economy to invest for future growth.

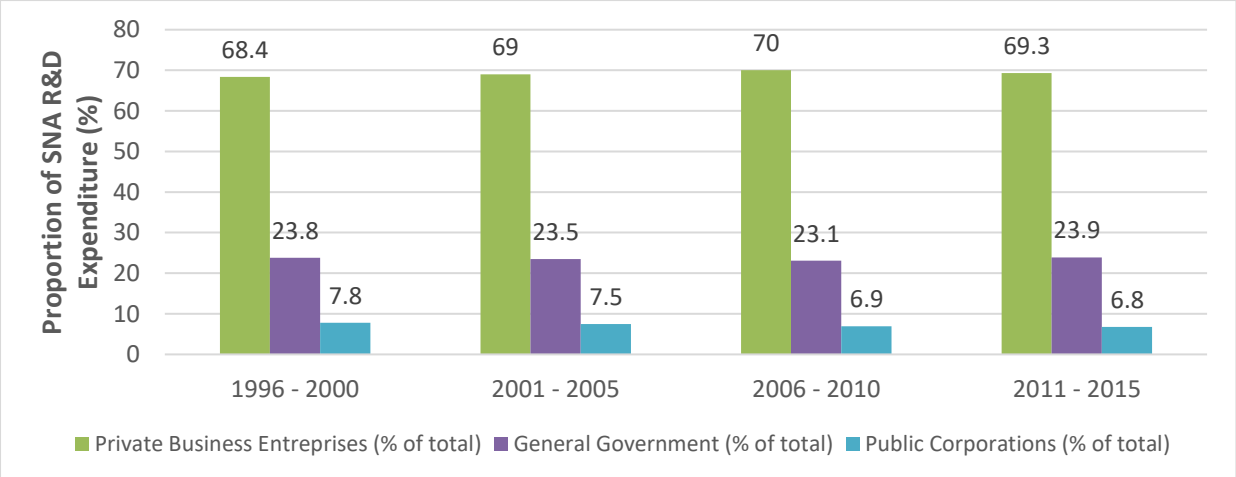


Figure 3.2: Trend in Systems of National Accounts R&D Expenditure

The international benchmarking of South African R&D expenditure (**Table 3.3**) shows that despite the disappointing share of investment in South Africa in R&D, the country's R&D

expenditure is proportionately very high compared with other SADC countries, accounting for 88.8% of R&D expenditure in the region in 2013/14. This proportion is also high in relation to the whole of SSA and the rest of Africa although it has been declining in both instances since 2008/09. Nonetheless, it also illustrates the appallingly low proclivity to invest in R&D in the African continent as a whole. This renders the continent highly dependent on know-how from other continents, leading to perceptions of being colonised.

Table 3.3: Benchmarking of South African R&D Expenditure

	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
SA R&D expenditure as % of SADC R&D expenditure	96.69	96.36	95.27	94.85	98.75	93.57	96.82	98.55	91.60	99.32	97.67	88.80
SA R&D expenditure as % of SSA R&D expenditure	51.80	52.94	52.75	55.18	55.72	54.62	53.06	48.35	42.75	41.54	40.24	38.29
SA R&D expenditure as % of Africa R&D expenditure	31.23	31.73	32.51	35.95	36.37	35.61	34.46	28.51	25.00	24.24	23.33	21.37
SA R&D expenditure as % of Upper Middle Income Economies R&D expenditure	3.30	2.99	2.97	2.86	2.79	2.53	2.31	1.80	1.46	1.35	1.21	1.11
SA R&D expenditure as % of BRICS R&D expenditure	2.99	-	2.69	2.69	2.60	2.49	2.28	2.09	1.64	1.36	1.26	1.30
SA R&D expenditure as % of G20 R&D expenditure	0.36	0.39	0.42	0.44	0.45	0.44	0.43	0.39	0.34	0.33	0.32	0.31
SA R&D expenditure as % of world R&D expenditure	0.33	0.36	0.38	0.41	0.42	0.40	0.40	0.36	0.31	0.30	0.29	0.28

Sources: computed by NACI from Unesco Institute for Statistics

Unfortunately, one observes South Africa falling behind the rest of the world over time in respect of the amount spent on R&D. There has been a decrease in South African R&D expenditure as a share of the world's R&D expenditure, from 0.42% in 2006/07 to 0.28% in 2013/14. This declining proportion of the country's share of global R&D expenditure is also taking place in relation to the BRICS countries, upper middle income economies and G20 countries. As is the case with SSA and the rest of Africa, most of the decline in the proportion of South Africa's R&D expenditure has taken place since the global financial recession of 2008/09. This trend is worrying as it is known that those countries that invest heavily in R&D during a period of slow economic growth emerge proportionately stronger during the subsequent upturn of the economy when it arrives. The relative increase in South Africa's

R&D expenditure in the early part of the last decade and the fall-off in such expenditure over the subsequent period also tallies with a similar trend in respect of its capital expenditure as a percentage of GDP more generally. Capital expenditure has declined from 25% of GDP a decade ago to 19% of GDP currently, representing a distinct failure to meet a critical goal of the NDP which is for this ratio to be held at 25% of GDP so as to enhance the country`s longer term growth potential.

Table 3.4 and **Figure 3.3** show an analysis of R&D intensity for various industries in the business sector. R&D expenditure of the agriculture industry as a percentage of the gross domestic product (GDP) accounted for by agriculture has grown significantly from 0.29% in 2003/04 to 0.66% in 2014/15. The services sector has also shown a fair increase in R&D intensity from 0.26% in 2003/04 to 0.36% in 2014/15. On the other hand, the industrial and manufacturing sectors experienced substantial decreases in R&D intensity over this period. Is it mere coincidence that the share of manufacturing within the economy has declined over this period, whereas that of the services sector has risen progressively?

The fact is that average annual growth in manufacturing has been virtually 0.2% per annum between 2008 and 2016 whereas the services sector have averaged growth of more than 2% per annum. Again, this this runs counter to the NDP`s goal of making the country more self-sufficient in terms of the supply of manufactured goods and less reliant on imports.

Table 3.4: Business R&D Expenditure in Different Economic Sectors

	R&D Expenditure (R 000s)		R&D Expenditure as % of Sector Value-Added	
	2003	2014	2003	2014
Agriculture. Hunting. Forestry and Fishing	98 659	460 464	0.29	0.66
Industry. Excl. Manufacturing	1 486 759	1 894 755	0.69	0.37
Manufacturing	2 478 200	4 501 146	1.35	0.94
Services	1 527 707	6 434 586	0.26	0.36
Total	**5 591 325**	**13 290 951**	**0.55**	**0.46**

Source: Department of Science and Technology "National Survey of research and Development"

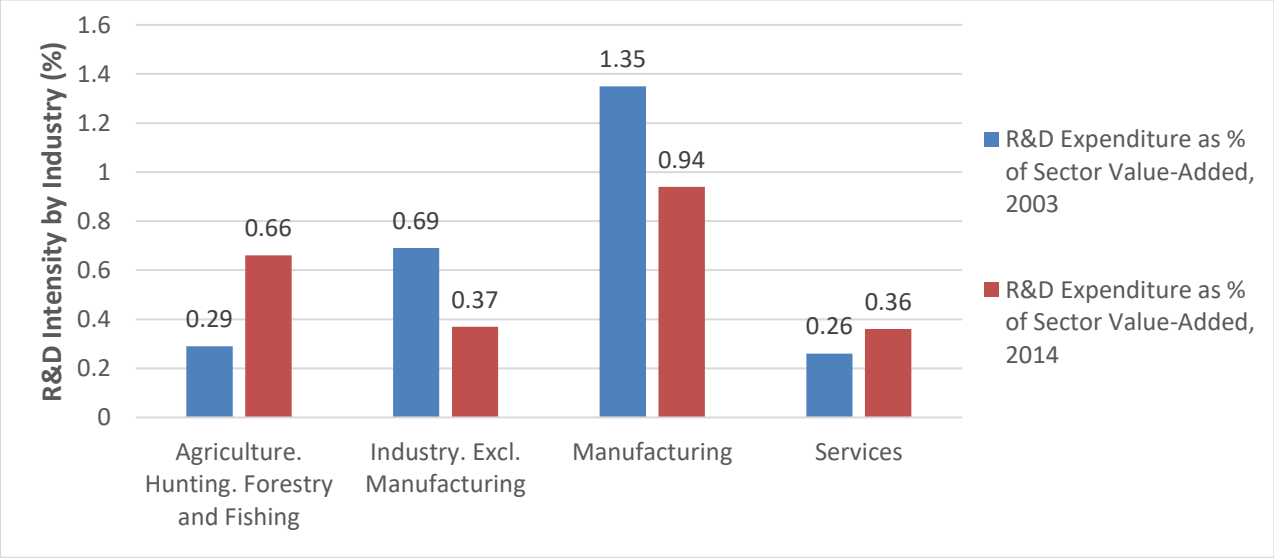


Figure 3.3: Change in Business Sector R&D Intensity by Industry

In terms of the proportion of R&D expenditure by research fields, the proportion of R&D spent in both the natural sciences as well as the engineering and technology research fields has been on the decline (**Table 3.5** and **Figure 3.4** respectively), from 34.5% and 32.3% respectively in 2007, to 29.1% and 24.0% in 2014. Presumably these declines correlate somewhat with the proportionate decline of R&D spent in the industrial and manufacturing sector which in turn has been associated with a relative decline in its importance and role within the overall economy over the past decade. Both of these research fields remain the largest in terms of their proportionate shares of R&D expenditure in South Africa but the shares of medical and health sciences as well as social sciences research fields' is increasing rapidly.

The proportionate share of R&D expenditure in the medical and health sciences research fields increased from 10.1% of total R&D expenditure in 2001/02 to 18.6% in 2014/15 whereas that of social sciences increased from 9.6% in 2003/04 to 17.0% in 2014/15. There has also been an impressive increase in the relative share of R&D expenditure in agricultural sciences, but in the humanities it has remained small and relatively insignificant.

Table 3.5: Proportion of R&D Expenditure by Research Field

	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	(%)												
Natural Sciences	35.1	32.3	33.5	34.4	34.3	34.5	33.7	33.2	33.3	33.8	30.6	30.5	29.1
Engineering and Technology	35.0	35.0	32.0	31.7	31.9	32.3	33.5	30.2	28.4	26.5	25.8	25.2	24.0
Medical and Health Sciences	10.1	13.5	14.8	14.8	15.1	14.0	14.9	16.7	17.1	17.2	17.2	18.2	18.6
Agricultural Sciences	9.2	7.4	7.2	6.8	6.9	6.8	5.5	6.9	6.5	7.7	7.6	8.6	9.1
Social Sciences	10.6	9.6	9.7	9.8	9.4	9.7	9.6	10.7	12.4	12.6	16.8	17.5	17.0
Humanities		2.2	2.8	2.5	2.4	2.7	2.8	2.3	2.3	2.2	2.0	2.3	2.2

Source: Department of Science and Technology "National Survey of research and Development"

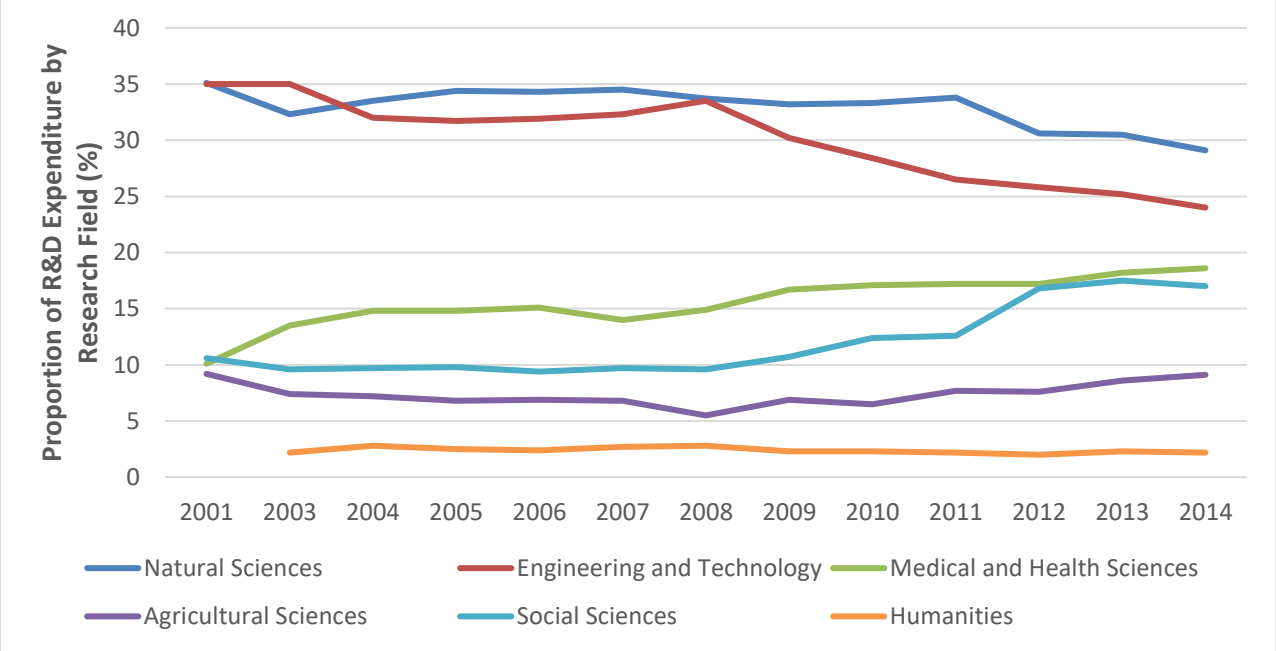


Figure 3.4: Trend in Proportion of R&D Expenditure by Research Field

3.2 Scientific Publications

Scientific publications constitute research outputs such as journal papers, conference proceedings, research notes, etc. Only indexed scientific publications are included in publications data shown in **Table 3.6**. The number of the country's publications grew significantly during 2006 - 2010 as well as during the 2011 – 2015 period. The 2013 to 2015 data seem to be higher than those previously reported by NACI due to the fact that the InCites version 2 has been harmonised with the Web of Science database. Both South Africa`s world share of scientific publications and that of citations is on a rising trend (**Figure 3.5**). The world share of publications increased from 0.39% in 1996 to 0.69% in 2015. For citations, the world share for these increased from 0.31% in 1996 to 0.91% in 2014 before dropping to 0.89% in 2015.

Table 3.6: South African Scientific Publications

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
Number of Scientific Publications	4 969		25 453	28 624	46 977	75 270		14 890	16 260	17 246
% World Share of Publications	0.39		0.39	0.39	0.48	0.63		0.61	0.66	0.69
% Publications in Top 1%	0.54		0.66	1.04	1.26	1.42		1.69	1.56	1.39
% Publications in Top 10%	6.88		7.33	8.90	9.89	9.54		9.99	10.15	9.32
% International Collaborations	19.72		25.31	36.24	40.13	46.19		45.68	48.16	50.18
Number of Citations	66 649		415 877	552 682	681 624	454 176		94 893	75 991	35 174
% World Share of Citations	0.31		0.35	0.41	0.55	0.76		0.76	0.91	0.89
Impact Relative to the World	0.785		0.899	1.052	1.155	1.202		1.235	1.376	1.287

Sources: Clarivate Analytics "InCites 2.0" and National Research Foundation

The rising trend of the share of publications globally taken up by South African publications data is impressive, but it calls into question why this successful output does not translate into more prolific progress in scientific innovations and through this faster growth in the economy overall. There are clearly some fault lines, either in the form of the appropriateness of the research for the economy's progress or in the transmission of this successful research output into practical results in the workplace.

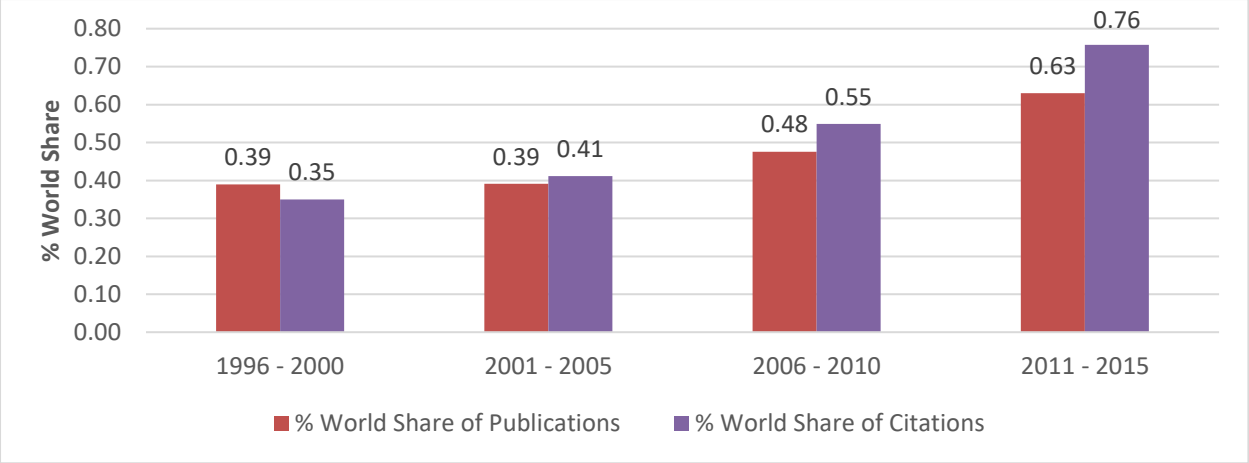


Figure 3.5: Trends in South African Scientific Publications and Citations

Table 3.7 and **Figure 3.6** show that the largest proportion of scientific publications in South Africa are in the natural sciences research field (38.3% in 2015), followed by medical and health sciences (23.4%), engineering technology (15.0%) and social sciences (14.4%). Agricultural sciences research has been showing a progressive decline over several decades and showed a negative trend in 2014 and 2015 in terms of its share of the country's total scientific publications. This is despite R&D intensity in the agricultural industry of the business sector having risen (**Table 3.5**). A research field that is showing significant growth is that of social sciences. It has shown an increase from 8.6% of publications during 1996 - 2000 to 14.8% during 2011 – 2015. In the opposite direction from agriculture, publications in social sciences have increased their share in line with the proportionate increase in R&D expenditure in the field reflected in **Table 3.5**.

Table 3.7: Percentage Proportion of South African Scientific Publications in Various Fields

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
Natural Sciences	40.1		41.0	42.8	39.8	38.6		38.6	38.5	38.3
Engineering and Technology	15.2		14.1	13.6	12.9	13.9		14.8	13.9	15.0
Medical and Health Sciences	25.1		25.9	23.8	23.4	23.3		23.3	24.7	23.4
Agricultural Sciences	6.0		6.1	5.8	5.3	4.6		5.1	4.2	4.1
Social Sciences	9.1		8.6	9.5	13.2	14.8		13.5	14.2	14.4
Humanities	4.4		4.2	4.5	5.4	4.8		4.7	4.6	4.8

Source: Clarivate Analytics "InCites 2.0"

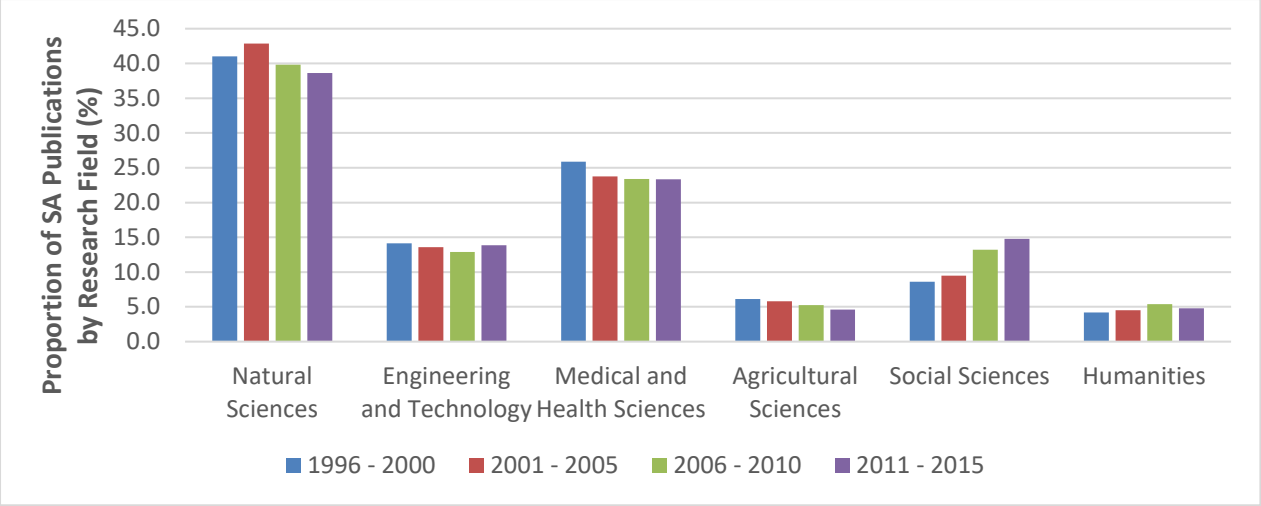


Figure 3.6: Trends in Proportion of South African Scientific Publications by Research Field

Figure 3.7 and **Figure 3.8** show a distribution of scientific publications from universities by university type, namely: traditional, comprehensive and universities of technology. The majority of universities' publications comes from traditional universities such as University of Cape Town, Uninersity of the Witwatersrand, University of KwaZulu Natal, University of Pretoria and University of Stellenbosch. Although the universities of technology produce a relatively small number of publications, their publication output is improving at a high pace. During the period 1996 – 2000 they contributed only 1.49% of total universities' publications but this contribution increased to 4.59% during 2011 -2015. This increase is driven by a number of factors such as the DHET's research output incentive but also the downsizing of this sector, with some being absorbed by the nowadays comprehensive universities.

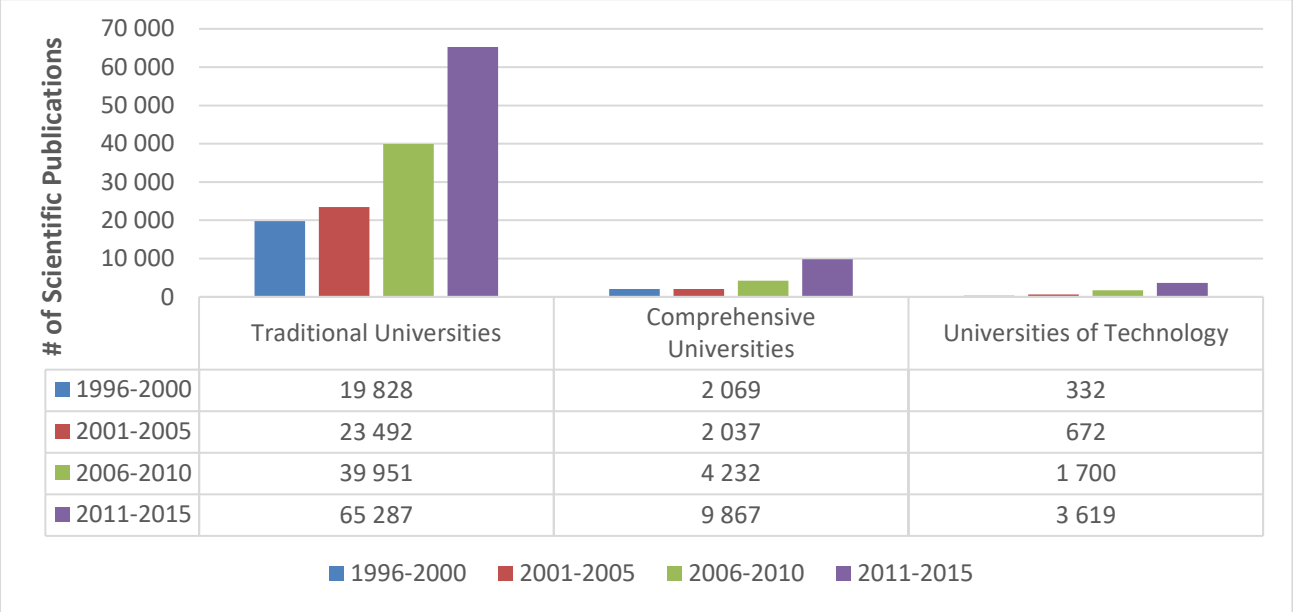
The merger of higher education institutions negatively affected the research performance of comprehensive universities during 2001 – 2005 as the number and percentage share of scientific publications by universities declined during this period. Some scholars have undertaken studies to understand the impact of these university mergers[3,4] and their findings show that power struggles and their negative impact on staff morale have affected the performance of these institutions post the merger. The situation stabilised over the period

[3] Goldman, G.A. and Van Tonder, C., 2006. The University of Johannesburg merger: academics experience of the pre-merger phase. *Acta Commercii*, *6*(1), pp.147-161.

[4] Mfusi, M.X., 2004. The effects of higher education mergers on the resultant curricula of the combined institutions: perspectives on higher education. *South African Journal of Higher Education*, *18*(1), pp.98-110.

2006 – 2010 as the number of publications from comprehensive universities doubled from 2 037 during 2001 – 2005 to 4 232 during 2006 – 2010.

The research output of comprehensive universities again doubled along with that of universities of technology from the period 2006 – 2010 to 2011 – 2015. This dramatic increase in scientific publications from these two type of universities has shifted the focus from technology development to knowledge generation as the number of local patents applications by South Africans has declined. This might be the unintended consequence of the research outputs incentive, an issue that needs further investigation.



	Traditional Universities	Comprehensive Universities	Universities of Technology
1996-2000	19 828	2 069	332
2001-2005	23 492	2 037	672
2006-2010	39 951	4 232	1 700
2011-2015	65 287	9 867	3 619

Figure 3.7: Number of Scientific Publications by University Type

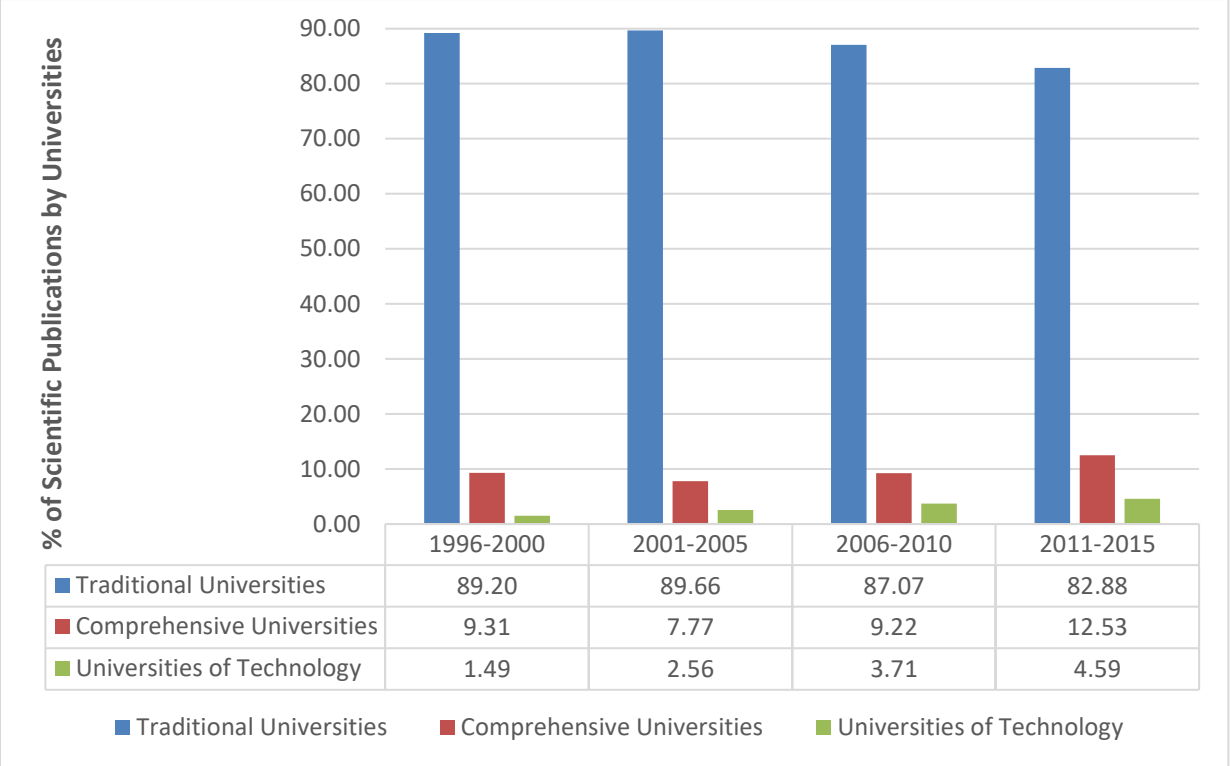


Figure 3.8: Proportion of Scientific Publications by University Type

4. TECHNICAL PROGRESS (IMPROVEMENT AND INNOVATION)

This section presents the indicators of technical progress and technological innovation by focusing on key issues such as information and communication technology (ICT) access; patents granted; industrial designs registered; and trademarks registered. Technological innovation is a critical catalyst for competitiveness of key industrial sectors as it encourages efficiency, differentiation, marketing innovation (e.g. product customisation), etc.

4.1 Information and Communication Technology Access

ICT access is very important especially taking into account the global trend of digitisation and the fourth industrial revolution. As **Table 4.1** shows, the country has experienced a huge increase in the number of mobile phone subscriptions per 100 people. It has increased from 9 per 100 during 1996 – 2000 to 142 per 100 persons during 2011 – 2015. In contrast, internet usage per 100 people is still relatively low (51.9 in 2015) even though there was a drastic increase in this indicator from an average of 11.7 to 44.6 internet users per 100 people from the period 2006 – 2010 to 2011 - 2015. Fixed broadband subscriptions per 100 people are much lower. This is in sync with the low rate of fixed telephone subscriptions per 100 people.

Table 4.1: Information Technology Diffusion in South Africa

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
Mobile cellular subscriptions per 100 people	2		9	41	89	142		146	149	159
Internet users per 100 people	0.8		3.0	7.2	11.7	44.6		46.5	49.0	51.9
Fixed broadband subscriptions per 100 people	0.0		0.0	0.1	0.9	3.1		3.1	3.2	5.3
Fixed telephones subscriptions per 100 people	10.1		11.2	10.5	9.7	8.1		7.3	6.9	7.7

Source: computed by NACI from The World Bank "World Development Indicators"

International benchmarking of the number of mobile cellular subscriptions per 100 people shows strong growth for South Africa over a period of 20 years (**Figure 4.1**). One contemplates the enormous opportunities which exist in fast tracking education and skills development by exploiting the high proclivity towards mobile cellular usage among large relatively underdeveloped sectors of society.

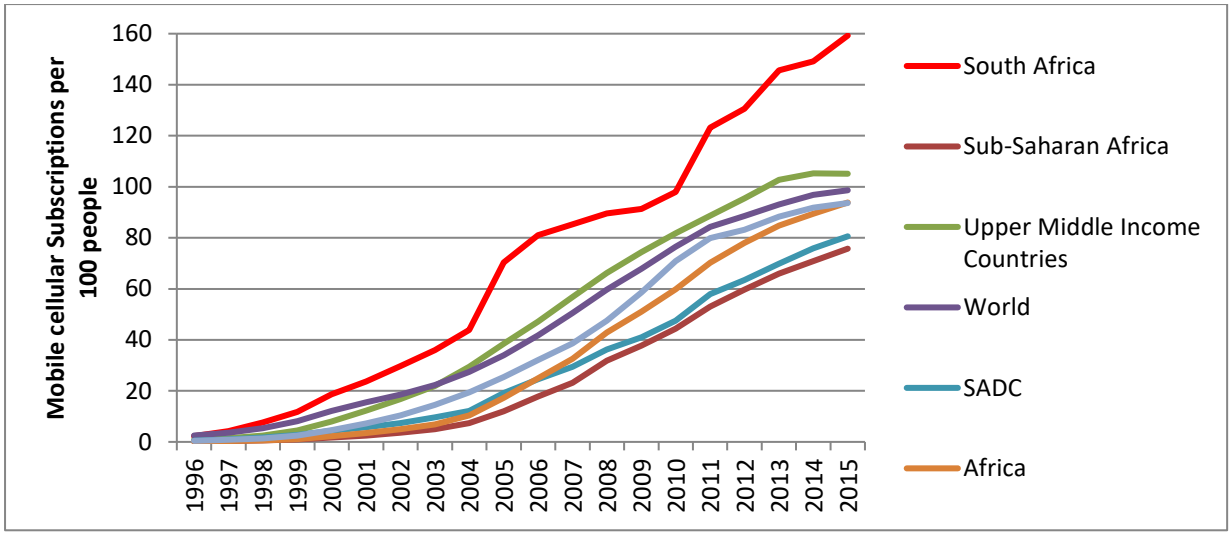


Figure 4.1: Benchmarking of Trends in Mobile Cellular Subscriptions

Source: computed by NACI from The World Bank "World Development Indicators"

Compared with other regions of the world the country had a large number of mobile cellular subscriptions per 100 people as far back as the period 1996 – 2000. During that period South Africa boasted nine mobile cellular subscriptions per 100 people compared to just three per 100 for upper middle income countries, one per 100 for Africa, two per 100 for BRICS countries and six per 100 for the rest of the world (**Figure 4.2**). This trend of higher cellular subscriptions relative to other countries and regions of the world continued into the 2011 – 2015.

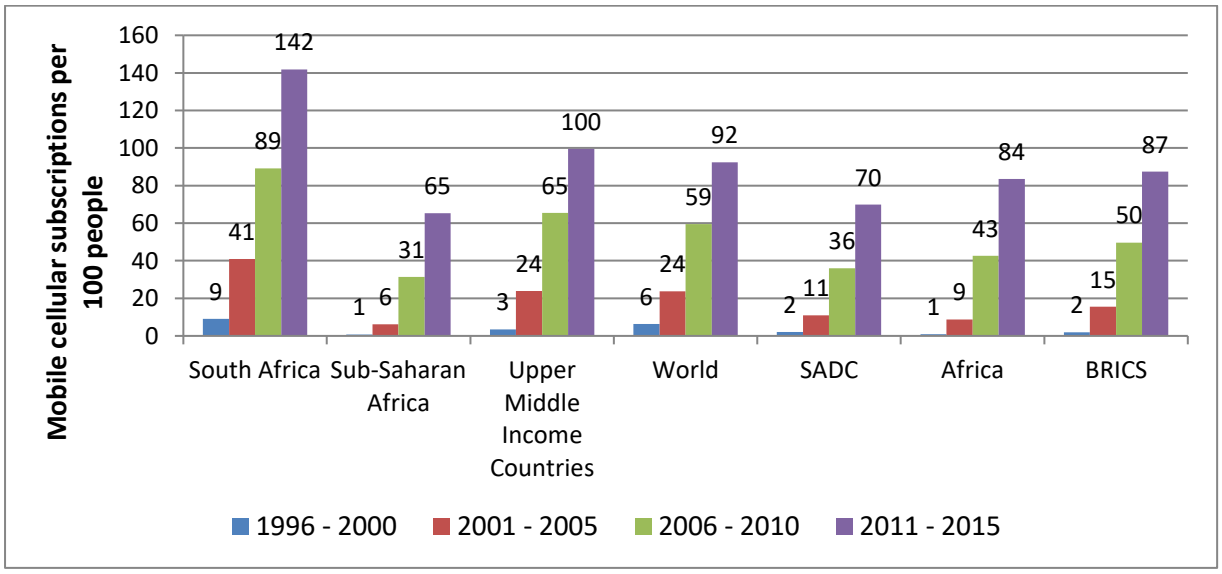


Figure 4.2: Benchmarking of Trends in Mobile Cellular Subscriptions (Five Year Periods)

Source: computed by NACI from The World Bank "World Development Indicators"

4.2 Patents

As Table 4.2 shows, despite South Africa having one of the highest ratios of cellular mobile subscriptions per 100 people, it had a low level of internet usage.

Table 4.2: Country Percentage Share of Patents Granted by Technology

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
Materials, metallurgy	3.6		3.2	3.9	5.9	10.7		12.2	9.7	6.3
Basic materials chemistry	3.4		2.6	3.9	4.6	8.8		9.7	6.8	8.7
Chemical engineering	4.0		4.3	5.7	6.1	8.5		7.6	6.6	9.6
Civil engineering	18.0		16.7	14.3	10.9	8.5		4.3	4.8	5.4
Other special machines	7.8		6.5	4.4	4.7	5.4		4.4	7.2	6.9
Organic fine chemistry	0.8		1.0	1.9	2.4	5.1		6.3	3.8	5.6
Medical technology	2.7		3.3	4.0	3.8	4.7		3.9	5.4	4.6
Pharmaceuticals	1.0		1.0	2.5	2.4	3.9		4.1	4.8	5.2
Electrical machinery	4.5		4.9	4.6	4.0	3.5		3.9	2.7	3.3
Engines, pumps, turbines	1.5		1.5	2.2	2.3	3.5		4.3	3.0	3.1
Environmental technology	1.9		2.1	2.5	2.5	3.0		1.8	3.9	2.5
Handling	7.6		8.4	7.3	5.9	3.0		3.3	3.2	2.5
Furniture, games	6.9		7.7	6.9	5.0	2.8		2.3	2.5	2.7
Machine tools	4.6		3.8	2.3	2.8	2.7		3.6	2.5	2.1
Measurement	2.5		2.4	2.3	2.4	2.5		3.5	4.5	1.7
Computer technology	0.6		1.0	2.5	2.4	2.5		2.5	2.7	3.3
Biotechnology	0.4		0.6	0.8	1.2	2.5		2.5	2.3	4.6
Mechanical elements	6.3		5.3	4.2	4.1	2.4		2.0	2.5	2.5
Transport	6.0		6.6	4.9	4.5	2.4		2.1	2.3	1.9
IT methods	0.0		0.0	0.2	1.4	2.1		1.3	2.5	2.1
Other consumer goods	4.4		3.8	3.1	3.2	1.8		1.3	2.3	2.5
Food chemistry	0.8		1.7	1.7	1.7	1.7		2.0	1.4	2.3
Semiconductors	0.3		0.3	0.2	1.2	1.6		1.0	2.3	2.1
Audio visual technology	0.9		1.3	2.0	1.5	1.4		1.5	0.7	1.2
Digital communication	0.6		0.4	0.7	1.1	1.3		0.8	2.0	1.3
Control	2.4		2.5	3.0	2.4	1.2		1.5	1.1	0.6
Surface technology, coating	0.8		1.2	1.1	0.8	1.2		1.3	1.1	1.2
Textile and paper machines	1.3		1.0	0.9	0.6	1.1		1.6	1.3	0.4
Macromolecular chemistry, polymers	0.3		0.5	0.5	0.5	1.0		1.2	0.7	1.0
Thermal processes and apparatus	2.4		2.4	2.1	2.2	1.0		0.8	0.9	0.6
Telecommunications	1.0		1.2	2.0	2.1	0.8		0.7	1.1	0.6
Basic communication	0.1		0.1	0.2	0.2	0.7		0.5	0.7	0.8
Optics	0.3		0.3	0.2	0.2	0.2		0.2	0.4	0.6
Analysis of biological materials	0.1		0.1	0.1	0.5	0.1		0.2	0.2	0.4
Micro-structural and nano-technology	0.0		0.0	0.0	0.0	0.1		0.0	0.2	0.0
Unknown	0.1		0.3	0.8	2.3	0.1		0.0	0.0	0.0

Source: WIPO "IP Statistics Data Center"

The low relative average low level of internet usage coincides with a low share of the country's patents being granted in respect of ICT related technologies such as computer technology (3.3% in 2015), IT methods (2.1%), semiconductors (2.1%), digital communication (1.3%), control (0.6%) and telecommunications (0.6%). The largest country share of patents granted during 2011 – 2015 was in respect of materials and metallurgy (10.7%), followed by basic materials chemistry (8.8%), chemical engineering (8.5%) and civil engineering (8.5%).

As shown in **Table 4.3** and **Figure 4.3** historically most patents originating from South Africa were granted to residents. The proportion was 53.9% during 1996 – 2000, 68.9% during 2001 – 2005 and 65.7% in 2006 – 2010. However, this trend was reversed sharply during 2011 – 2015 as more South African patents registered during this period were for non-residents (59.2%). This signifies a large role played by multinational corporations (MNCs) for technological development in South Africa. It begs the question as to how the country can capitalize on this characteristic to speed up technological development in the country.

Table 4.3: Percentage of Residents and Non-Residents South African Patents Granted

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
Residents	65.4		53.9	68.9	65.7	40.8		32.9	33.4	38.1
Non-residents	34.6		46.1	31.1	34.3	59.2		67.1	66.6	61.9

Source: WIPO "IP Statistics Data Center"

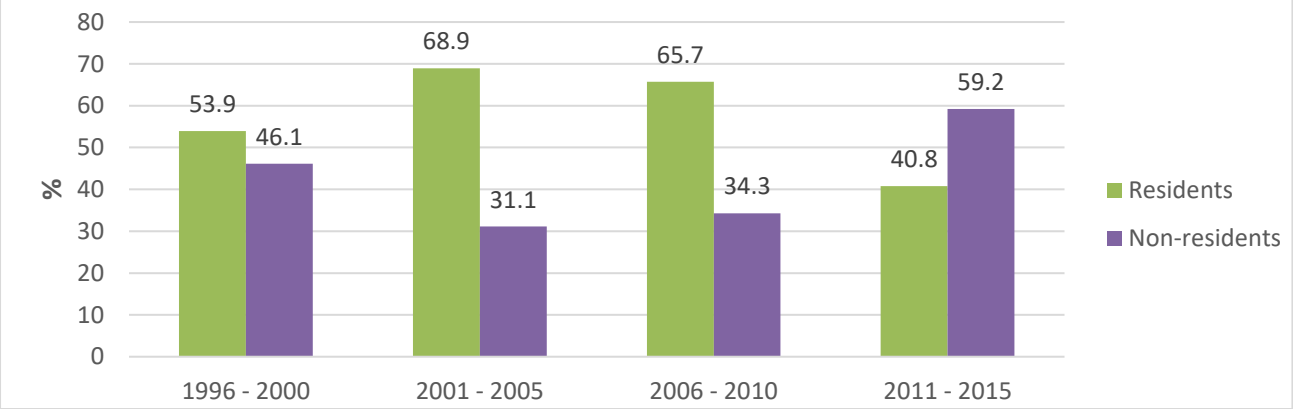


Figure 4.3: Trend in Residents and Non-Residents South African Patents Granted

Table 4.4 shows the various destinations of South African patents over a 20 year period in which the number of the country's patents granted over the period 2011 – 2015 was actually a little different from what it had been in 1996 – 2000. Instead, there was a noticeable increase in the number of such patents being granted in countries such as the United States of America (US), the European Patent Office, China, Japan, Canada, Russia, etc. In contrast, there was

a huge decline in patents granted locally between the period 2006 – 2010 and 2011 – 2015, from 4 304 to 2 624 respectively.

Table 4.4: South African Patents Granted by Various Patent Offices

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
South Africa	766		2 363	4 842	4 304	2 624		474	445	453
United States of America	111		548	533	491	744		161	152	166
Australia	56		277	276	244	311		40	66	48
European Patent Office	49		194	216	272	281		54	50	59
China	1		22	112	184	277		47	52	61
Japan	20		58	23	89	198		63	50	23
Canada	9		73	78	144	189		36	41	27
Russian Federation	5		35	40	60	104		27	25	16
African Regional Intellectual Property Organization	24		52	12	9	86		31	19	36
New Zealand	6		42	61	41	81		13	7	23
Republic of Korea	7		25	20	53	71		20	17	18
India	6		18	21	20	67		5	21	13
Mexico	3		19	33	55	63		11	9	8
Brazil	4		23	17	13	48		7	9	16
Chile	0		13	10	30	48		10	17	1
African Intellectual Property Organization	0		16	12	0	40		17	14	9
Singapore	0		0	35	33	36		6	6	7
United Kingdom	25		104	87	40	31		6	0	9
China. Hong Kong SAR	1		11	18	29	29		7	8	3
Ukraine	0		5	10	15	26		6	9	6
Peru	2		10	9	21	23		1	3	3
Other Patents Offices	76		480	564	404	1 060		397	314	185
Total Patents Granted	1 171		4 388	7 029	6 551	6 437		1 439	1 334	1 190

Source: WIPO "IP Statistics Data Center"

The decline in local patents granted was possibly driven by the Department of Higher Education and Training (DHET)'s scientific publications incentive as local researchers shift their focus from patents to publications. According to the Companies and Intellectual Property Commission (CIPC) [5], "more substantial legislative changes and the introduction of

[5] CIPC 2013/14 Annual Report

substantive examination are required" to improve patent applications. CIPC is increasing its capacity to prepare to become the patents examination authority. As the diagnosis for the decline in local patents might be wrong, once CIPC becomes a full examination authority, the number of patents by residents could decline further since invalid patent filings are likely to be eliminated. It is worthwhile noting that recently South Africa was among the top 20 countries in terms of patents granted to various countries worldwide (**Table 4.5**). Among these top patent granting countries, the highest share of the country's patents granted was locally (10.16% during 2011 – 2015) followed by Australia (0.33%), New Zealand (0.33%) and India (0.27%).

Table 4.5: South Africa's Percentage World Share of Patents Granted by Top 20 Patent Offices

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
China	0.03		0.07	0.06	0.04	0.02		0.02	0.02	0.02
United States of America	0.10		0.08	0.07	0.06	0.05		0.06	0.05	0.06
Japan	0.01		0.01	0.00	0.01	0.02		0.02	0.02	0.01
South Korea	0.04		0.01	0.01	0.01	0.01		0.02	0.01	0.02
European Patent Office	0.12		0.11	0.09	0.09	0.09		0.08	0.08	0.09
Russian	0.03		0.03	0.04	0.04	0.06		0.09	0.07	0.05
Australia	0.64		0.47	0.43	0.41	0.33		0.23	0.34	0.21
Canada	0.13		0.15	0.13	0.16	0.17		0.15	0.17	0.12
Germany	0.01		0.02	0.01	0.01	0.01		0.00	0.03	0.02
France	0.06		0.04	0.01	0.01	0.01		0.01	0.01	0.01
Mexico	0.09		0.10	0.10	0.11	0.12		0.11	0.09	0.09
Italy	0.04		0.01	0.00	0.02	0.00		0.00	0.00	0.00
Singapore	0.00		0.00	0.11	0.11	0.12		0.11	0.11	0.10
India	0.59		0.23	0.19	0.04	0.27		0.15	0.34	0.22
Hong Kong	0.05		0.10	0.11	0.12	0.10		0.11	0.13	0.05
United Kingdom	0.35		0.26	0.19	0.13	0.10		0.11	0.00	0.16
South Africa	11.29		8.12	27.88	37.08	10.16		9.97	8.79	10.07
Israel	0.28		0.35	0.19	0.15	0.01		0.00	0.00	0.02
New Zealand	0.22		0.24	0.23	0.23	0.33		0.27	0.15	0.54
Brazil	0.27		0.31	0.16	0.10	0.31		0.24	0.33	0.47

Source: WIPO "IP Statistics Data Center"

The South African status of being in the top 20 patent granting countries worldwide is more likely due to its previous status as a non-examining authority. There has been a gradual decline in the world share of the country's patents granted at the US Patent Office, from

0.10% in 1996 to 0.06% in 2015. That said, in absolute numbers the highest number of South African patents granted outside of the country have been in the US.

4.3 Industrial Designs

As shown in **Table 4.6**, during 2012 – 2015, the largest country share in industrial designs registered by class was in respect of packages and containers for the transport or handling of goods (13.2%). This was followed by means of transport or hoisting (12.7%), tools and hardware (8.9%), medical and laboratory equipment (7.6%), as well as recording, communication or information retrieval equipment (7.5%). The country's share of industrial designs in packages and containers declined drastically from 20.2% in 2013 to 5.7% in 2015.

Table 4.6: Country Percentage Share of Industrial Designs Registered by Classification

	Description	2008 - 2011	2012 - 2015		2013	2014	2015
Class 09	Packages and containers for the transport or handling of goods	9.7	13.2		20.2	4.9	5.7
Class 12	Means of transport or hoisting	20.5	12.7		16.7	9.0	14.7
Class 08	Tools and hardware	7.0	8.9		5.2	13.2	14.3
Class 24	Medical and laboratory equipment	6.0	7.6		6.8	16.8	4.2
Class 14	Recording, communication or information retrieval equipment	1.5	7.5		1.4	16.0	1.0
Class 23	Fluid distribution equipment, sanitary, heating, ventilation and air-conditioning equipment, solid fuel	3.0	5.9		7.2	6.2	3.2
Class 06	Furnishing	3.2	5.8		3.9	8.2	11.0
Class 20	Sales and advertising equipment, signs	2.1	4.9		1.2	1.4	0.8
Class 02	Articles of clothing and haberdashery	2.9	3.9		2.6	3.1	4.0
Class 25	Building units and construction elements	6.9	3.5		1.5	2.8	7.5
Class 10	Clocks and watches and other measuring instruments, checking and signalling instruments	2.6	3.5		2.7	6.9	3.7
Class 07	Household goods	3.8	3.2		2.6	2.3	9.5
Class 21	Games, toys, tents and sports goods	5.7	3.0		3.8	2.2	1.0
Class 31	Machines and appliances for preparing food or drink	0.4	2.9		0.0	0.1	13.5
Class 32	Graphic symbols and logos, surface patterns, ornamentation	0.0	2.2		2.6	0.0	0.1
Class 28	Pharmaceutical and cosmetic products, toilet articles and apparatus	0.6	1.9		2.5	0.2	1.9
Class 11	Articles of adornment	6.1	1.8		6.2	0.6	0.1
Class 15	Machines	0.9	1.4		2.6	2.0	0.7
Class 26	Lighting apparatus	1.6	1.3		1.3	0.5	0.4
Class 19	Stationery and office equipment, artists' and teaching materials	2.5	1.1		2.5	0.4	0.1
Class 03	Travel goods, cases, parasols and personal belongings	3.9	0.8		1.3	0.4	0.5
Class 22	Arms, pyrotechnic articles, articles for hunting, fishing and pest killing	1.4	0.8		2.5	0.2	0.4

Class 13	Equipment for production, distribution or transformation of electricity	0.7	0.8		0.0	1.1	1.0
Class 01	Foodstuffs	4.1	0.7		1.3	1.4	0.1
Other	Other	0.0	0.5		1.2	0.0	0.0
Class 29	Devices and equipment against fire hazards, for accident prevention and for rescue	1.1	0.1		0.0	0.1	0.4
Class 30	Articles for the care and handling of animals	1.2	0.1		0.0	0.0	0.2
Class 04	Brushware	0.1	0.0		0.0	0.1	0.0
Class 27	Tobacco and smokers' supplies	0.1	0.0		0.0	0.0	0.1
Class 05	Textile piecegoods, artificial and natural sheet material	0.0	0.0		0.0	0.0	0.1
Class 17	Musical instruments	0.0	0.0		0.0	0.0	0.0
Class 18	Printing and office machinery	0.1	0.0		0.0	0.0	0.0
Class 16	Photographic, cinematographic and optical apparatus	0.1	0.0		0.0	0.0	0.0

Source: WIPO "IP Statistics Data Center"

In a pattern similar to that of patents granted, non-residents' trademarks registered from South Africa have increased significantly, from 45.6% during 1996 – 2000, to 52.1% during 2006 – 2010 and to 69.5% during 2011 – 2015 (**Table 4.7** and **Figure 4.4**). This again shows the significance of the impact of MNCs although it is shown in later sections that there has been a decline of foreign direct investment (FDI) inflow into the country, reflecting somewhat contradictory patterns between the two trends. It is almost as if MNC`s have become reluctant to invest overall in South Africa, but instead have found it more profitable to register patents, trademarks and industrial designs in the country.

Table 4.7: Percentage of Residents and Non-Residents South African Industrial Designs Regi stered

	1996		**1996 - 2000**	**2001 - 2005**	**2006 - 2010**	**2011 - 2015**		**2013**	**2014**	**2015**
Residents	84.7		54.4	61.2	47.9	30.5		28.6	20.4	30.5
Non-residents	15.3		45.6	38.8	52.1	69.5		71.4	79.6	69.5

Source: WIPO "IP Statistics Data Center"

Figure 4.4: Trend in Residents and Non-Residents South African Industrial Designs Registered

Although there has been a decline in the number of South African industrial designs registered locally, from 3 199 during 2006 – 2010 to 2 323 during 2011 – 2015, the country's share of industrial designs registered at the CIPC in 2015 was very high, at 74.6% (371 out of 497) (**Table 4.8**).

The country's share of industrial designs registered in South Africa in 1996 was 84.7% (316 out of 373). Although not so significant, the number of South African industrial designs registered in the US has remained relatively high, at 108 during 2011 – 2015. One suspects that this could be a function also of the high number of skilled South Africans residing in the US.

Table 4.8: South African Industrial Designs Registered by Various Offices

	1996		**1996 - 2000**	**2001 - 2005**	**2006 - 2010**	**2011 - 2015**		**2013**	**2014**	**2015**
South Africa	316		373	2 520	3 199	2 323		572	343	371
European Union Intellectual Property Office	0		0	58	117	171		44	44	26
United States of America	5		56	57	137	108		20	26	29
Australia	4		43	49	77	81		21	9	14
African Regional Intellectual Property Organization	0		3	0	0	66		11	25	19
China	1		8	10	21	65		26	12	13
Canada	1		14	5	24	20		1	7	2
India	2		2	0	2	20		6	6	3
Japan	0		10	2	15	14		6		2
New Zealand	4		11	15	17	12		4	3	3
Mexico	0		4	0	8	9		4	2	2
Brazil	0		0	5	5	8		4	0	1
Saudi Arabia	0		0	0	1	8		0	8	
Russian Federation	0		1	0	10	7		2	1	1
Indonesia	0		0	1	0	6		2	2	2
Republic of Korea	0		0	1	7	6		0	3	1
Singapore	0		0	3	10	6		2	0	1
African Intellectual Property Organization	0		0	0	0	5		4	0	1
Chile	0		3	4	4	5		1	2	1
Norway	0		0	0	0	4		2	0	0
Other IP offices	40		158	59	37	34		16	4	5
Total industrial designs registered	**373**		**686**	**2 789**	**3 691**	**2 978**		**748**	**497**	**497**

Source: WIPO "IP Statistics Data Center"

Table 4.9 shows that during 2011 – 2015 the highest world share of South African industrial designs in leading countries for industrial designs registration was at the European Union Intellectual Property Office (0.143%), followed by the US (0.092%), Canada (0.081%), Mexico (0.068%), India (0.058%) and Indonesia (0.058%).

Table 4.9: South Africa's Percentage World Share of Industrial Designs Registered by Top IP Offices

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
China	0.007		0.006	0.003	0.002	0.003		0.006	0.003	0.003
South Korea	0.000		0.016	0.000	0.054	0.036		0.058	0.027	0.018
Japan	0.000		0.005	0.001	0.010	0.010		0.021	0.000	0.007
United States of America	0.044		0.080	0.074	0.118	0.092		0.085	0.110	0.109
European Union Intellectual Property Office	N/A		N/A	0.140	0.123	0.143		0.181	0.181	0.105
Turkey	0.000		0.000	0.000	0.018	0.002		0.000	0.000	0.000
India	0.100		0.100	0.000	0.008	0.058		0.086	0.085	0.040
Australia	0.029		0.012	0.005	0.000	0.000		0.000	0.000	0.000
Canada	0.053		0.103	0.035	0.095	0.081		0.026	0.112	0.035
United Kingdom	0.145		0.151	0.062	0.000	0.013		0.000	0.000	0.018
Germany	0.000		0.000	0.002	0.000	0.003		0.000	0.000	0.018
Russian	0.000		0.000	0.001	0.004	0.002		0.000	0.006	0.002
Indonesia	N/A		0.000	0.013	0.000	0.058		0.066	0.052	0.057
Brazil	0.000		0.000	0.022	0.022	0.042		0.151	0.000	0.030
Ukraine	0.000		0.000	0.000	0.000	0.031		0.074	0.065	0.000
Mexico	0.000		0.098	0.000	0.064	0.068		0.140	0.084	0.070
Switzerland	0.000		0.000	0.006	0.063	0.008		0.000	0.000	0.000
Hong Kong	N/A		0.000	0.011	0.011	0.009		0.000	0.000	0.039

Source: WIPO "IP Statistics Data Center"

Among BRICS member countries, South Africa had the largest world share of industrial designs registered during 2011 – 2015 in India (0.058% followed by Brazil (0.042%), China (0.003%) and Russia (0.002%). The above figures suggest that use of the English language may play an important role in the registration of industrial designs in other countries.

South Africa had a relatively high world share of industrial designs registered in the United Kingdom in 1996 (0.145%). However, this has since declined significantly due to the existence of the European Union Intellectual Property Office that manages European Union trademarks and designs.

4.4 Trademarks

Almost 70% of South Africa's economy is located in service-based industries in which non-technological innovation is a major factor of competitiveness and productivity growth. Marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. According to the Organisation of Economic Cooperation and Development (OECD), trademark is a sign (a word, a logo, a phrase, etc.) that enables people to distinguish between the goods or services of one party from those of another. Trademarks are therefore a proxy indicator for marketing innovation.

Table 4.10 shows the country's share of trademarks registered by the Nice Classification which is detailed in Appendix A, **Table A2**. Under this classification, there are two types of trademarks, those of goods (class 01 – 34) and those of services (class 35 – 45). During 2011 – 2015, the largest country share of trademarks registered was in respect of advertising; business management, business administration and office functions (12.9%), followed by alcoholic beverages, including beers (9.2%). The share of alcoholic beverage trademarks registered has shown a sharp decline from the 19.9% share which prevailed during 2001 – 2005. Goods related trademarks had a country share of 54.2% during 2011 – 2015, with a share of 45.8% for services related trademarks registered.

Table 4.10: Country Percentage Share of Trademarks Registered by Nice Classification

	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
Class 35	7.1	12.0	12.9		11.5	12.7	15.2
Class 33	19.9	10.3	9.2		9.8	10.4	8.4
Class 41	4.1	6.5	7.0		6.7	6.3	7.9
Class 36	2.8	6.1	6.6		5.7	6.0	7.8
Class 16	5.5	5.0	4.7		5.4	3.7	4.5
Class 30	3.2	3.3	4.4		3.3	5.2	5.4
Class 09	6.1	6.3	4.3		6.1	4.7	1.5
Class 42	4.5	3.7	4.1		3.9	4.5	4.4
Class 25	2.0	4.2	4.1		4.2	3.9	4.6
Class 29	2.9	2.6	3.2		3.2	3.7	3.4
Class 43	2.0	3.0	3.0		2.3	3.4	3.7
Class 05	3.0	4.1	2.7		3.8	1.0	1.2
Class 37	1.8	2.2	2.7		2.4	2.9	3.0
Class 32	5.2	2.7	2.5		2.8	2.8	2.1
Class 38	1.7	2.1	2.4		2.0	2.7	2.4

Class 44	1.2	1.4	2.4		2.3	1.9	2.8
Class 03	3.8	3.0	2.2		3.1	2.1	1.0
Class 39	1.3	1.7	2.1		1.8	2.5	2.0
Class 31	2.1	1.7	1.8		1.5	1.7	2.1
Class 45	1.2	0.7	1.7		1.2	1.4	1.9
Class 11	0.8	1.3	1.5		1.3	2.2	1.4
Class 12	0.6	1.2	1.2		0.9	1.1	1.4
Class 18	1.6	1.3	1.2		1.5	0.9	1.4
Class 28	1.7	1.2	1.1		1.0	1.2	1.0
Class 21	0.6	0.8	1.0		0.9	1.3	0.9
Class 01	1.9	1.3	1.0		1.5	0.9	0.4
Class 19	0.5	0.9	1.0		0.9	0.8	1.4
Class 40	0.8	0.8	0.9		0.7	1.5	0.9
Class 20	1.1	1.2	0.9		0.8	0.9	0.9
Class 10	0.8	0.5	0.8		1.1	0.5	0.5
Class 07	1.3	0.9	0.7		1.1	0.4	0.4
Class 06	1.5	1.2	0.7		0.9	0.4	0.6
Class 14	0.9	0.8	0.6		0.5	0.8	0.5
Class 24	1.0	0.6	0.6		0.4	0.5	0.9
Class 02	0.1	0.5	0.5		0.9	0.4	0.2
Class 04	0.5	0.4	0.4		0.7	0.5	0.3
Class 17	0.4	0.4	0.4		0.4	0.4	0.5
Class 34	0.1	0.3	0.3		0.3	0.6	0.3
Class 26	0.1	0.3	0.3		0.3	0.4	0.2
Class 27	0.4	0.2	0.2		0.2	0.1	0.2
Class 22	0.3	0.3	0.2		0.1	0.3	0.2
Class 08	0.3	0.4	0.2		0.4	0.0	0.0
Class 13	0.9	0.3	0.1		0.2	0.2	0.1
Class 23	0.0	0.0	0.1		0.1	0.0	0.0
Class 15	0.1	0.1	0.1		0.1	0.0	0.0
Other	0.0	0.1	0.0		0.0	0.0	0.0

Source: WIPO "IP Statistics Data Center"

Contrary to the large share of non-residents' patents and industrial designs, there has been a large percentage share of residents' trademarks being registered in various countries, viz. 72.8% during 2011 – 2015 (**Table 4.11** and **Figure 4.5**).

Table 4.11: Percentage of Residents and Non-Residents South African Trademarks Registered

	1996		**1996 - 2000**	**2001 - 2005**	**2006 - 2010**	**2011 - 2015**		**2013**	**2014**	**2015**
Residents	78.6		78.3	71.4	73.8	72.8		68.2	71.5	70.2
Non-residents	21.4		21.7	28.6	26.2	27.2		31.8	28.5	29.8

Source: WIPO "IP Statistics Data Center"

Figure 4.5: Trend in Residents and Non-Residents South African Trademarks Registered

Table 4.12: South African Trademarks Registered by Various Offices

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
South Africa	4 220		24 572	30 611	76 751	80 724		14 923	17 019	14 547
China	16		204	204	807	901		213	272	0
European Union Intellectual Property Office	0		143	380	867	834		177	161	189
United States of America	44		346	412	572	595		127	129	131
Australia	47		371	450	414	399		89	65	102
Uganda	0		0	0	0	248		81	-	120
United Kingdom	0		0	111	226	223		59	48	41
Brazil	7		7	26	152	208		10	82	39
India	1		2	0	24	182		26	23	11
Hong Kong	19		146	407	143	166		29	55	28
Canada	14		90	131	165	138		29	24	30
African Intellectual Property Organization	0		0	0	0	123		56	67	0
Madagascar	39		44	40	61	116		28	26	23
New Zealand	82		401	161	72	116		23	28	25
Malaysia	0		4	0	67	113		19	34	24
Japan	12		104	105	122	111		34	5	31
Chile	20		115	59	118	91		15	32	27
Singapore	0		0	158	151	86		12	16	24
Russian	15		33	30	120	80		12	25	14
Mexico	16		45	57	62	67		10	13	11
Other IP offices	775		2 487	1 281	781	1 082		228	250	192
Total trademarks registered	**5 327**		**29 114**	**34 623**	**81 675**	**86 603**		**16 200**	**18 374**	**15 609**

Source: WIPO "IP Statistics Data Center"

Most of the country's trademarks are registered locally viz., 93% (or 80 724 out of 86 603) during 2011 – 2015 (**Table 4.12**), which is an increase from 84% during 1996 - 2000. The largest proportionate location for South Africa's trademarks elsewhere is in China, followed by the European Union, the US, Australia, Uganda, the United Kingdom, Brazil and India.

Among the top 20 intellectual property registration offices (**Table 4.13**), during 2011 – 2015, the world share of South Africa's trademarks registered was largest in Australia (0.18%) followed by the European Union Intellectual Property Office (0.16%), the United Kingdom (0.11%), Hong Kong (0.11%), Canada (0.10%) and Malaysia (0.08%).

Table 4.13: South Africa's Percentage World Share of Trademarks Registered by Top 20 Offices

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
United States of America	0.05		0.06	0.06	0.06	0.06		0.06	0.06	0.06
South Korea	0.00		0.03	0.02	0.02	0.01		0.01	0.01	0.02
European Union Intellectual Property Office	N/A		0.15	0.18	0.21	0.16		0.18	0.16	0.17
Japan	0.01		0.01	0.02	0.02	0.02		0.03	0.00	0.03
Brazil	0.02		0.00	0.03	0.04	0.06		0.03	0.10	0.04
Mexico	0.06		0.03	0.03	0.02	0.02		0.01	0.02	0.01
Turkey	0.01		0.01	0.00	0.01	0.02		0.01	0.01	0.02
India	0.02		0.01	0.00	0.01	0.05		0.04	0.04	0.02
Argentina	N/A		0.04	0.05	0.00	0.02		0.05	0.00	0.02
Germany	0.06		0.05	0.03	0.02	0.01		0.01	0.01	0.00
United Kingdom	0.00		0.00	0.07	0.14	0.11		0.14	0.11	0.08
Australia	0.24		0.36	0.28	0.20	0.18		0.20	0.15	0.21
Spain	0.02		0.02	0.01	0.00	0.00		0.00	0.00	0.00
Russian	0.08		0.03	0.02	0.06	0.04		0.03	0.06	0.03
Hong Kong	0.16		0.20	0.42	0.14	0.11		0.09	0.16	0.07
Indonesia	N/A		N/A	0.00	0.00	0.03		0.00	0.03	0.03
Italy	0.00		0.00	0.00	0.00	0.00		0.00	0.01	0.00
Canada	0.09		0.10	0.11	0.13	0.10		0.10	0.10	0.10
Malaysia	0.00		0.03	0.00	0.07	0.08		0.07	0.12	0.08
Colombia	0.04		0.02	0.01	0.02	0.05		0.07	0.05	0.06

Source: WIPO "IP Statistics Data Center"

4.5 Technology Receipts

Selected indicators for receipts on charges for the use of intellectual property show an improvement for the country from the period 2006 – 2010 to the period 2011 – 2015 (**Table**

4.14). Technology receipts as a percentage of GDP increased from 0.20% to 0.31% respectively for the two periods while technology receipts in 2010 prices increased in real terms from R3 405 million to R4 808 million.

Table 4.14: Trends in Technology Receipts

	2005		2006 - 2010	2011 - 2015		2013	2014	2015
Technology receipts (nominal values, R million)	288		3 012	5 750		1 156	1 260	1 334
Technology receipts (real values, 2010 base year, R million)	414		3 405	4 808		967	997	1 015
Technology receipts per capita (rands)	6.1		12.2	21.6		21.7	23.3	24.3
Technology receipts as a % of GDP	0.11		0.20	0.31		0.32	0.36	0.43

Source: South African Reserve Bank "Online Statistical Query"

The international benchmarking of South African technology receipts (**Table 4.15**) shows a very low world share value for the country (0.04% during 2006 – 2010 and 2011 – 2015). In comparison to other STI indicators, the share of South African technology receipts is high relative to other BRICS countries even if there was a decline from 5.84% during 2006 – 2010 to 4.80 during 2011 – 2015. On the positive side, there was a large increase in South African technology receipts in relation to SSA, SADC and the rest of Africa.

Table 4.15: Benchmarking of South African Technology Receipts

	2005		2006 - 2010	2011 - 2015		2013	2014	2015
SA Technology receipts (TR) as % of SADC TR	33.37		17.68	79.50		80.41	74.78	81.81
SA TR as % of SSA TR	28.05		16.43	50.83		44.09	47.93	79.24
SA TR as % of Africa TR	13.49		14.01	45.24		40.13	42.66	65.50
SA TR as % of BRICS TR	5.91		5.84	4.80		4.69	4.67	3.48
SA TR as % of G20 TR	0.03		0.04	0.04		0.04	0.04	0.03
SA TR as % of world TR	0.03		0.04	0.04		0.04	0.04	0.03

Source: The World Bank "World Development Indicators"

5. IMPORTED KNOW-HOW

An open innovation model has gained prominence especially in the area of strategic global innovation collaborations. The use of imported knowledge exploits the difference in products, process and industry lifecycles between various countries. Unfortunately for an uptake of locally produced technologies, there is a need for a proper match between current market needs and technological capacity. Imported know-how fills this gap. Technology payments, inflows of foreign direct investment (FDI) and imports of merchandise goods are discussed in this section.

5.1 Technology Payments

Payment for the charges on the use of intellectual property includes items such as patents, trademarks, copyrights, industrial processes and designs that include trade secrets and franchises. As **Table 5.1** shows, South African technology payments have increased from R61.6 billion during 2006 – 2010 to R91.2 billion during 2011 – 2015. In real terms technology payments increased by 8.4% between these two periods. Per capita technology payments in nominal value terms also increased from R144.1 in 2005 to R397.4 in 2015. The country has one of the highest technology payments per GDP, at 7% of GDP in 2015. Similarly, technology payments as a proportion of the country's current account deficit in 2015 were about 12.5%, a marginal improvement from 2005 (13.3%) although over the past three years this figure has been on an upward trend.

Table 5.1: Trends in Technology Payments

	2005		2006 - 2010	2011 - 2015		2013	2014	2015
Technology payments (nominal values, R million)	6 812		61 648	91 177		18 651	18 791	21 839
Technology payments (real values, 2010 base year, R million)	9 801		70 304	76 242		15 594	14 866	16 620
Technology payments per capita (rands)	144.1		250.0	342.6		350.6	347.6	397.4
Technology payments as a % of GDP	2.64		4.03	4.95		5.10	5.37	6.98
Technology payments as a % of current account (BoP) deficit	13.28		14.12	14.10		8.96	9.32	12.53

Source: South African Reserve Bank "Online Statistical Query"

South African technology payments declined from 2006-2010 to 2011-2015 in relation to the rest of the world including Africa, G20 countries, BRICS countries, SSA and SADC (**Table 5.2)**. That said, South African technology payments increased from 2014 to 2015 specifically in relation to all these country groups.

Table 5.2: Benchmarking of South African Technology Payments

	2005		2006 - 2010	2011 - 2015		2013	2014	2015
SA Technology payments (TP) as % of SADC TP	87.53		90.16	88.67		91.21	80.62	82.30
SA TP as % of SSA TP	78.30		79.07	50.83		77.62	67.01	72.52
SA TP as % of Africa TP	66.81		67.93	63.32		66.55	58.58	63.60
SA TP as % of BRICS TP	10.71		8.53	5.08		4.86	4.01	4.31
SA TP as % of G20 TP	0.73		0.84	0.68		0.70	0.55	0.55
SA TP as % of world TP	0.63		0.73	0.58		0.59	0.47	0.48

Source: The World Bank "World Development Indicators"

5.2 Inflow of Foreign Direct Investment

An alternative mode of technology localisation is through foreign direct investment. In this type of arrangement, a local company has access to advanced technologies of the parent company and in some instances the parent company sets up R&D facilities for customisation of its technologies to the local market. As **Table 5.3** and **Figure 5.1** show, South African FDI inflow increased from the 1996 – 2000 period to 2006 – 2010 and started to decrease in real returns during the 2011 – 2015 period. FDI as percentage of GDP has also been on a declining trend. It is no coincidence that overall GDP growth also declined over this period, just as FDI had increased together with GDP growth through the first decade of the 21st century.

Table 5.3: Indicators for Inflow of Foreign Direct Investment

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
FDI inflow (nominal values. R million)	3 515		39 547	127 916	214 435	233 616		80 138	62 629	22 614
FDI inflow (real values. 2010 base year. R million)	9 842		96 307	218 026	241 378	196 092		67 030	49 560	17 214
FDI inflow as % of GDP	0.55		1.02	1.91	1.85	1.32		2.26	1.64	0.56

Source: United Nations Conference on Trade and Development "UNCTADstat"

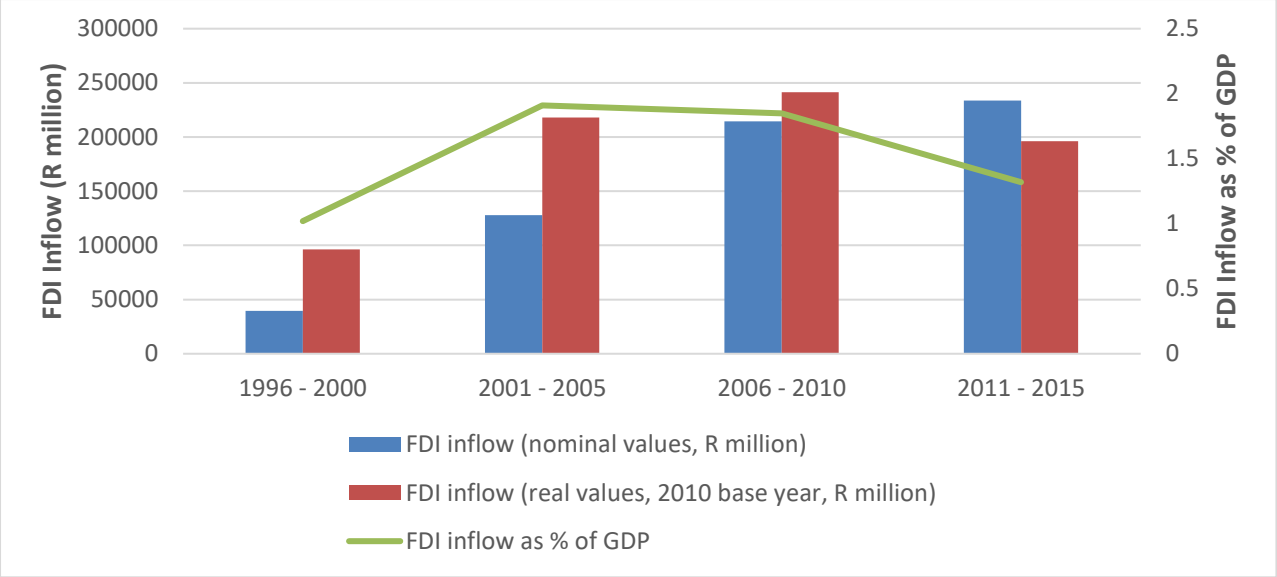


Figure 5.1: Trend in Inflow of Foreign Direct Investment to South Africa

Table 5.4 clearly shows a reduction of FDI into the country, especially during 2014 and 2015. The decline of inflows of FDI seems to have been very high for South Africa in the current decade, with the country losing its attractions as an FDI destination even in relation to comparator countries in BRICS, as well as in relation to developing economies and upper middle income economies. According to the United Nations Conference on Trade and Development (UNCTAD), the large decline in FDI to African countries is due to the recent end of the commodity "super-cycle", which has seriously affected the flow of FDI to resource-rich countries. In South Africa, the slowdown in FDI has arguably also been negatively affected by increased political uncertainty and uncertainty about economic policy.

Table 5.4: Benchmarking of South African Inflow of Foreign Direct Investment

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
SA FDI inflow as % of SADC FDI	45.85		37.21	45.47	45.48	27.66		51.07	25.73	8.05
SA FDI inflow as % of SSA FDI	17.89		20.17	22.48	18.33	11.45		20.20	12.15	4.13
SA FDI inflow as % of Africa FDI	13.54		15.12	16.48	11.31	9.21		15.91	9.90	3.28
SA FDI inflow as % of BRICS FDI	1.40		2.04	3.61	2.49	1.83		3.11	2.13	0.69
SA FDI inflow as % of developing economies FDI	0.56		0.79	1.41	1.05	0.71		1.25	0.83	0.23
SA FDI inflow as % of upper middle income countries FDI	0.85		1.19	2.05	1.64	1.24		1.99	1.52	0.48
SA FDI inflow as % of G20 FDI	0.34		0.30	0.83	0.64	0.61		0.98	0.89	0.19
SA FDI inflow as % of world FDI	0.21		0.19	0.48	0.37	0.33		0.58	0.45	0.10

Source: United Nations Conference on Trade and Development "UNCTADstat"

5.3 Imports of Merchandise Goods

As shown by **Table 5.5**, in tandem with the decline in FDI into the country, there has been a decline in imports of capital goods (25.76% in 2015 versus 34.12% in 1996) and industrial supplies (28.78% in 2015 versus 33.20% in 1996). Imports of merchandise such as transport equipment, food and beverages and consumer goods rose between the 1996 – 2000 and 2011 – 2015 periods. Although the import of fuels and lubricants rose between 1996 – 2000 and 2006 – 2010, there was a decline during 2011 – 2015 period. This decline was to some extent associated with the recent fall in crude oil prices.

Table 5.5: Proportion of Merchandise Imports by Broad Economic Categories

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
	%									
Food and Beverages	5.77		5.28	5.39	5.54	6.10		9.34	4.92	4.85
Industrial Supplies (n.e.s)	33.20		32.12	34.42	27.58	27.12		57.89	27.85	28.78
Fuels and Lubricants	8.99		10.76	11.41	16.47	15.98		6.13	13.32	12.55
Capital Goods (excl. transport equipment)	34.12		32.38	23.94	26.01	25.75		9.36	26.03	25.76
Transport Equipment	8.87		10.51	16.89	14.78	14.89		12.75	18.19	19.02
Consumer Goods (n.e.s)	8.92		8.76	7.52	9.30	10.03		4.11	8.45	8.83
Other Goods (n.e.s)	0.13		0.20	0.44	0.32	0.12		0.42	1.25	0.21

Source: Department of Trade and Industry "

Analysis by system of national accounts (SNA) broad end use classification (**Figure 5.2**) shows a decline in intermediate and capital goods imports although in this case the proportion of capital goods increased slightly during the 2011 – 2015 period.

The share of imports of consumer goods was on an upward trend between 2001 – 2005 and 2011 2015, from 7.52% to 10.03%, following a corresponding decline in the proportion of consumption goods imported during the preceding decade, from 12.38% during 1996 – 2000 to 11.66% during the 2001 – 2005 period. The decline in imports of investment goods relative

to consumption goods is disturbing as it suggests an erosion of the economy's capital and productive base to accommodate innovative processes and through this a decline in the ability to generate higher economic growth more generally in the longer term.

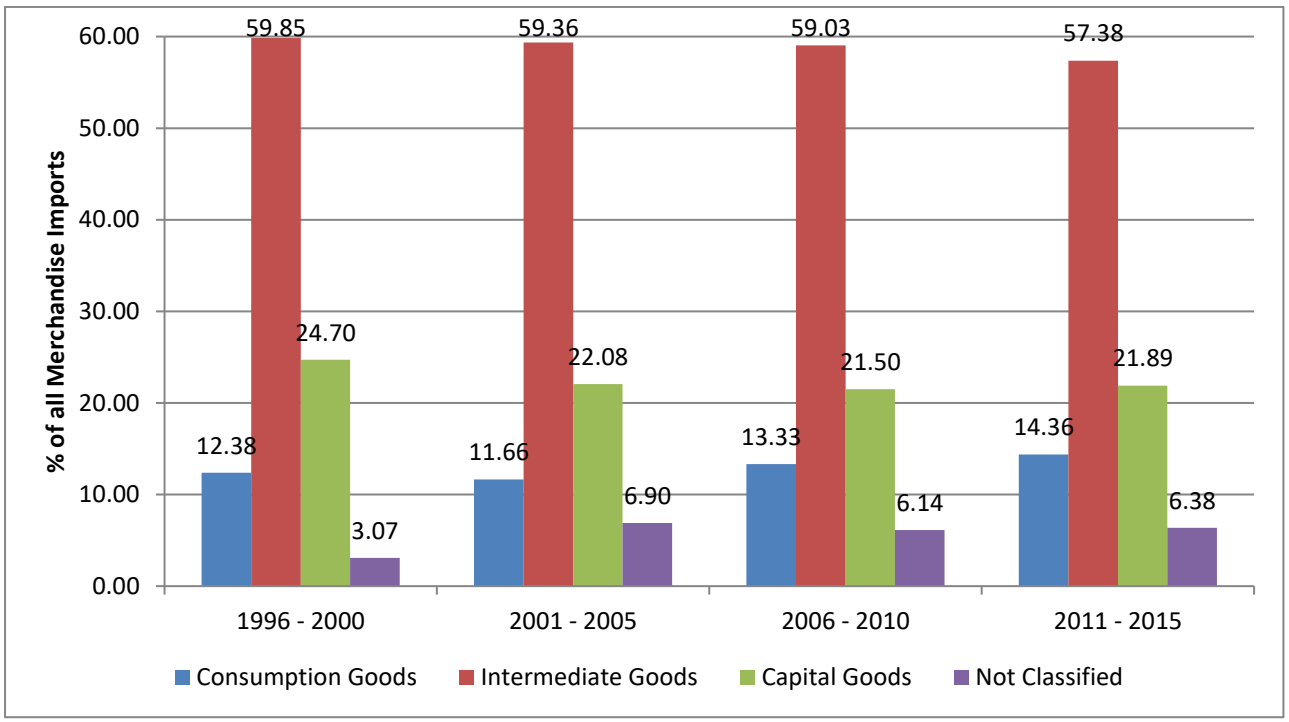


Figure 5.2: Proportion of Merchandise Imports by Broad End Use Classification

Source: Department of Trade and Industry

6. BUSINESS PERFORMANCE AND KEY INDUSTRIAL SECTORS

Improved competitiveness of key industrial sectors has a direct positive impact on economic growth and job creation and leads to an improvement in the standard of living. Technological improvement is key to increasing the competitiveness of various key industrial sectors, especially those that have the potential to accelerate economic growth and grow or retain jobs. This section discusses the findings of the Accenture Innovation Index, and also deals with total factor productivity growth, the export of goods and services, high technology exports and Johannesburg Stock Exchange (JSE) performance by industry.

6.1 Innovation Performance at Firm Level

The Accenture Innovation Index was designed as a national benchmark for innovation, providing businesses and policymakers with an authorative and objective snapshot of the state of innovation in South Africa. The index is derived by measuring innovation and systems of innovation in organisations of all sizes in the South African public and private sectors.

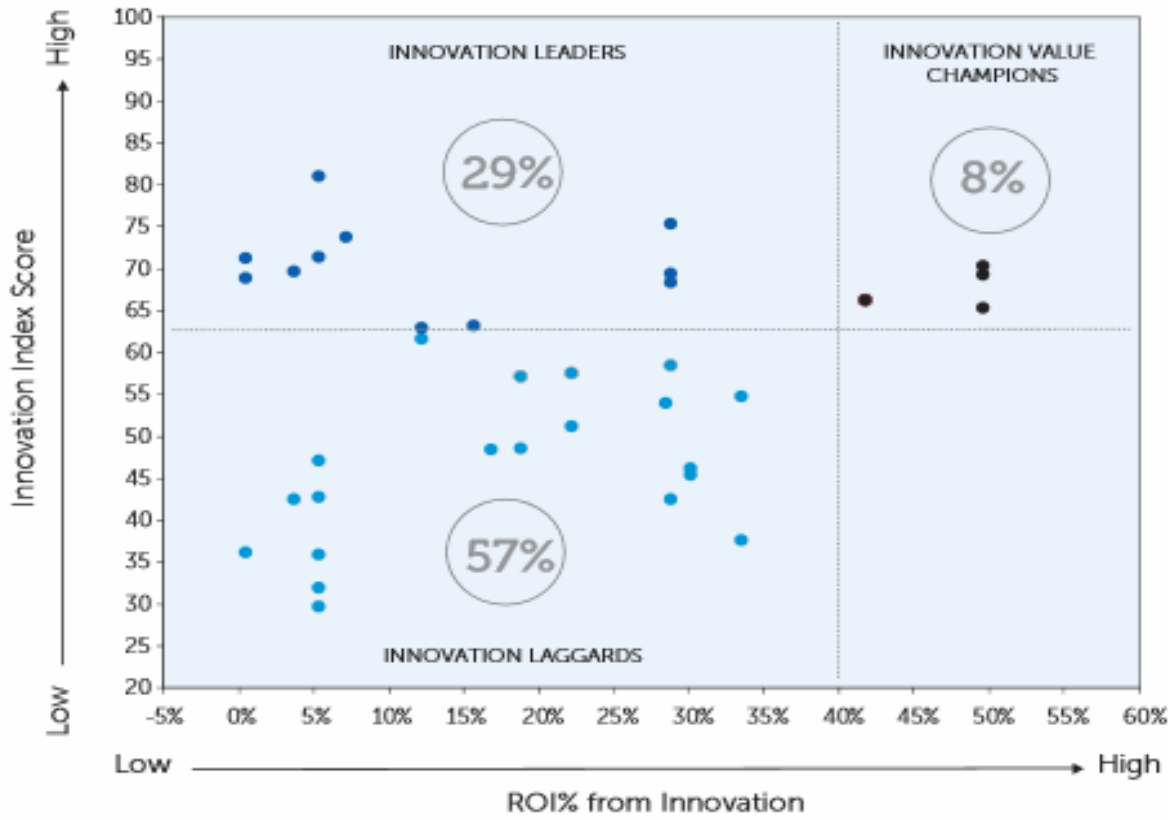


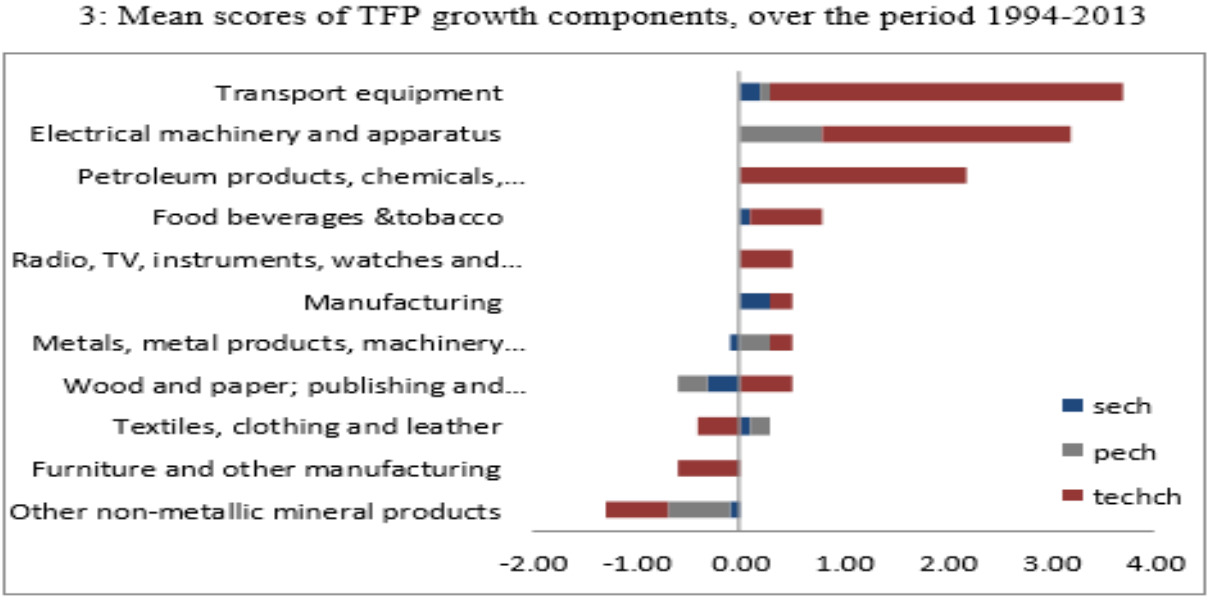
Figure 6.1: Innovation and Return on Investment

Source: Accenture South Africa "2016 Accenture Innovation Index"

This index shows that within the sample of 90 companies analysed, only approximately 37% of the organisations in South Africa can be thought of as innovative and of those, only 8% are innovation value champions as measured by their high innovation index scores and higher returns of investment (ROI) from innovation (**Figure 6.1**). The majority of organisations analysed (57%) were innovation laggards and these were characterised by low innovation index scores and a low ROI from innovation. Admittedly the sample size is relatively small and one is therefore reluctant to treat such findings as totally deterministic.

6.2 Total Factor Productivity Growth in the Manufacturing Sector

Total factor productivity (TFP) measures the residual growth in total output of a firm, industry or national economy that cannot be explained by the accumulation of traditional inputs such as labour and capital alone. The estimated TFP can further be decomposed into components such as technological change, pure efficiency and scale efficiency. **Figure 6.2** shows the mean scores of TFP growth components for the manufacturing sector for the two decade period 1994 - 2013. Overall, technical change accounted for most of TFP growth in seven of the 10 manufacturing subsectors. This growth has been high for capital-intensive sub-sectors and there has been a decline in TFP growth in labour-intensive sub-sectors such as textiles, clothing and leather; furniture; etc.



sech = scale efficiency change; pech = pure efficiency change; techch = technical change

Figure 6.2: Manufacturing Total Factor Productivity Growth and its Drivers

Source: Tsebe M. and Biniza S. (2015)

6.3 Export of Goods and Services

The nature of the country's exports depends largely on its businesses' sophistication levels. High technology exports are often associated with a knowledge-based economy. The country's share of high technology exports is very low. In 2015, it was 4.01% of total exports. This figure had been on a shallow decline between the 1996 – 2000 period and 2011 – 2015 (**Table 6.1**), but encouragingly over the last three years (2013 to 2015) specifically, the country's share of high technology exports as percentage of all the merchandise exports increased.

Table 6.1: Export Performance on Various South African Merchandise by Technological Intensity

		1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
Primary Products	Exports (R billion)	35		189	357	767	1 092		228	230	240
	% World Share	1.04		0.90	0.81	0.81	0.69		0.66	0.62	0.77
	% Country Share	27.47		24.84	28.19	30.95	24.91		24.78	23.42	26.97
Resource-Based Manufactures	Exports (R billion)	34		211	337	659	1 284		282	296	244
	% World Share	0.98		0.93	0.76	0.77	0.85		0.87	0.84	0.73
	% Country Share	27.13		27.83	26.65	26.59	29.27		30.69	30.14	27.50
Low Technology Manufactures	Exports (R billion)	13		82	145	209	308		62	71	63
	% World Share	0.35		0.33	0.32	0.29	0.26		0.26	0.25	0.21
	% Country Share	10.46		10.73	11.43	8.45	7.03		6.75	7.27	7.13
Medium Technology Manufactures	Exports (R billion)	29		179	367	730	1201		241	282	265
	% World Share	0.41		0.37	0.40	0.49	0.49		0.49	0.50	0.43
	% Country Share	23.42		23.52	29.04	29.44	27.39		26.27	28.72	29.88
High Technology Manufactures	Exports (R billion)	5		28	47	89	155		30	38	36
	% World Share	0.10		0.09	0.07	0.09	0.09		0.09	0.10	0.08
	% Country Share	3.59		3.75	3.68	3.60	3.53		3.27	3.89	4.01
Unclassified Products	Exports (R billion)	10		71	13	24	345		76	65	40
	% World Share	1.22		1.14	0.09	0.09	0.71		0.70	0.63	0.34
	% Country Share	7.92		9.33	1.01	0.97	7.86		8.24	6.56	4.51

Source: United Nations Conference on Trade and Development "UNCTADstat"

As **Figure 6.3** shows, during the 1996 – 2000 period, the highest country share of merchandise exports was that of resource-based manufacturers (27.83%), followed by primary producers (24.84%) and medium technology manufacturers (23.52%). The country share of exports from resource-based manufacturers grew to 29.27% during 2011 – 2015 from 26.59% during 2006 – 2010. This followed a slight decline from 1996 – 2000 levels.

However, between 2013 and 2015 specifically, the country share of exports from resource-based manufacturers declined quite sharply in line with the fall of commodity prices more generally.

The country share of exports from low technology manufacturers is on the decline and it is also the same for South Africa's world share of exports in this category. The country's highest world share of exports in 2015 was in respect of the primary products category (0.77%), followed by resource-based manufacturers (0.73%) and medium technology manufacturers (0.43%).

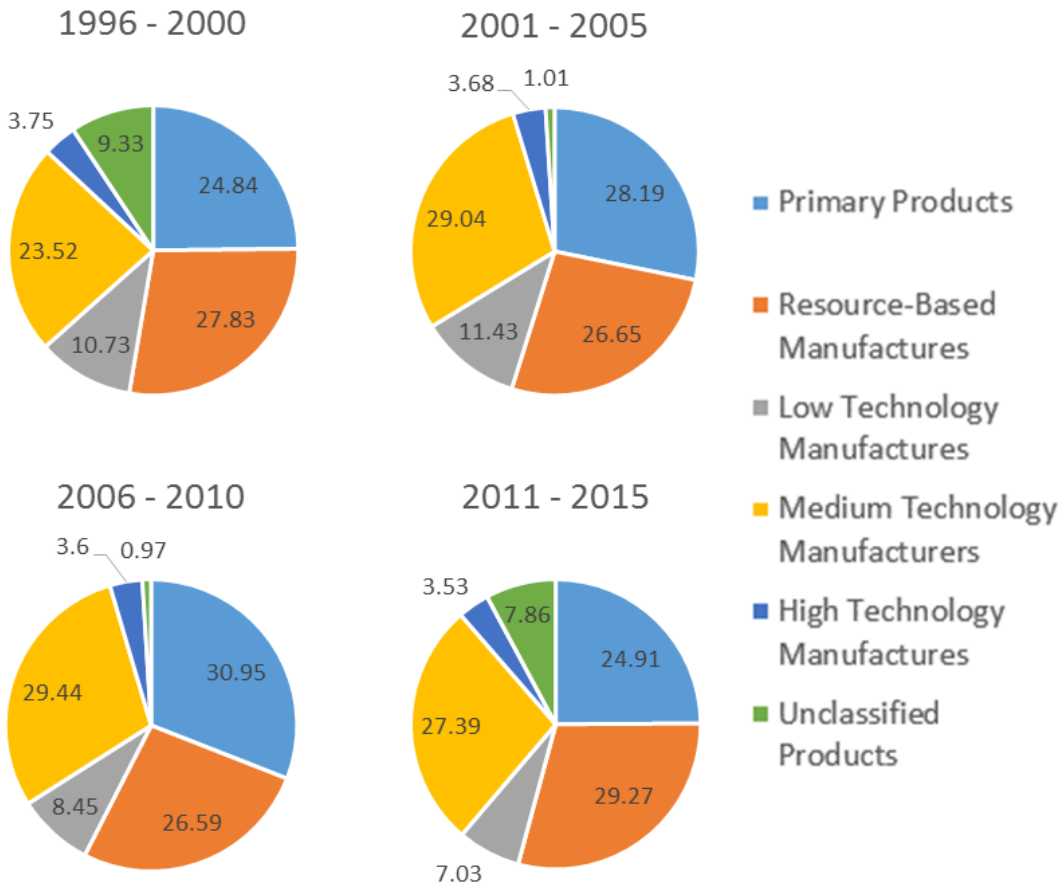


Figure 6.3: Country Share of Merchandise Exports by Technology Intensiveness

As shown by **Table 6.2**, although the country share of the world`s high technology exports is low, South Africa's percentage share of high technology exports is high (72.02%. 51.46% and 29.38% respectively in 2015) in relation to SADC, SSA and Africa. Unfortunately, the trend in this competitiveness is downward. The situation is similar in relation to BRICS

countries, developing economies and upper middle income countries. Again this is indicative of a gradual decline in the country's competitiveness relative to its peers.

The country's share of high technology exports as a percentage of G20 countries and the rest of the world is very low (0.11% and 0.08% respectively in 2015).

Table 6.2: Benchmarking of South African High Technology Merchandise Exports

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
SA high-tech exports as % of SADC high-tech exports	84.43		85.39	79.03	75.75	77.07		77.85	77.22	72.02
SA high-tech exports as % of SSA high-tech exports	69.34		67.53	61.89	57.26	56.91		57.94	57.98	51.46
SA high-tech exports as % of Africa high-tech exports	51.77		44.41	37.53	35.40	33.41		34.08	33.13	29.38
SA high-tech exports as % of BRICS high-tech exports	3.56		2.30	0.76	0.51	0.42		0.39	0.44	0.35
SA high-tech exports as % of developing economies high-tech exports	0.35		0.28	0.19	0.19	0.18		0.17	0.19	0.15
SA high-tech exports as % of upper middle income countries high-tech exports	1.05		0.75	0.42	0.37	0.33		0.31	0.35	0.28
SA high-tech exports as % of G20 high-tech exports	0.14		0.11	0.10	0.11	0.13		0.12	0.14	0.11
SA high-tech exports as % of world high-tech exports	0.10		0.09	0.07	0.09	0.09		0.09	0.10	0.08

Source: United Nations Conference on Trade and Development "UNCTADstat"

As **Table 6.3** shows, in terms of high technology merchandise exports as a percentage of total merchandise exports, most high technology exports go to regions of the world which have not industrialised significantly by SSA (7.63% in 2015), SADC (7.62%), Africa (7.54%), least developed countries (7.50%), South America and Central America (6.18%), developing economies (5.18%), upper middle income countries (4.85%) and Oceania (4.55%).

The proportion of high technology exports to BRICS countries has fallen drastically, from 5.19% during 2001 – 2005 to only 0.55% during 2011 – 2015. This shows the growing dominance of China as a competitive producer of high technology goods which killed off much

of the need for South African exports. Overall, South African high technology exports as a percentage of total merchandise exports to various regions and economies is declining.

Over the last three years there has been an improvement, notably in respect of the proportion of high technology merchandise exports to South America and Central America, with an increase from 2.57% in 2013 and 3.15% in 2014 to 6.18% in 2015.

Table 6.3: High Technology Merchandise Exports to Various Economies as a Percentage of Total Merchandise Exports

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 – 2015		2013	2014	2015
SADC	7.68		7.73	7.15	7.81	7.19		6.64	7.40	7.62
SSA	8.06		8.27	8.56	8.33	7.38		6.91	7.67	7.63
Africa	8.15		8.27	8.56	8.33	7.38		6.88	7.66	7.54
Least Developed Countries	7.24		7.23	7.96	8.15	6.85		6.38	7.50	7.50
Developing Economies	5.35		8.06	5.77	4.26	4.91		4.20	5.12	5.18
Upper Middle Income Economies	5.77		5.57	4.26	3.83	4.04		3.35	4.32	4.85
Oceania	7.47		8.06	5.77	4.26	4.91		5.14	4.02	4.55
BRICS	1.91		1.81	5.19	1.00	0.55		0.34	0.65	0.78
South America and Central America	6.55		6.17	4.43	1.88	3.28		2.57	3.15	6.18
Asia	1.27		1.28	2.21	1.54	1.28		1.23	1.83	1.73
Europe	2.70		3.02	2.84	3.13	2.60		2.44	2.85	3.06
G20	2.53		2.87	2.83	2.35	1.92		1.74	1.96	2.36
Developed Economies	2.58		2.97	2.61	2.67	2.48		2.37	2.55	2.83

Source: The World Bank "World Development Indicators"

In terms of services exports by category, as **Table 6.4** shows, South Africa's largest share of services exports in 2015 was in respect of travel (54.86%), followed by transport (16.41%). Having risen in line with the build-up to the Fifa World Cup, travel service exports declined from a country share of 58.41% during 2006 – 2010 to 55.38% during 2011 – 2015 (**Figure 6.4**).

Table 6.4: Service Export Performance by Various Categories

			2005		2006 - 2010	2011 - 2015		2013	2014	2015
Goods-Related Services		Exports (R billion)	0.13		0.82	2.56		0.59	0.99	0.45
		% World Share	0.02		0.02	0.03		0.04	0.05	0.02
		% Country Share	0.18		0.15	0.30		0.36	0.54	0.24
Transport		Exports (R billion)	12.85		99.00	144.70		30.24	32.93	31.52
		% World Share	0.35		0.34	0.33		0.33	0.31	0.28
		% Country Share	17.08		18.38	18.06		18.62	18.02	16.41
Travel		Exports (R billion)	47.79		313.68	447.13		89.26	101.35	105.37
		% World Share	1.09		0.94	0.78		0.77	0.72	0.67
		% Country Share	63.54		58.41	55.38		54.98	55.46	54.86
Other Services	Construction	Exports (R billion)	0.22		1.07	1.13		0.23	0.25	0.25
		% World Share	0.08		0.04	0.02		0.02	0.02	0.02
		% Country Share	0.29		0.20	0.14		0.14	0.14	0.13
	Insurance and Pension Services	Exports (R billion)	0.79		8.49	12.61		2.53	2.62	2.72
		% World Share	0.19		0.24	0.22		0.21	0.18	0.17
		% Country Share	1.05		1.56	1.59		1.56	1.43	1.41
	Financial Services	Exports (R billion)	3.40		29.65	42.58		8.39	9.49	10.86
		% World Share	0.25		0.24	0.22		0.21	0.21	0.20
		% Country Share	4.52		5.51	5.24		5.16	5.19	5.65
	Telecommunications. Computer and Information Services	Exports (R billion)	2.06		14.27	28.27		5.80	6.56	7.29
		% World Share	0.16		0.12	0.13		0.14	0.13	0.12
		% Country Share	2.73		2.66	3.45		3.58	3.59	3.80
	Charges for the Use of Intellectual Property (n.e.s.)	Exports (R billion)	0.29		3.03	5.74		1.16	1.26	1.32
		% World Share	0.03		0.04	0.04		0.04	0.04	0.03
		% Country Share	0.38		0.56	0.72		0.71	0.69	0.69
	Other Business Services	Exports (R billion)	5.32		49.89	96.33		18.77	21.59	25.16
		% World Share	0.16		0.18	0.20		0.19	0.18	0.19
		% Country Share	7.08		9.21	11.82		11.56	11.81	13.10
	Personal. Cultural. and Recreational Services	Exports (R billion)	0.72		4.58	7.35		1.39	1.58	2.17
		% World Share	0.46		0.41	0.35		0.33	0.33	0.43
		% Country Share	0.96		0.85	0.89		0.86	0.86	1.13
	Government and Services n.e.s.	Exports (R billion)	1.65		13.62	19.54		4.00	4.12	4.95
		% World Share	1.05		0.53	0.53		0.94	0.86	0.97
		% Country Share	2.19		2.51	2.41		2.47	2.25	2.58

Source: United Nations Conference on Trade and Development "UNCTADstat"

Services exports in respect of charges for the use of intellectual property as a percentage of the country's services exports increased from 0.56% during 2006 – 2010 to 0.72% during 2011 – 2015.

In terms of their world share, services exports for charges for the use of intellectual property remain very low and stagnant at 0.04%. Government services had the highest percentage world share of services exports in 2015 (0.97%), followed by travel services (0.67%).

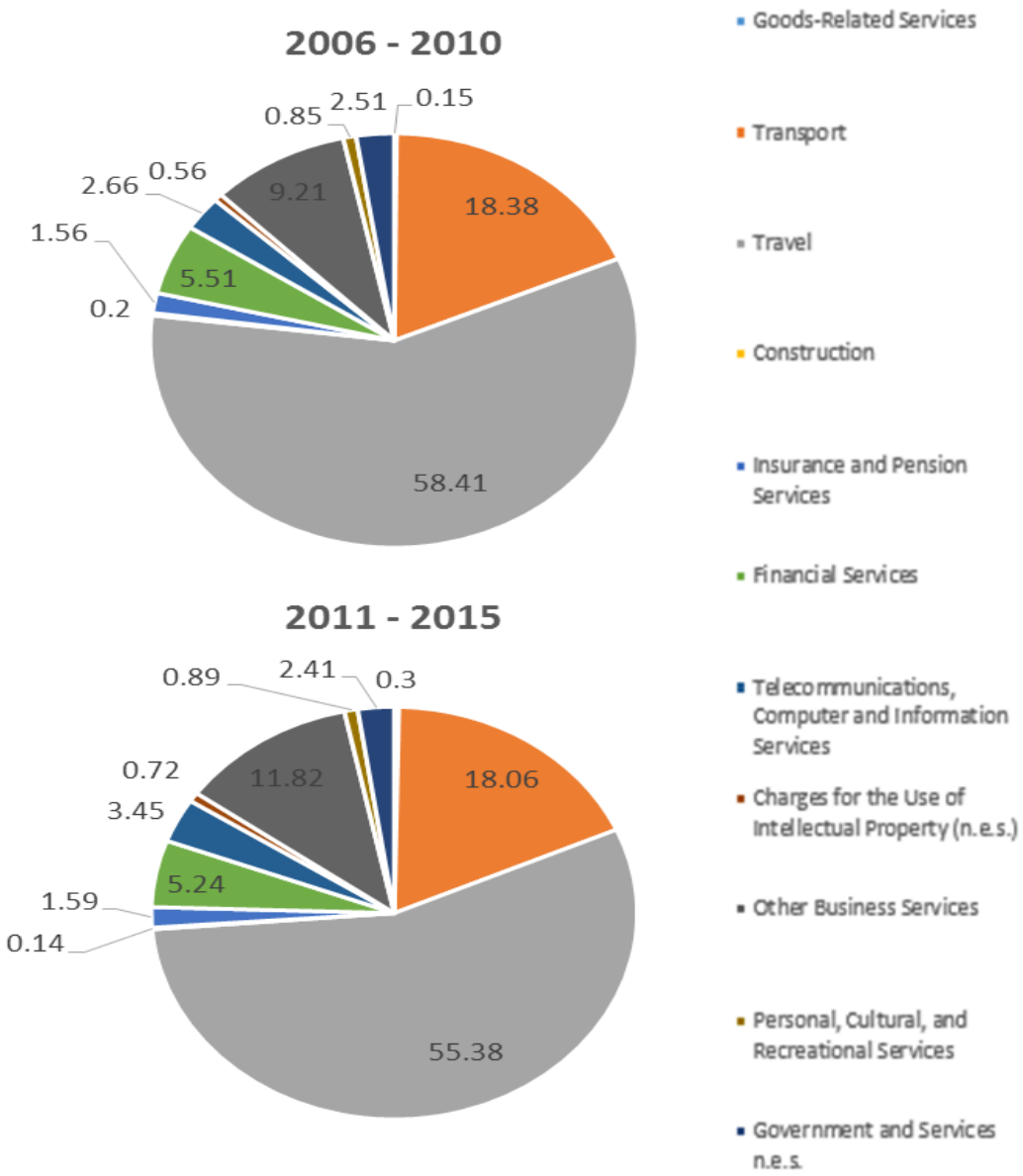


Figure 6.4: Country Share of Service Exports by Category

Telecommunications, computer and information (TCI) services exports are a key indicator with which to monitor the impact of the recent onset of the fourth industrial revolution. South

Africa is also a host to the Square Kilometer Array, an international project that is aimed at building a large multi radio telescope with a total collecting area of about one square kilometer. Capacity building in the area of big data is therefore important. As **Table 6.5** shows, the country's exports of TCI services as a percentage of SADC exports remains very high (60.82% in 2015). However, it is only about 10% relative to the rest of Africa. TCI services exports relative to BRICS, developing economies, middle income countries, G20 countries and the rest of the world unfortunately have been on the decline during the last three years.

Table 6.5: Benchmarking of Telecommunications. Computer and Information Services Export

	2005		2006 - 2010	2011 - 2015		2013	2014	2015
SA TCI service exports as % of SADC TCI service exports	62.16		52.44	56.54		57.81	56.52	60.82
SA TCI service exports as % of SSA TCI service exports	26.93		20.25	19.52		19.58	18.27	19.92
SA TCI service exports as % of Africa TCI service exports	14.89		9.46	10.32		10.38	9.96	11.06
SA TCI service exports as % of BRICS TCI service exports	1.55		0.88	0.76		0.80	0.73	0.65
SA TCI service exports as % of developing economies TCI service exports	0.93		0.56	0.52		0.54	0.51	0.45
SA TCI service exports as % of upper middle income countries TCI service exports	3.34		1.96	1.54		1.66	1.49	1.26
SA TCI service exports as % of G20 TCI service exports	0.47		0.44	0.44		0.39	0.36	0.34
SA TCI service exports as % of world TCI service exports	0.16		0.12	0.13		0.14	0.13	0.12

Source: United Nations Conference on Trade and Development "UNCTADstat"

6.4 JSE Market Performance by Industry

To the extent that the performance of equity markets in specific sectors might be seen to be a reflection of the underlying macroeconomic progress in those sectors, it may be of interest to reflect on the JSE performance of such sectors and especially the relative role of technologically driven industries. The market capitalisation of the financials sector on the JSE increased significantly from R755 billion in 2006 to R1.6 trillion in 2016 (**Table 6.6**). As a result, this sector is now the biggest on the JSE in terms of market capitalization, with a share of 25.5% in 2016, from 21.3% in 2006 (**Figure 6.4**).

Table 6.6: JSE Market Capitalisation by Sector

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sector Name	**R billion**										
Basic materials	1 326	1 678	1 115	1 535	1 698	1 515	1 591	1 431	1 210	1 054	1 427
Consumer goods	481	539	342	492	607	775	1 098	1 419	1 612	2 090	1 007
Consumer services	247	228	219	305	423	435	636	754	935	1 330	1 374
Financials	755	761	571	728	840	891	1 172	1 157	1 460	1 544	1 624
Health care	44	36	39	70	90	91	157	201	275	253	241
Industrials	305	349	193	234	277	263	351	376	414	361	336
Oil and gas	162	212	187	190	221	248	234	282	239	0	0
Technology	17	22	14	23	11	14	18	22	25	25	30
Telecommunications	200	277	236	259	303	327	401	444	456	308	328

Source: Johannesburg Stock Exchange

The market capitalisation of the health care industry has also grown significantly over the decade although as a percentage share of JSE market capitalisation it was only 3.8% in 2016, having grown from a low base of 1.2% in 2006. Technology and telecommunications industries show no signs of growth on the JSE, a worrisome factor in terms of the potential for local innovations, whilst the relative market capitalisation of the oil and gas industry has shrunk drastically recently linked to the decline in oil prices between 2013 and 2015. The recent fall in metal prices also contributed to a decline in a share of JSE market capitalisation for basic materials from 37.5% in 2006 to 22.4% in 2016.

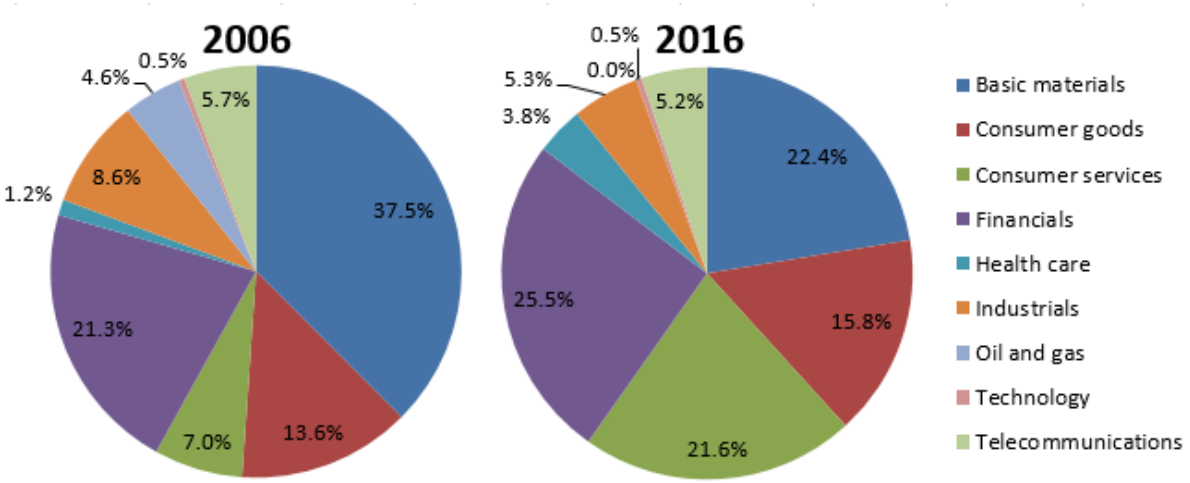


Figure 6.5: Proportion of JSE Market Capitalisation by Sector

7. WEALTH CREATION

Economic growth is a key driver in achieving several development targets for the country as is the case with the NDP. The Schumpeterian economic model places innovation and entrepreneurship as the primary drivers of competitiveness and rapid economic growth. The areas that are discussed in this section reflect the contribution to GDP of various economic sectors, together with the balance of payments, share of wealth between capital and labour, as well as income per capita.

7.1 GDP Contribution by Sector

As **Table 7.1** shows, in 1996 the largest sectoral contribution to GDP came from Community. Social and Personal Services (17.6%) followed by Finance, Real Estate and Business Services (14.6%), Manufacturing (14.3%) and Mining and Quarrying (13.1%).

Table 7.1: Value-Added as Percentage of GDP in Various Sectors

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
Agriculture. forestry and fishing	2.8		2.7	2.6	2.3	2.4		2.4	2.5	2.3
Mining and quarrying	13.1		12.6	11.0	8.8	7.7		7.8	7.5	7.7
Manufacturing	14.3		14.3	14.1	13.6	12.8		12.8	12.6	12.4
Electricity and water	3.2		3.0	2.7	2.6	2.3		2.3	2.2	2.2
Construction	2.4		2.3	2.4	3.2	3.5		3.5	3.5	3.6
Wholesale. retail and motor trade; catering and accommodation	12.4		12.6	13.2	13.4	13.7		13.8	13.7	13.7
Transport. storage and communication	6.2		6.8	8.0	8.3	8.5		8.4	8.5	8.5
Finance. real estate and business services	14.6		15.2	17.0	18.8	19.5		19.4	19.6	19.9
General government services	5.4		5.5	5.6	5.5	5.4		5.4	5.4	5.3
Community. social and personal services	17.6		16.8	14.6	14.3	15.1		15.1	15.3	15.2

Source: South African Reserve Bank "Online Statistical Query"

Since then, the financial sector and its associated industries have grown in prominence over the intervening two decades. During the period 2011 – 2015 this sector accounted for 19.5% of GDP, up from 15.2% during 1996 – 2000 (Figure 7.1). In contrast, the Manufacturing sector's share of GDP declined in line with global trends, from 14.3% during 1996 – 2000 to

12.8% during 2011-2015. Automation and the global economic recession are the main factors contributing to this decline. Mining is one of the sectors that declined drastically in terms of its size within the South African economy. Most of this decline took place between the 2001 – 2005 and 2006 – 2010 periods, falling from 11.0% to 8.8% of GDP. As most gold mines are getting deeper and unsafe, improved mining methods are urgently required to extract South Africa's enormous mineral deposits. Huge electricity, steel and wage cost increases have also raised the costs of mining. Costs have also risen abruptly in line with efforts to improve safety and productivity, focusing on niche areas of mining automation and recently mining robotics.

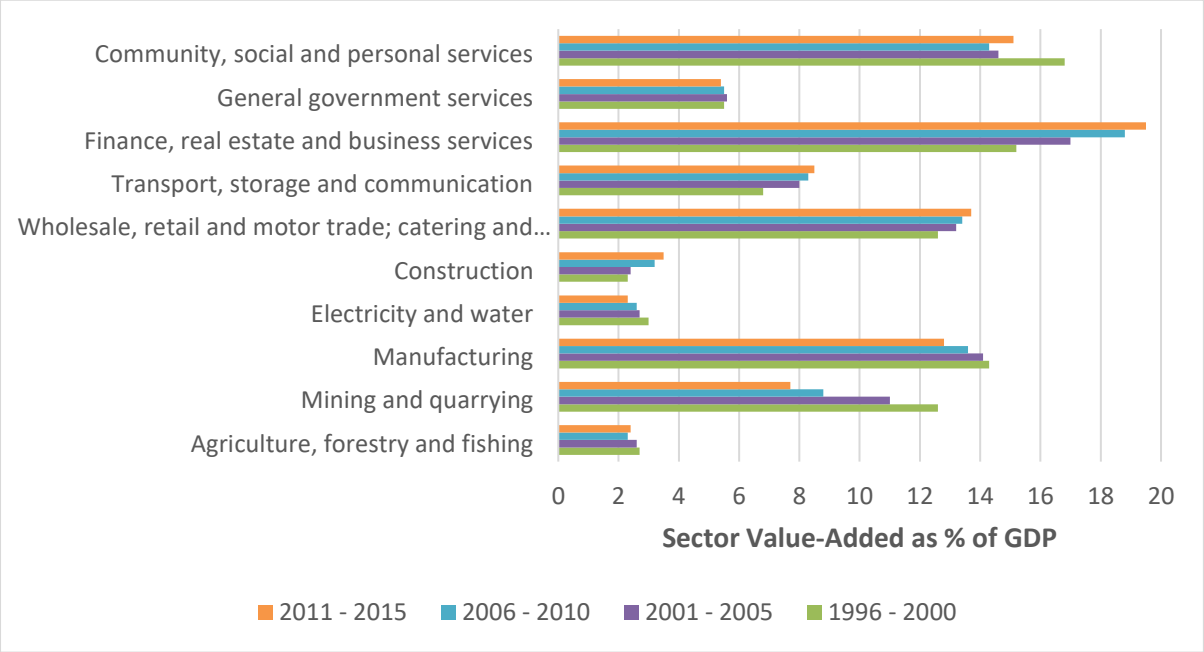


Figure 7.1: Trend in Sector Value-Added as Percentage of GDP

International benchmarking (**Table 7.2** and **Figure 7.2**) indicates that the country's GDP is declining relative to its African counterparts, including SADC and SSA. This declining share of South Africa's GDP is a function of the higher economic growth rates in those regions which has been driven by rising levels of foreign direct investment and industrialisation in contrast with South Africa`s declining share of foreign investment. South Africa lost its status temporarily as the largest economy in Africa to Nigeria following the rebasing of Nigeria's GDP in 2013. During 2016 South Africa regained its spot as the largest African economy following huge depreciation of the currencies of Nigeria and Egypt and a severe recession in Nigeria following the collapse of oil prices between 2014 and 2016.

With the rapid growth in China's GDP between 1996 and 2015 (annual growth rates of more than 10% until 2010), as well as impressive GDP growth rates in India of between 6% and 8% in the past five years, South Africa's share of BRICS GDP declined dramatically from 5.3% during 1996 – 2000, to just 2.3% during 2011 – 2015.

Table 7.2: Benchmarking of South African GDP

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
SA GDP as % of SADC GDP	75.0		72.1	69.2	62.2	55.9		54.4	52.4	52.9
SA GDP as % of SSA GDP	44.6		42.4	38.6	31.1	23.6		22.7	20.7	20.7
SA GDP as % of Africa GDP	27.5		25.2	24.4	20.5	16.3		15.6	14.5	14.3
SA GDP as % of BRICS GDP	5.6		5.3	4.9	3.4	2.3		2.2	2.0	1.9
SA GDP as % of G20 GDP	0.5		0.5	0.5	0.6	0.6		0.6	0.5	0.5
SA GDP as % of World GDP	0.5		0.5	0.5	0.5	0.5		0.5	0.5	0.4

Source: World Development Indicators

In relation to the G20 and the rest of the world, South Africa's GDP has been stagnant, hovering between 0.5% and 0.6% of World GDP between 1996 and 2015.

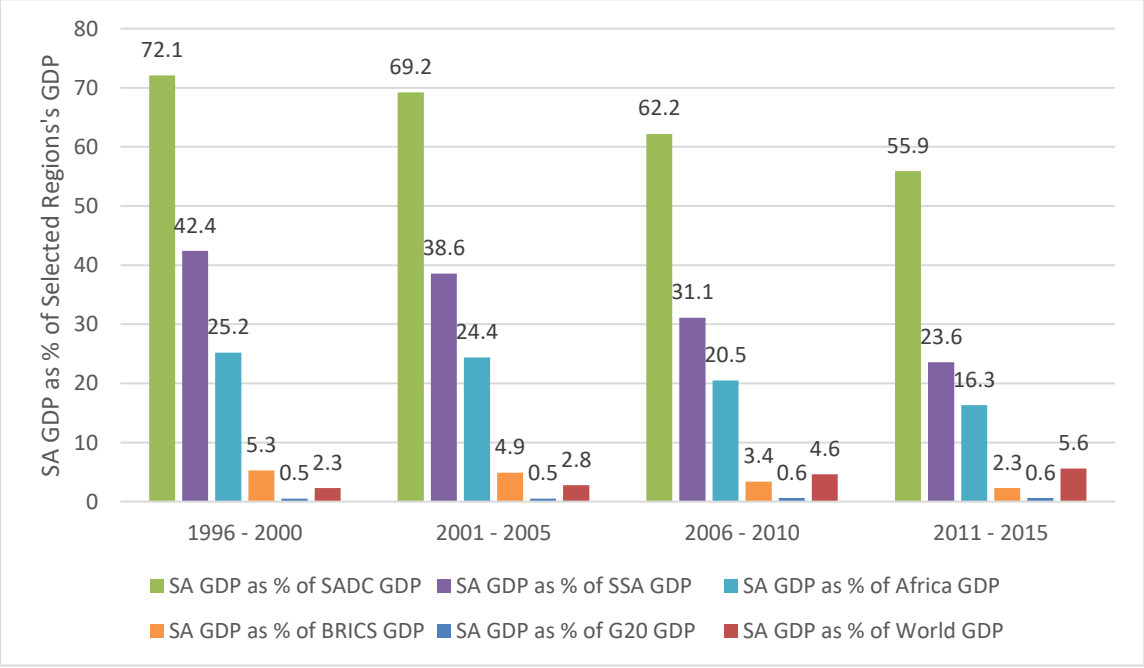


Figure 7.2: Trend in South African GDP as Proportion of Selected Regions

7.2 Balance of Payments

The balance of payments is a record of all transactions made between one particular country and all other countries during a specified time period. These transactions include the flow of goods, services and funds across national boundaries. South Africa has experienced a deterioration in its current account balance over the last 20 years, both in nominal and real terms (**Table 7.3** and **Figure 7.2**). The current account deficit increased from less than one percent of GDP during 1996 – 2000, to 4.6% during 2011 – 2015. On the positive side, the 2013 to 2015 data show some narrowing of the current account deficit.

Table 7.3: Balance of Payment on Current Account

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
Balance of payment on current account (R billion. nominal values)	-7.1		-35.8	-89.2	-436.8	-818.1		-208.1	-201.7	-174.3
Balance of payment (R billion. real values. 2010 base year)	-19.9		-89.8	-129.3	-516.8	-678.3		-174.5	-159.8	-132.7
Ratio of current account balance to the GDP (%)	-1.1		-0.9	-1.3	-3.8	-4.6		-5.9	-5.3	-4.3

Source: South African Reserve Bank "Online Statistical Query"

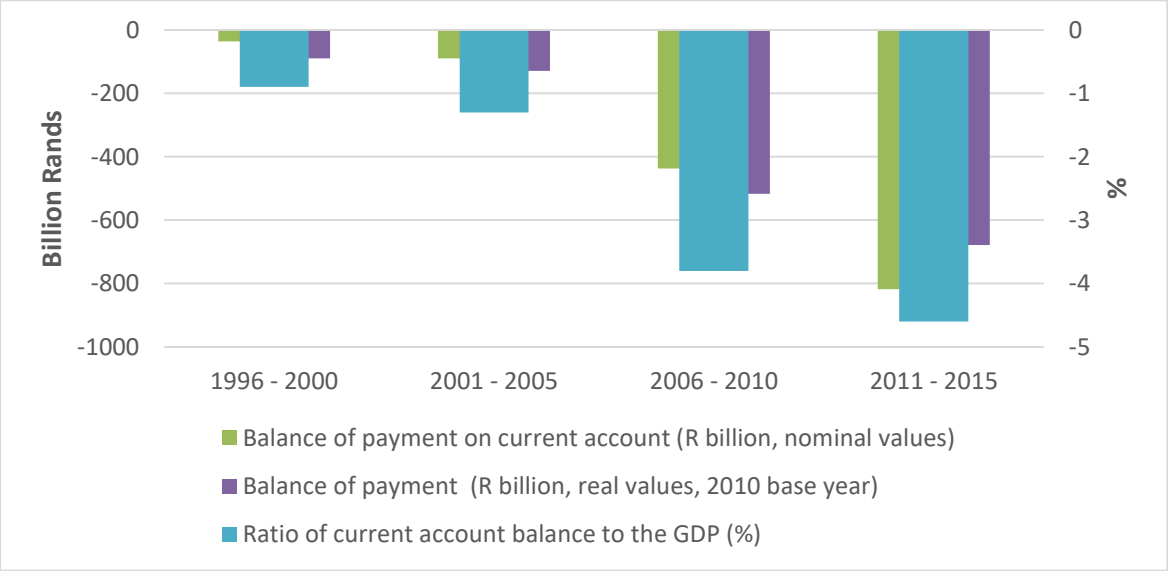


Figure 7.2: Trend in South African Balance of Payment on Current Account

International benchmarking in **Table 7.4** shows a similar trend of an increasing current account deficit for SADC, SSA and Africa as a whole. This rise in the current account deficit for Africa accelerated in 2015 to 7.8% of GDP from 3.9% of GDP in 2014. Declining commodity prices and associated export values of African mineral exports were the main reason. In contrast, the current account deficit of BRICS countries decreased between the periods 2006 – 2010 and 2011 - 2015 from 3.5% to 0.9% of GDP.

Table 7.4: Benchmarking of South African Current Account Balance as Percentage of GDP

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
South Africa	-1.1		-0.9	-1.3	-3.8	-4.6		-5.9	-5.3	-4.3
Southern African Development Community	-1.5		-1.8	-1.3	-2.2	-3.8		-4.4	-5.5	-5.8
Sub-Saharan Africa	-0.8		-2.1	1.2	-0.3	-2.8		-2.6	-3.9	-6.4
Africa	-0.3		-1.2	2.7	2.4	-2.5		-2.4	-3.9	-7.8
BRICS	0.3		0.4	2.9	3.5	0.9		0.2	1.1	2.3
G20	-0.2		-0.6	-0.8	-0.3	0.0		0.0	0.2	0.3
World Total	-0.1		-0.4	-0.3	0.2	0.4		0.3	0.4	0.5

Source: World Development Indicators

7.3 Capital to Labour Ratio

The capital to labour ratio is an important indicator of income sharing between capital owners and labour. This indicator is important for South Africa due to the high inequality prevalent within the country. **Figure 7.3** shows a declining capital to labour ratio from 1996 to 2004 followed by an increase from 2005 to 2015. **Figure 7.3** also shows an inverse relationship between the capital to labour ratio and the GDP growth rate. This casts doubt on the premise that increased capital intensity necessarily contributes toward improved growth. Instead, it appears as if declining productivity, industrial relation tensions and poor overall economic growth drive businesses to adopt more capital intensive processes.

When the economy is growing, there appears to be an increase in aggregate demand for labour in relation to capital, hence a decrease in the capital to labour ratio during such periods. In principle, unemployment should also decrease although the opposite took place in South Africa over the period 1996 to 2004. This was associated with a large decrease in the labour force absorption rate (**Figure 7.4**) at the time. As sanctions were lifted and South Africa entered the mainstream of global trade for the first time in many decades, the country

reduced tariffs on imports, opening the economy to the rest of the world. This forced efficiencies to be effected, leading to capital intensity at the expense of the masses.

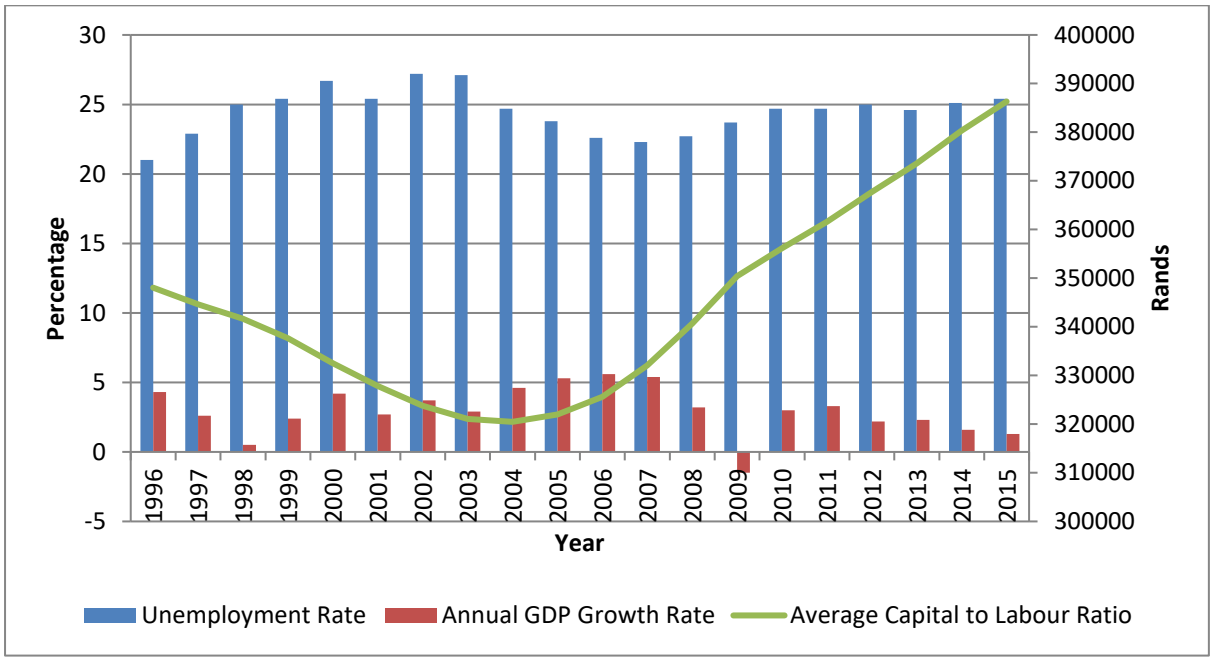


Figure 7.3: Employment. GDP Growth and Capital to Labour Ratio

Source: South African Reserve Bank "Online Statistical Query"; unemployment data from World Development Indicators

Figure 7.4: Trend in South African Labour Force Participation Rate

Source: World Development Indicators

While there has been an increase on average in the capital to labour ratio, the unemployment rate has been rising consistently and this is the biggest challenge to the economy as shown in **Table 7.5**. Out of 174 countries, South African unemployment was the seventh highest in

2014. South Africa has the biggest population of the top 10 countries characterised by the highest unemployment rates.

Table 7.5: Countries with the Highest Unemployment Rate

Rank (out of 174)	Country Name	Unemployment Rate (%), 2014
1	Mauritania	31
2	Bosnia and Herzegovina	27.9
3	Macedonia. FYR	27.9
4	Greece	26.3
5	Lesotho	26.2
6	West Bank and Gaza	26.2
7	South Africa	25.1
8	Spain	24.7
9	Mozambique	22.6
10	Swaziland	22.3

Source: World Development Indicators

7.4 GDP per Capita

Although GDP is the most commonly used measure of the size of a country's economy, GDP per capita is the most commonly used indicator of standard of living for the country's average citizen. Since it is a scale-adjusted indicator, it allows for a fair comparison between countries with different populations. South Africa's GDP per capita increased by 300% in nominal terms between the periods 1996 – 2000 and 2011-2015 (**Table 7.6** and **Figure 7.5**). However, in real terms, i.e. adjusted for inflation, it increased by a much more modest 27% from R44 177 to R55 541.

Table 7.6: GDP per Capita in Real and Nominal Values

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015		2013	2014	2015
GDP per capita (R. nominal values)	15 782		18 500	29 114	46 931	66 336		67 126	71 200	73 966
GDP per capita (R. real values. 2010 base year)	44 193		44 177	47 039	53 687	55 541		56 147	56 343	56 304

Source: South African Reserve Bank "Online Statistical Query"

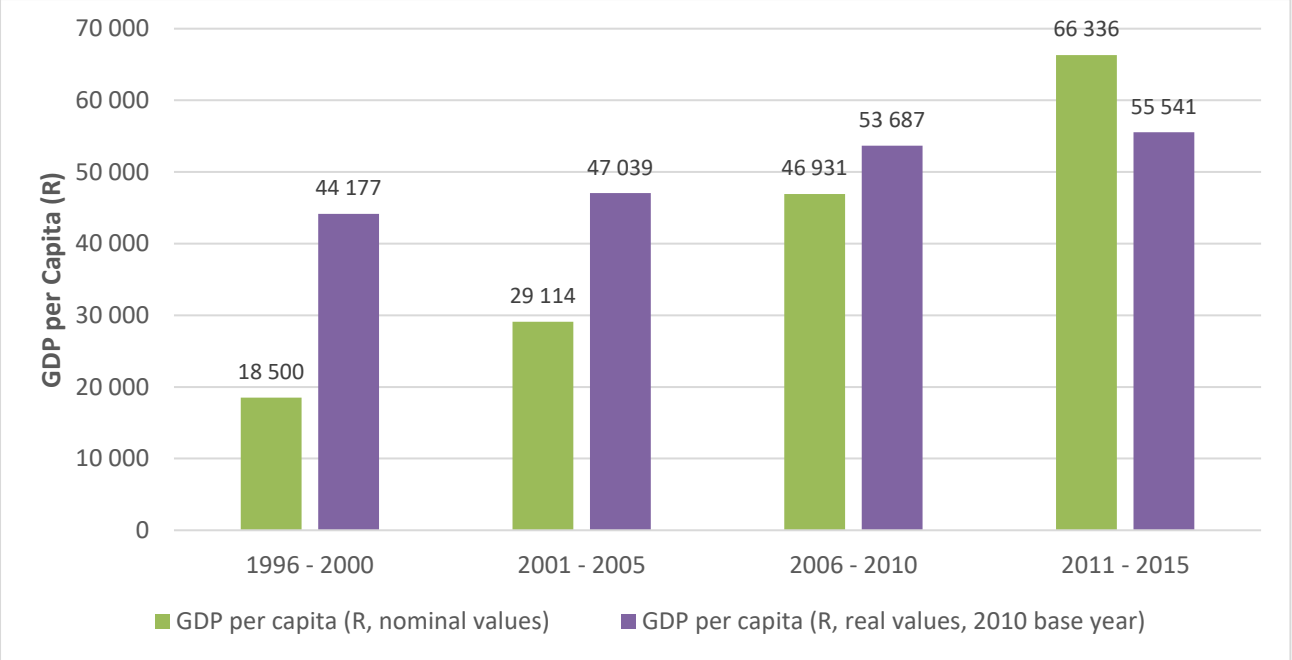


Figure 7.5: Trend in South African GDP per Capita

International benchmarking of South African GDP per capita (**Table 7.7**) shows that compared to SADC, SSA and the African continent overall, the country has a better standard of living and it has maintained this status over the last 20 years. Unfortunately, over the last three years specifically, the GDP per capita of South Africa and these African regions has been declining due to the slow domestic economic growth environment caused in part by soft commodity prices. In 1996, the country's GDP per capita was much larger than the average of the BRICS countries but this gap has narrowed due to rapid economic growth in China and India and at one point Brazil as well. The value of South African GDP per capita has consistently been lower than the world's average and that of the G20 countries over the last two decades.

Table 7.7: Benchmarking of South African GDP per Capita (current USD)

	1996		**1996 - 2000**	**2001 - 2005**	**2006 - 2010**	**2011 - 2015**		**2013**	**2014**	**2015**
South Africa	3 523		3 390	4 495	6 201	6 925		6 882	6 472	5 692
SADC	1 066		1 014	1 174	1 948	2 279		2 326	2 245	1 946
SSA	588		564	686	1267	1 764		1 823	1 856	1 631
Africa	769		768	890	1 582	2 106		2 182	2 193	1 952
BRICS	1 039		1 025	1 326	3 074	5 244		5 404	5 612	5 294
G20	7 146		7 111	8 334	11 703	13 876		14 068	14 300	13 399
World Total	5 481		5 421	6 254	8 873	10 518		10 661	10 794	10 114

Source: World Development Indicators

8. QUALITY OF LIFE

The success of the nation is not only measured by the performance of its economy. The improvement in well-being and quality of life of its citizens is also important. There is also a view that an improved quality of life impacts positively on STI capacity, a good example being health. This section focus on the key quality of life indicators in the areas of health, education, water & sanitation and environment.

8.1 Health

As **Table 8.1** and **Figure 8.1** show, although the country's life expectancy at birth in 2015 (62.1 years) was lower than the world average (71.4 years[6]), there has been a sharp improvement from 55.2 years in 2002. Over this period, the improvement was higher for females (8.1 years) than for males (5.7 years). This can be largely attributed to the successful rollout of free anti-retroviral drugs to combat AIDS from about 2005 onwards.

Table 8.1: Key Health Indicators

	2002	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Life expectancy at birth (years)	55.2	53.8	54.0	54.5	55.6	56.4	57.0	58.3	59.9	61.0	61.6	62.1
Female life expectancy at birth (years)	56.6	54.8	55.0	55.5	56.9	57.9	58.6	60.2	62.2	63.6	64.2	64.7
Male life expectancy at birth (years)	53.6	52.8	53.0	53.4	54.2	54.7	55.3	56.2	57.4	58.3	58.9	59.3
HIV/AIDS prevalence rate for adults. % (ages 15 – 49)	17.1	17.3	17.4	17.5	17.6	17.8	17.9	18.1	18.3	18.5	18.7	18.8
HIV/ AIDS prevalence for adult females (ages 15 – 49)	19.6	20.0	20.1	20.3	20.5	20.7	20.9	21.2	21.5	21.8	22.0	22.2
HIV/ AIDS prevalence for youth. % (ages 15 – 24)	7.6	6.4	6.3	6.2	6.2	6.3	6.4	6.3	6.2	6.1	5.9	5.8
HIV prevalence. % (total population)	10.3	10.8	11.0	11.1	11.3	11.5	11.6	11.8	12.0	12.2	12.4	12.5

Source: Statistics South Africa "Mid-Year Population Estimates"

[6] http://www.who.int/gho/mortality_burden_disease/life_tables/situation_trends/en/

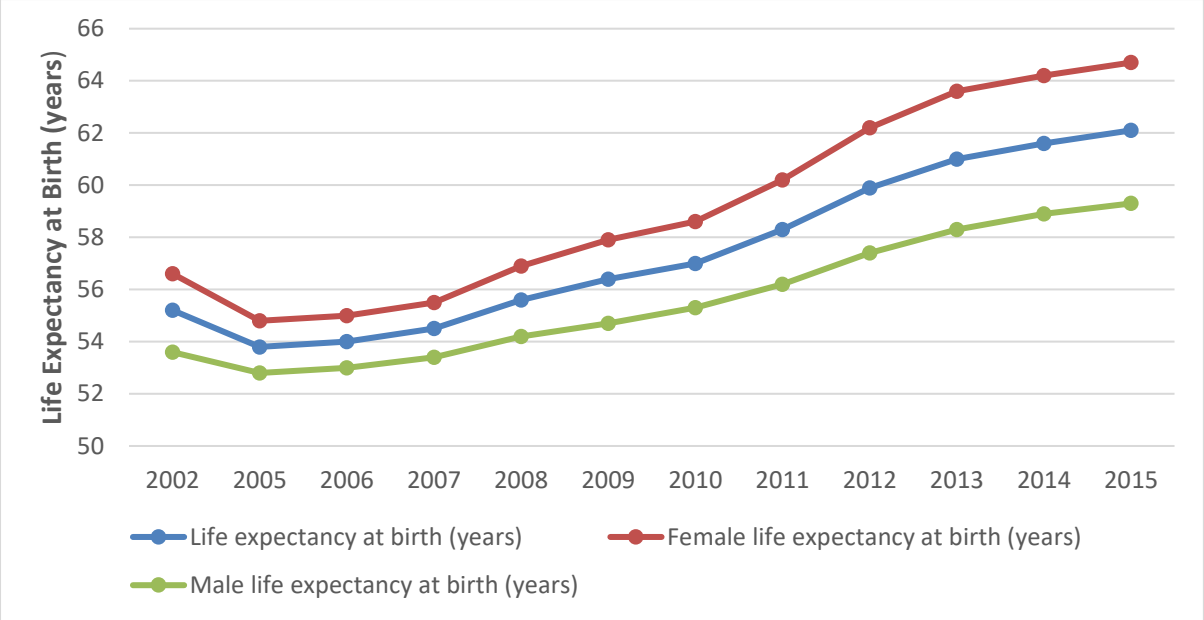


Figure 8.1: Trend in South African Life Expectancy at Birth

Despite an improvement in life expectancy, HIV/ AIDS prevalence remains high in the country, rising consistently from 10.3% in 2002 to 12.5% in 2015. In absolute numbers, it is the highest in the World. As **Figure 8.2** shows, adult females are the group most severely infected with HIV/ AIDS, with a prevalence of 22.2% of the population in 2015, up from 22.0% in 2014 and 19.6% in 2002. As reported previously, the HIV/ AIDS prevalence rate is decreasing among the youth which is a positive start towards achieving an HIV-free nation.

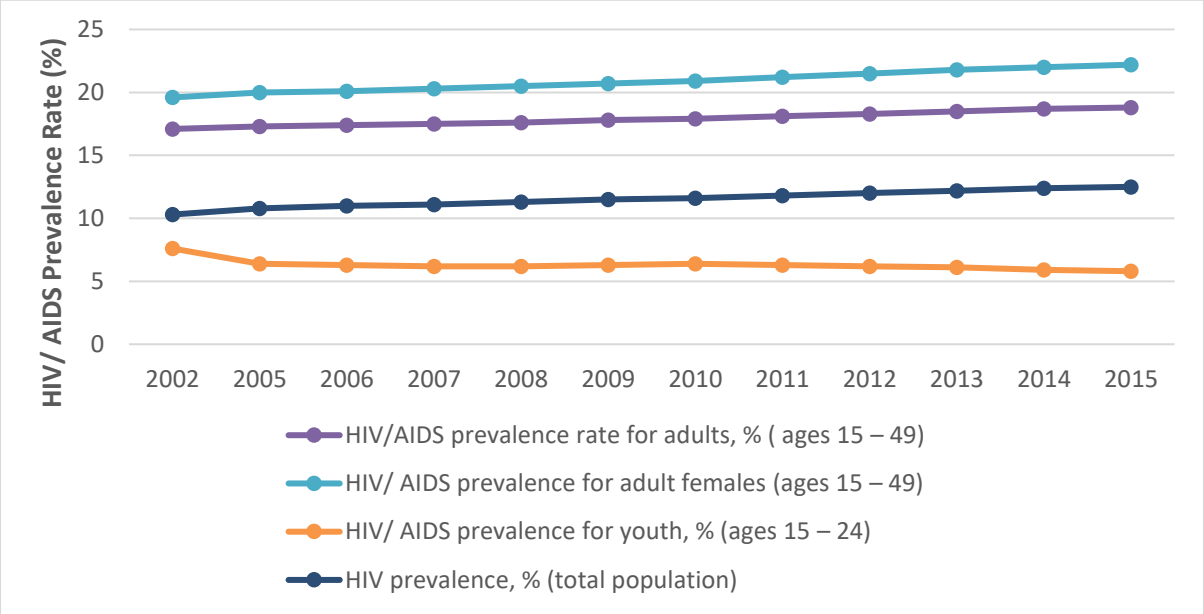


Figure 8.2: Trend in South African Prevalence Rate

It is important to note that South Africa has reduced its HIV-infection rate from 8% in 2008 to 1.5% in 2015. The increase in HIV/ AIDS prevalence rate is therefore related more to the improved survival rate due to the antiretroviral drug program than to a decline in new HIV infections. This is a good example of technological intervention improving the quality of life. The South African government is working on a plan to produce these antiretroviral drugs itself by 2019 through a state-owned pharmaceutical company, Ketlaphela, a subsidiary of Pelchem.

8.2 Education

It is a known fact that education is an essential element contributing towards a good quality of life. Various data have shown that a higher level of education is necessary to eliminate unemployment and to radically transform the wellbeing of those from disadvantaged backgrounds. The literacy rate is one of the proxy indicators typically used to measure an improvement in the standard of living. Prior to 2009 Statistics South Africa (StatsSA) used individuals' functional literacy such as whether they have completed grade seven to determine the rate of improvement in quality of education, whereas from 2009 onwards, a specific question about literacy rate was added to the General Household Surveys. As **Table 8.2** and **Figure 8.3** show, the adult literacy rate has improved drastically from 1996 (82.4%) to about 94.6% in 2015.

Table 8.2: Key Education Indicators

	1996		2007	2008	2009	2010	2011	2012	2013	2014	2015
Adult literacy rate (% of people aged 15 and above)	82.4		88.7	-	92.9	92.9	93.1	93.7	-	94.1	94.6
Youth literacy rate (% of people aged 15-24)	93.9		97.6	-	98.4	98.6	98.8	98.9	-	98.9	99.0
Female youth literacy rate (% of females aged 15-24)	94.3		98.1	-	98.8	98.9	99.2	99.3	-	99.1	99.4
Male youth literacy rate (% of males aged 15-24)	93.5		97.0	-	97.9	98.4	98.4	98.5	-	98.7	98.7

Source: The World Bank "World Development Indicators"

The youth literacy rate has also increased, from a high base of 93.9% in 1996, to 97.6% in 2007 and 99.0% in 2015. There is a minor difference in literacy rates of female and male youths, with female youth literacy rates being consistently higher than those of males.

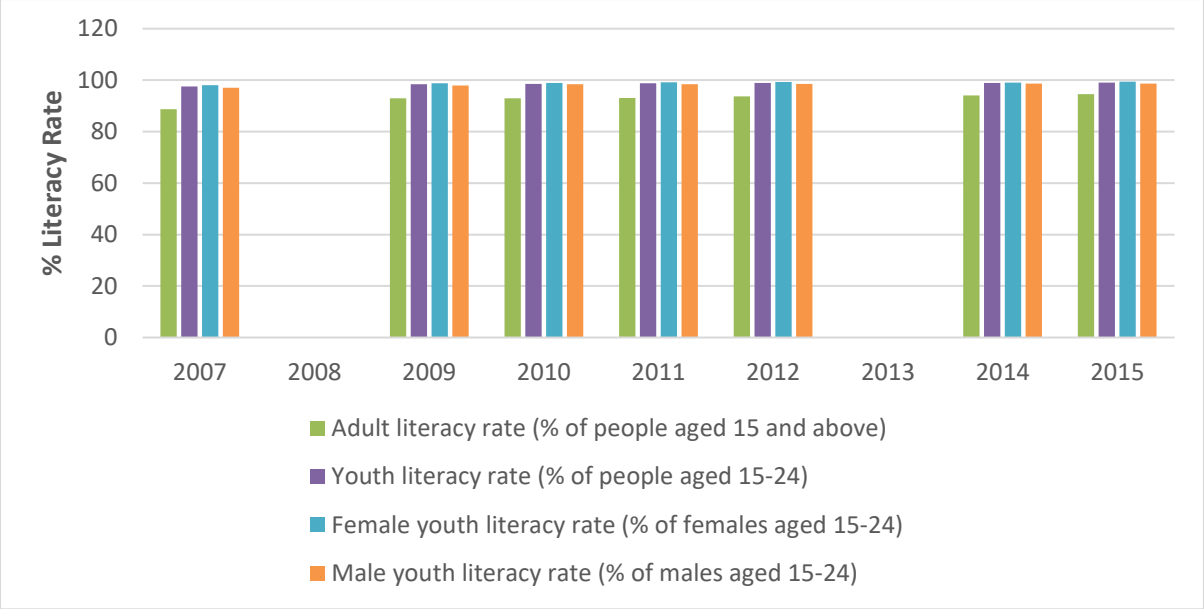
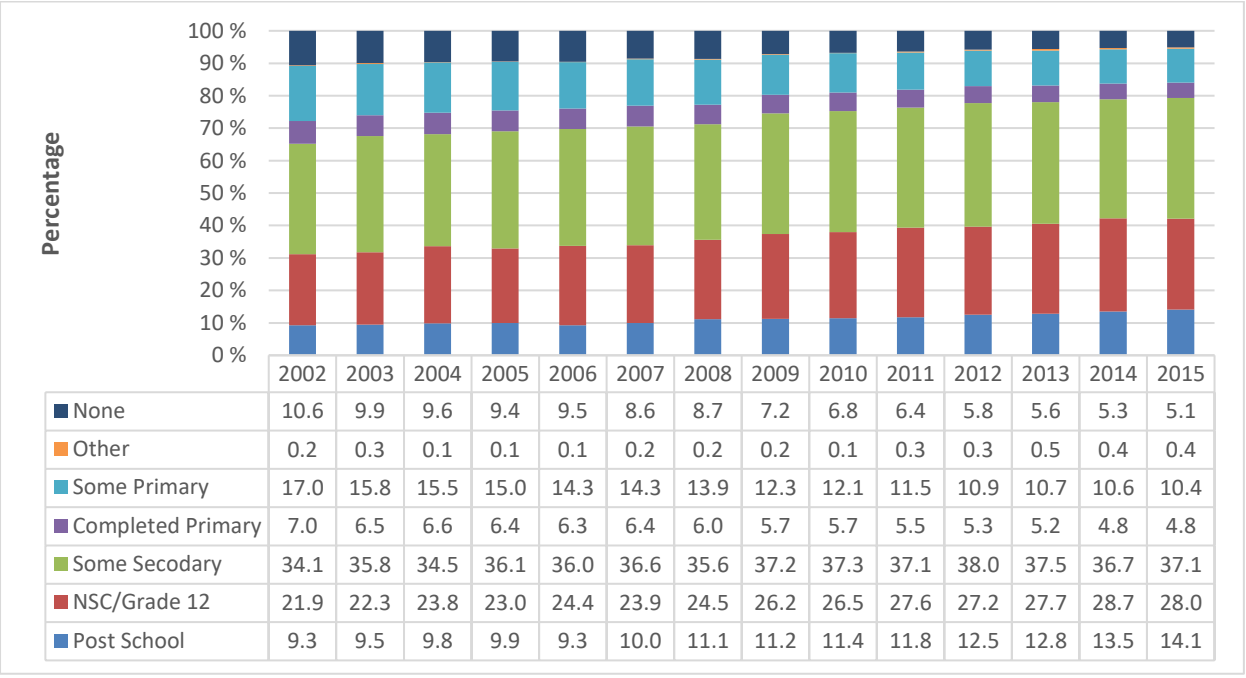


Figure 8.3: Trend in South African Literacy Rate

As **Figure 8.4** shows, a high literacy rate is associated with a large increase of the population attaining at least some secondary school qualification, be it NSC/ grade 12 or post school education. The biggest increase in the proportion of educational attainment for persons aged at least 20 years has been at the NSC/ grade 12 level, rising from 21.9% in 2002 to 28.0% in 2015. The percentage of the population (20 years or more) with post school (tertiary) education (14% in 2015) is nearly the same as that of Brazil.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
None	10.6	9.9	9.6	9.4	9.5	8.6	8.7	7.2	6.8	6.4	5.8	5.6	5.3	5.1
Other	0.2	0.3	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.3	0.3	0.5	0.4	0.4
Some Primary	17.0	15.8	15.5	15.0	14.3	14.3	13.9	12.3	12.1	11.5	10.9	10.7	10.6	10.4
Completed Primary	7.0	6.5	6.6	6.4	6.3	6.4	6.0	5.7	5.7	5.5	5.3	5.2	4.8	4.8
Some Secodary	34.1	35.8	34.5	36.1	36.0	36.6	35.6	37.2	37.3	37.1	38.0	37.5	36.7	37.1
NSC/Grade 12	21.9	22.3	23.8	23.0	24.4	23.9	24.5	26.2	26.5	27.6	27.2	27.7	28.7	28.0
Post School	9.3	9.5	9.8	9.9	9.3	10.0	11.1	11.2	11.4	11.8	12.5	12.8	13.5	14.1

Figure 8.4: Percentage Distribution of Educational Attainment for Persons Aged 20 Years and Older

Source: StatsSA "2015 General Household Survey"

8.3 Water and Sanitation

The mode and nature of water being accessed by communities contributes significantly to the standard of living of those communities. Both water and sanitation are essential basic human needs and there is a dependency between these and other wellbeing dimensions such as health. A lack of access to clean water might result in various waterborne diseases.

As **Table 8.3** shows, the country has increased the percentage of its population with access to improved water sources to 93.2% in 2015 from 87.4% in 2002. The same improvement has been achieved in respect of access to improved sanitation facilities although the level is still very low, at 66.4% in 2015. Much still needs to be done to assist in the national roll-out of decent sanitation facilities, hence there is a scope for STI to bring innovative appropriate solutions such aslow cost sanitation facilities.

Table 8.3: Water and Sanitation Indicators

	2002	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
% of population with access to improved water source	87.4	88.9	89.4	89.8	90.3	90.7	91.1	91.6	92.0	92.4	92.8	93.2
% of population with access to improved sanitation facilities	58.5	60.4	61.1	61.7	62.3	62.9	63.5	64.1	64.7	65.3	65.8	66.4

Source: The World Bank "World Development Indicators"

8.4 Environment

The environmental footprint of a human civilisation, if not properly kept under check, can have an adverse impact on the long-term sustainability of predictable quality livelihoods, resulting in issues such as global climate change. Droughts and flooding are the most well-known natural phenomena that occur as a result of climate change. Due to the abundance of coal and industrialisation within the country, South Africa is one of the highest carbon dioxide (CO_2) emitters and it has recently experienced one of the most severe droughts in its history. There have also been isolated cases of floods recently.

As **Table 8.4** and **Figure 8.5** show, CO_2 emissions (in metric tons per capita) decreased from 8.94 from the period 1996 – 2000 to 8.69 during 2001 – 2005 but increased sharply again to 9.69 in the period 2006 – 2010. The 2006 – 2010 level is close to the 1996 CO_2 emission of 9.14 metric tons per capita. On the positive side, from 2011 to 2013, the CO_2 level has been decreasing. The NDP acknowledges the need for climate change mitigation and adaptation policies, which include the reduction in greenhouse gas emissions.

Table 8.4: Key Environment Indicators

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011	2012	2013	2014	2015
CO_2 emissions (metric tons per capita)	9.14		8.94	8.69	9.69	9.22	9.02	8.86	-	-

Source: The World Bank "World Development Indicators

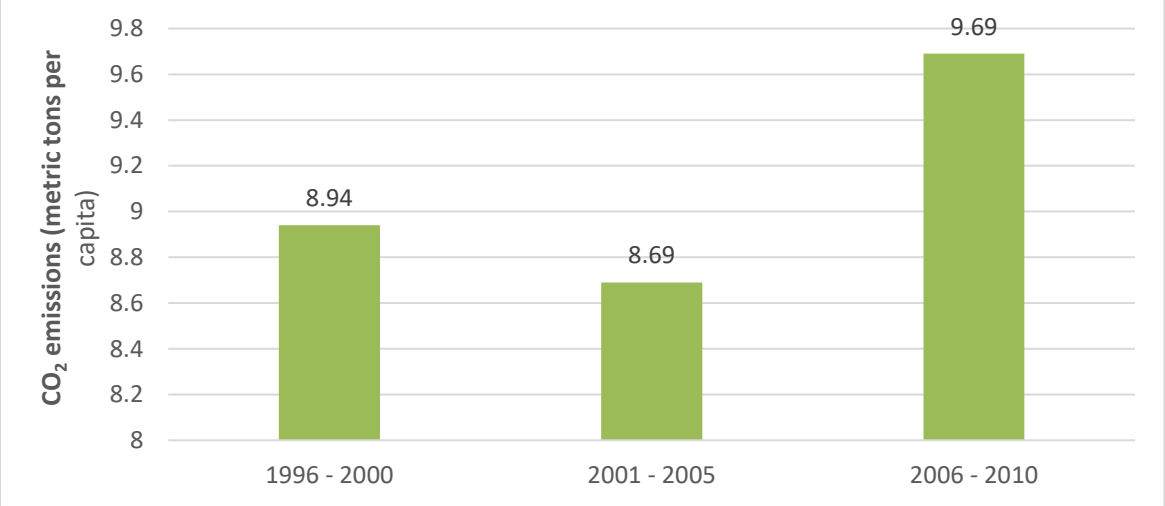


Figure 8.5: Trend in South African Carbon Dioxide Emission

Table 8.5 benchmarks the level of South African CO_2 emission against various regions. In 1996 the proportion of the country's CO_2 emissions in relation to those of total SADC, was 92.82%. This has gradually decreased to 86.38% in 2013 as other SADC countries are becoming more industrialised and as South Africa starts to reduce its own CO_2 emissions. A similar pattern is also manifesting itself in relation to SSA and Africa as a whole. Furthermore, the country's CO_2 emission is also declining in relation to BRICS, G20 countries and the rest of the world.

Table 8.5: Benchmarking of South African CO_2 emissions

	1996		1996 - 2000	2001 - 2005	2006 - 2010	2011	2012	2013
SA CO2 emissions as % of SADC CO2 emissions	92.82		93.15	91.66	89.52	87.87	86.78	86.38
SA CO2 emissions as % of SSA CO2 emissions	74.82		74.00	67.16	67.38	64.62	63.26	62.51
SA CO2 emissions as % of Africa CO2 emissions	46.87		45.91	42.39	41.59	39.70	38.17	38.01
SA CO2 emissions as % of BRICS CO2 emissions	5.53		5.70	5.00	4.19	3.33	3.19	3.13
SA CO2 emissions as % of G20 CO2 emissions	1.88		1.92	1.85	1.90	1.71	1.67	1.66
SA CO2 emissions as % of World CO2 emissions	1.62		1.64	1.57	1.60	1.45	1.41	1.40

***Source: World Development** Indicators*

APPENDIX A: INDUSTRIAL DESIGNS AND TRADEMARKS CLASSIFICATION

Table A1: Industrial Designs International Classification under Locarno Agreement

	Definition
Class 1	Foodstuffs
Class 2	Articles of clothing and haberdashery
Class 3	Travel goods, cases, parasols and personal belongings, not elsewhere specified
Class 4	Brushware
Class 5	Textile piece goods, artificial and natural sheet material
Class 6	Furnishing
Class 7	Household goods, not elsewhere specified
Class 8	Tools and hardware
Class 9	Packages and containers for the transport or handling of goods
Class 10	Clocks and watches and other measuring instruments, checking and signaling instruments
Class 11	Articles of adornment
Class 12	Means of transport or hoisting
Class 13	Equipment for production. distribution or transformation of electricity
Class 14	Recording, communication or information retrieval equipment
Class 15	Machines, not elsewhere specified
Class 16	Photographic, cinematographic and optical apparatus
Class 17	Musical instruments
Class 18	Printing and office machinery
Class 19	Stationery and office equipment, artists' and teaching materials
Class 20	Sales and advertising equipment, signs
Class 21	Games, toys, tents and sports goods
Class 22	Arms, pyrotechnic articles, articles for hunting, fishing and pest killing
Class 23	Fluid distribution equipment, sanitary, heating, ventilation and air-conditioning equipment, solid fuel
Class 24	Medical and laboratory equipment
Class 25	Building units and construction elements
Class 26	Lighting apparatus
Class 27	Tobacco and smokers' supplies
Class 28	Pharmaceutical and cosmetic products, toilet articles and apparatus
Class 29	Devices and equipment against fire hazards, for accident prevention and for rescue
Class 30	Articles for the care and handling of animals
Class 31	Machines and appliances for preparing food or drink, not elsewhere specified
Class 32	Graphic symbols and logos, surface patterns, ornamentation

Source: World Intellectual Property Office

Table A2: Trademarks International Classification under Nice Agreement

	Definition
	Goods
Class 01	Chemicals used in industry, science and photography, as well as in agriculture, horticulture and forestry; unprocessed artificial resins, unprocessed plastics; manures; fire extinguishing compositions; tempering and soldering preparations; chemical substances for preserving foodstuffs; tanning substances; adhesives used in industry
Class 02	Paints, varnishes, lacquers; preservatives against rust and against deterioration of wood; colorants; mordants; raw natural resins; metals in foil and powder form for painters, decorators, printers and artists
Class 03	Bleaching preparations and other substances for laundry use; cleaning, polishing, scouring and abrasive preparations; soaps; perfumery, essential oils, cosmetics, hair lotions; dentifrices
Class 04	Industrial oils and greases; lubricants; dust absorbing, wetting and binding compositions; fuels (including motor spirit) and illuminants; candles and wicks for lighting
Class 05	Pharmaceutical and veterinary preparations; sanitary preparations for medical purposes; dietetic food and substances adapted for medical or veterinary use, food for babies; dietary supplements for humans and animals; plasters, materials for dressings; material for stopping teeth, dental wax; disinfectants; preparations for destroying vermin; fungicides, herbicides
Class 06	Common metals and their alloys; metal building materials; transportable buildings of metal; materials of metal for railway tracks; non-electric cables and wires of common metal; ironmongery, small items of metal hardware; pipes and tubes of metal; safes; goods of common metal not included in other classes; ores
Class 07	Machines and machine tools; motors and engines (except for land vehicles); machine coupling and transmission components (except for land vehicles); agricultural implements other than hand-operated; incubators for eggs; automatic vending machines
Class 08	Hand tools and implements (hand-operated); cutlery; side arms; razors
Class 09	Scientific, nautical, surveying, photographic, cinematographic, optical, weighing, measuring, signaling, checking (supervision), life-saving and teaching apparatus and instruments; apparatus and instruments for conducting, switching, transforming, accumulating, regulating or controlling electricity; apparatus for recording, transmission or reproduction of sound or images; magnetic data carriers, recording discs; compact discs, DVDs and other digital recording media; mechanisms for coin-operated apparatus; cash registers, calculating machines, data processing equipment, computers; computer software; fire-extinguishing apparatus
Class 10	Surgical, medical, dental and veterinary apparatus and instruments, artificial limbs, eyes and teeth; orthopedic articles; suture materials
Class 11	Apparatus for lighting, heating, steam generating, cooking, refrigerating, drying, ventilating, water supply and sanitary purposes
Class 12	Vehicles; apparatus for locomotion by land, air or water
Class 13	Firearms; ammunition and projectiles; explosives; fireworks
Class 14	Precious metals and their alloys and goods in precious metals or coated therewith, not included in other classes; jewellery, precious stones; horological and chronometric instruments
Class 15	Musical instruments
Class 16	Paper, cardboard and goods made from these materials, not included in other classes; printed matter; bookbinding material; photographs; stationery; adhesives for stationery or household purposes; artists' materials; paint brushes; typewriters and office requisites (except furniture); instructional and teaching material (except apparatus); plastic materials for packaging (not included in other classes); printers' type; printing blocks

Class 17	Rubber, gutta-percha, gum, asbestos, mica and goods made from these materials and not included in other classes; plastics in extruded form for use in manufacture; packing, stopping and insulating materials; flexible pipes, not of metal
Class 18	Leather and imitations of leather, and goods made of these materials and not included in other classes; animal skins, hides; trunks and travelling bags; umbrellas and parasols; walking sticks; whips, harness and saddlery
Class 19	Building materials (non-metallic); non-metallic rigid pipes for building; asphalt, pitch and bitumen; non-metallic transportable buildings; monuments, not of metal
Class 20	Furniture, mirrors, picture frames; goods (not included in other classes) of wood, cork, reed, cane, wicker, horn, bone, ivory, whalebone, shell, amber, mother-of-pearl, meerschaum and substitutes for all these materials, or of plastics
Class 21	Household or kitchen utensils and containers; combs and sponges; brushes (except paintbrushes); brush-making materials; articles for cleaning purposes; steelwool; unworked or semi-worked glass (except glass used in building); glassware, porcelain and earthenware not included in other classes
Class 22	Ropes, string, nets, tents, awnings, tarpaulins, sails, sacks and bags (not included in other classes); padding and stuffing materials (except of rubber or plastics); raw fibrous textile materials
Class 23	Yarns and threads, for textile use
Class 24	Textiles and textile goods, not included in other classes; bed covers; table covers
Class 25	Clothing, footwear, headgear
Class 26	Lace and embroidery, ribbons and braid; buttons, hooks and eyes, pins and needles; artificial flowers
Class 27	Carpets, rugs, mats and matting, linoleum and other materials for covering existing floors; wall hangings (non-textile)
Class 28	Games and playthings; gymnastic and sporting articles not included in other classes; decorations for Christmas trees
Class 29	Meat, fish, poultry and game; meat extracts; preserved, frozen, dried and cooked fruits and vegetables; jellies, jams, compotes; eggs; milk and milk products; edible oils and fats
Class 30	Coffee, tea, cocoa and artificial coffee; rice; tapioca and sago; flour and preparations made from cereals; bread, pastry and confectionery; edible ices; sugar, honey, treacle; yeast, baking-powder; salt; mustard; vinegar, sauces (condiments); spices; ice
Class 31	Grains and agricultural, horticultural and forestry products not included in other classes; live animals; fresh fruits and vegetables; seeds; natural plants and flowers; foodstuffs for animals; malt
Class 32	Beers; mineral and aerated waters and other non-alcoholic beverages; fruit beverages and fruit juices; syrups and other preparations for making beverages
Class 33	Alcoholic beverages (except beers)
Class 34	Tobacco; smokers' articles; matches
	Services
Class 35	Advertising; business management; business administration; office functions
Class 36	Insurance; financial affairs; monetary affairs; real estate affairs
Class 37	Building construction; repair; installation services
Class 38	Telecommunications
Class 39	Transport; packaging and storage of goods; travel arrangement
Class 40	Treatment of materials
Class 41	Education; providing of training; entertainment; sporting and cultural activities
Class 42	Scientific and technological services and research and design relating thereto; industrial analysis and research services; design and development of computer hardware and software

Class 43	Services for providing food and drink; temporary accommodation
Class 44	Medical services; veterinary services; hygienic and beauty care for human beings or animals; agriculture, horticulture and forestry services
Class 45	Legal services; security services for the protection of property and individuals; personal and social services rendered by others to meet the needs of individuals

Source: WIPO "IP Statistics Data Center"