# A bibliometric analysis of the research performance of Stellenbosch University

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DSI-NRF CENTRE OF EXCELLENCE IN SCIENTOMETRICS AND STI POLICY

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Stellenbosch

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# Executive Summary

## 1 Consistent and steady increase in total publication output from 2005 to 2021

Since the first major revision of the DHET Funding Framework in 2005, SU has maintained a steady increase in its total annual publication output subsidy-units (journal articles, books, book chapters and published conference proceedings. The summary table below shows how the output subsidy units in each individual category increased over the reporting period and the rate at which it increased.

| | 2005 | 2021 | CAGR |
|---|---|---|---|
| Journal article units | 789.4 | 1774.54 | 4.89% |
| Books and book chapter units | 14.0 | 304.6 | 19.8% |
| Conference proceedings | 22.74 | 161.3 | 12.13% |
| Total publication units | 826.1 | 2240.49 | 6.04% |

## 2 Comparison of SU with selected universities in terms of annual growth rate in publication output

A comparison with the other top research universities shows that SU has recorded the fourth highest annual growth rate in publication output over the past seven years. The fact that UJ (and NWU to a lesser extent) has recorded the highest overall CAGR values over the entire period is partially a function of the smaller baseline values in 2000. For the remainder of the universities, these values range between 6 and 7%. As far as the latter period is concerned, the much higher growth rates of UJ and UFS are the function of exceptional growth in conference proceedings and book chapters and books.

| University | CAGR (2005 to 2021) | CAGR (2015 to 2021) |
|---|---|---|
| UJ | 14,31% | 13,75% |
| UFS | 7,42% | 10,46% |
| WITS | 7,63% | 7,99% |
| SU | 6,30% | 7,58% |
| UKZN | 6,63% | 7,03% |
| NWU | 10,70% | 4,82% |
| UP | 4,95% | 4,45% |
| UCT | 4,53% | 1,56% |
| UNISA | 6,38% | 0,86% |

## 3 SU maintains an above average rate of increase in the annual production of journal articles.

In total, SU authors have produced 31 207 articles in accredited journals which translates into 20 793 article subsidy units between 2005 and 2021. The average annual rate of increase in the publication of articles occurred at an overall rate of 5.19% (5th highest in the sector) and at 5.93% for the past seven years. The majority of the top research universities maintained an annual growth rate of between 5 and 9%. The exception if UJ which has performed very well and recorded an overall CAGR score of 12.59. One of the more surprising results is the decline in output at UCT with the second lowest annual growth rate recorded for the more recent period of 1.67%.

## 4 Journal articles are increasingly being published in a wider range of journals, but large proportion is still published in a small set of core journals

The 31 207 articles that were produced by SU academics and other staff and students were published in 5 662 unique journals. The number of journals in which SU authors publish has increased nearly threefold from 524 in 2005 to 1 555. This increase reflects the fact that the number of accredited journals, especially those indexed in the [CA]Web of Science and Scopus (since 2015), has continued to increase every year. In addition, it could also be that – given the increasing competition to publish in the top and high-impact journals and the pressure to earn a publication subsidy – has 'forced' academics and students to search more widely for journals to submit their papers and possibly even journals where the turnround time from submission to acceptance of a manuscript is shorter than in the top journals in a field.

## 5 Women authors at SU increased their contribution to overall article publication to more than 46%

The results of our analysis of the gender of all SU-authored papers over the past seventeen years shows a significant positive change over this period. Although the goal of reaching representative shares of men and women authors according to the distribution of academic staff in the HE sector (which is closer to 50:50) has not been reached, the trend is clearly in that direction. A comparison with the national percentages also shows that the percentage of 46% of women-authored papers at SU in 2021 is two percentage points higher than the sector average of 44%.

## 6 Share of articles authored by academics and students not borne in South Africa decreases in recent years.

As is the case with all SA universities, SU has also benefitted from the contribution to its knowledge production from staff and students who were not born in South Africa. Over the past seventeen years foreign-born academics and staff contributed 29% to SU's publications. Authors from countries in Africa specifically contributed 16%. However, the most significant trend is the rapid decline in contributions from foreign-born authors and specifically from Africa (only 8%) in 2021.

## 7 Share of black authored articles double from 10% in 2005 to 20% in 2021.

Our analysis shows a slow but steady increase in the percentage of Black (Black African, Coloured, Indian) authors from 10% in 2005 to 20% in 2021. Although this a positive trend, the challenge remains that SU should continue to aim to produce publications that are more inclusive of Black academics and students.

## 8 Contribution of authors under the age of 40 increases as does the share of articles produced by individuals over the age of 60.

The analysis of article production by age category has revealed a number of interesting trends as is the case in most universities in the world the most 'productive' age category are those between the ages of 40 and 49 (contributing 27% to SU output). What is interesting though is the significant contribution (16%) by authors 60 years and older (with 3% of articles produced by authors older then70 years). If we define an early career academic (as the DSI and DHET) as younger than 40, our data shows a positive trend. In 2005 28% of authors were 40 and younger; by 2021 this percentage has increased to 35%. Further analysis shows that the latter shift is due to an increase in the number of post-graduate students and post-doctoral fellows contributing to the university's publication output – especially in the recent past.

## 9 SU continues to increase its output of books, book chapters and conference proceedings although relatively large year on year fluctuations are recorded.

SU continued to increase its production of books, book chapters and conference proceedings over the period 2005 to 2021. Because of the relatively small samples, the year-to-year fluctuations are relatively large with overall CAGR of 19.8% for books and book chapters and a CAGR value of 12.13% for published conference proceedings. Both these categories of publications have been subjected to significant gaming by certain universities which have led DHET to reject substantial subsidy claims in three or four cases. SU has consistently adhered to the DHET policy for these outputs and have not been at the receiving end of any major penalties in this regard.

## 10 SU's production of research Masters' students maintain recent levels of around 900 graduates per year.

SU has more than doubled its production of research Masters' graduates from around 400 per year seventeen years ago to recent annual numbers of graduates at around 900. When we compare this trend with the overall production of all Masters' students at the university, it is also clear that although the number of research Masters' may have stabilized around 900 per year (with 2021 being an exceptionally good year), the picture for all Masters' students is more negative. The overall number of graduates have been declining for the past four years. This suggests that the decline is actually in the number of course work (fully or partially) Masters. At the same time the data on all Masters' students also show a promising trend with some growth in new Masters' enrolments.

## 11 The trends as far as the demographics of SU's Masters' graduates are concerned are more mixed with some positive and less positive outcomes

Gender: The recent decline in Masters' graduates (from a high of 1601 in 2017 to 1285 in 2021) has not had the same impact across female and male graduates. For the first time in 2021, the number of female Masters' graduates exceeded that of their male counterparts (675 women versus 609 men). However, this result is mostly a function of the steeper decline in the number of male versus female graduates and not because of a sustained growth in the number of female graduates since 2018.

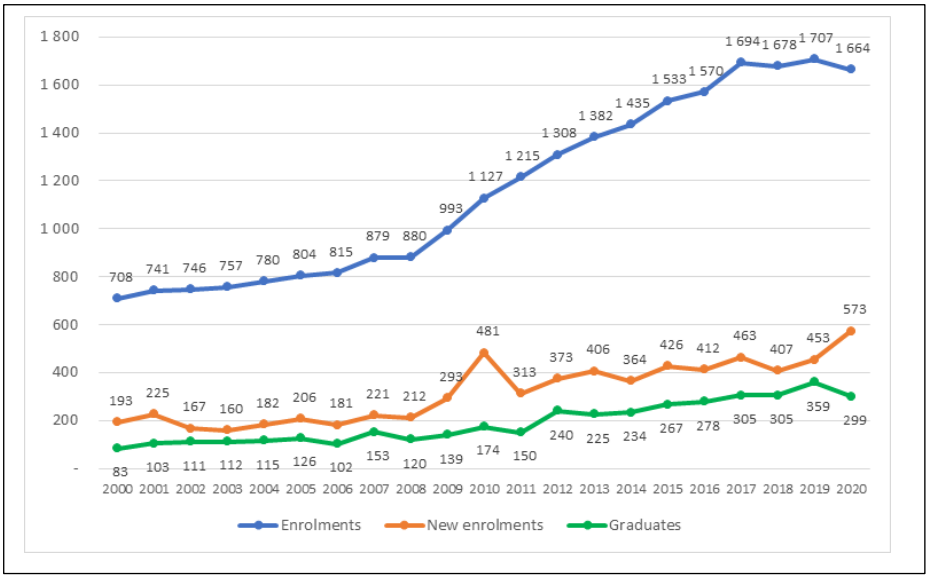
Region: SU, like most other South African universities, benefit from post-graduate enrolments from foreign students. SU attracted significant number of students from Africa and the rest of the world which peaked around 2016 at 40% of total number of graduates. Since then, there has been a slow decline in foreign graduates. It is possible that financial reasons as well as the difficulties in getting study visas may drive this decline. It is also likely that this trend may continue as the potential negative effect of COVID is not yet evident in these data.

Race: The overall trend in terms of the race of our Masters' graduates over the past 21 years is a positive one with the percentage of Black (Africa, Coloured and Indian) students increasing their share of the total number of graduates from 10% in 2000 to 24% in 2020.

It is clear from the trends at the national level that the competition of high quality Maters' students may be increasing. This fact, coupled with the rather negative and in some cases, devastating effects, of the NRF Funding Policy, will require a strategic and systematic plan of action to ensure that SU maintains sufficient levels of growth whilst increasing the inclusivity of our students.

## 12 SU manages to maintain its growth in doctoral graduates despite trends to the contrary in the sector

Context: The most recent figures released by the DHET shows that the number of doctoral graduates in 2021 stood at 3 532 which is less than the figure for 2020 (3539). This is the first year in the past two decades that the number of doctoral graduates has shown a decline. Given the decline in new doctoral enrolments, it now seems likely that the number of doctoral graduates in the new future will in all likelihood also start to decline (keeping in mind again that the full impact of COVID, loss of students from the rest of Africa and continued economic recession are not reflected in the most recent data. When we turn to SU, the overall trend – both in enrolments and graduates – is more positive. The exception is the decline in doctoral graduates in 299. Data that CREST received from DHET recently showed that SU will receive subsidy for 307 students which reflects a small improvement.



## 13 SU's production of doctoral graduates compares favourably with the other universities in the sector.

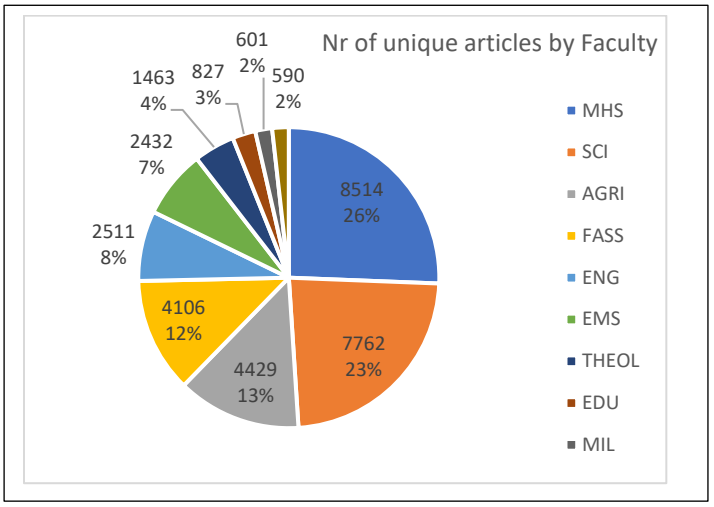
It is insightful to compare the recent trends in doctoral graduates for the top universities to see whether there are any large shifts. The result displayed in the table on the rights show that the year-to-year changes at the majority of the universities are not extreme. UJ is the exception with sustained growth over this period. UNISA also displays some larger year to year fluctuations but there are some questions about the quality of the HEMIS data for UNISA. The annual output of SU which hovers around 300 compares well with the much larger universities above it on the table and is consistently higher than UCT which is of a similar size.

| University | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|
| UKZN | 388 | 497 | 451 | 487 | 445 |
| UNISA | 286 | 296 | 334 | 422 | 421 |
| UP | 354 | 424 | 399 | 374 | 367 |
| WITS | 283 | 280 | 291 | 321 | 316 |
| SU | 305 | 305 | 359 | 299 | 307 |
| UCT | 277 | 195 | 261 | 276 | 274 |
| UJ | 126 | 189 | 223 | 224 | 266 |
| NWU | 235 | 248 | 314 | 251 | 264 |
| UFS | 127 | 138 | 128 | 113 | 161 |
| UWC | 120 | 124 | 126 | 123 | 123 |

## 14 Positive trends in the representivity of women and black doctoral graduates

The percentage women doctoral graduates at SU increased from 35% in 2005 to 47% in 2021. The latter is 4 percentage points higher than the national average for that year. Our analysis of the race of doctorates also shows that SU has managed to increase the percentage of black doctoral graduates from 20% in 2000 to 35% in 2020. Although this is a significant achievement, the comparison with the national picture shows that there is still some room for improvement. In 2021 the percentage of Black doctoral graduates nationally nearly reached 60%.

## 15 SU hosts a comprehensive suite of scientific disciplines across ten faculties.

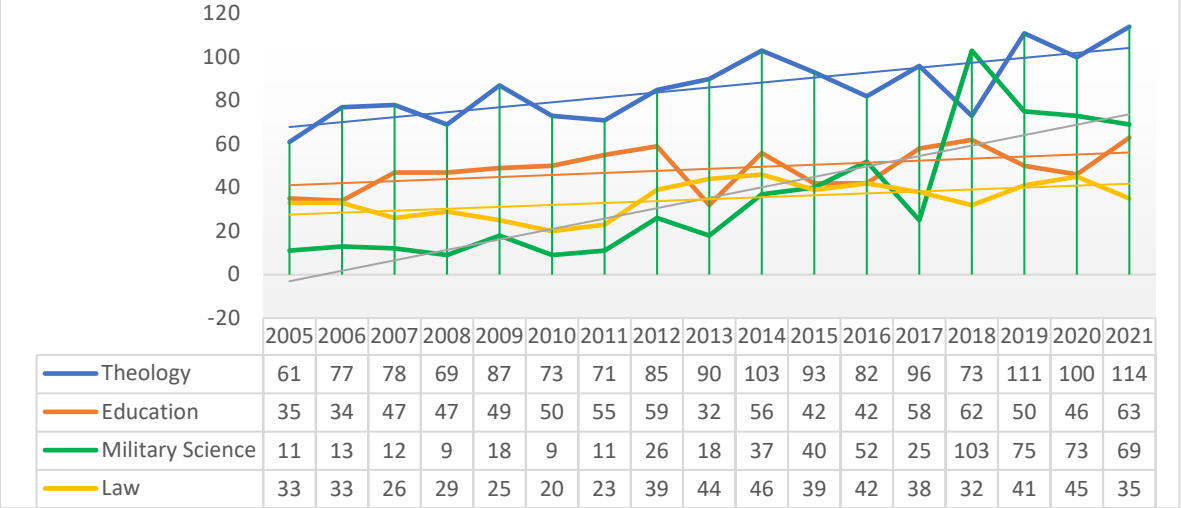



Two faculties (Medicine and Health Sciences and the Science Faculty) dominate research publication output at the university. Together with two other 'medium-sized' research faculties (Agriscience and Arts and Social Sciences) they produced nearly 75% of total output over the past seventeen years. It is not surprising that the more 'profession-orientated' faculties such as Engineering, Economic and Management Sciences, Education, Law and Theology all make smaller contributions to the overall research output. It is worth stating that this distribution of articles by Faculty is a typical one for universities which have a comprehensive academic offering. At most SA universities with a Medical Faculty or School, papers in the field of Medicine and Health Sciences would predominate followed by the natural sciences faculties.

An analysis of the trends in journal article output by Faculty between 2005 and 2021, shows differential growth rates. In our discussion of the drivers of these trends we have grouped the faculties into four 'groupings' based on size and nature of disciplines (basic versus professional). These groupings resulted in more homogeneous profiles which allowed for more robust interpretations of the shifts in output at each faculty.

## 16 Trends in the output of small and predominantly professional training faculties (THEOL/EDU/MIL/LAW)

The first grouping of Faculties is all nearly predominantly dedicated to train professionals (Lawyers/ Dominees/ Teachers/School principals/Military personnel). They are also the four smallest faculties in terms of research output and – with the exception of Military Science which started at a very low base of 11 articles in 2005 – all recorded the smallest CAGR-values. The trend lines for the faculties would suggest that, unless there are fundamental changes in the organisational design of these faculties – for example the establishment of more dedicated research centres or the addition of more staff, post-doctoral fellows and post-graduate students – it is more than likely that the current fairly low growth trajectories will be maintained in the near future.



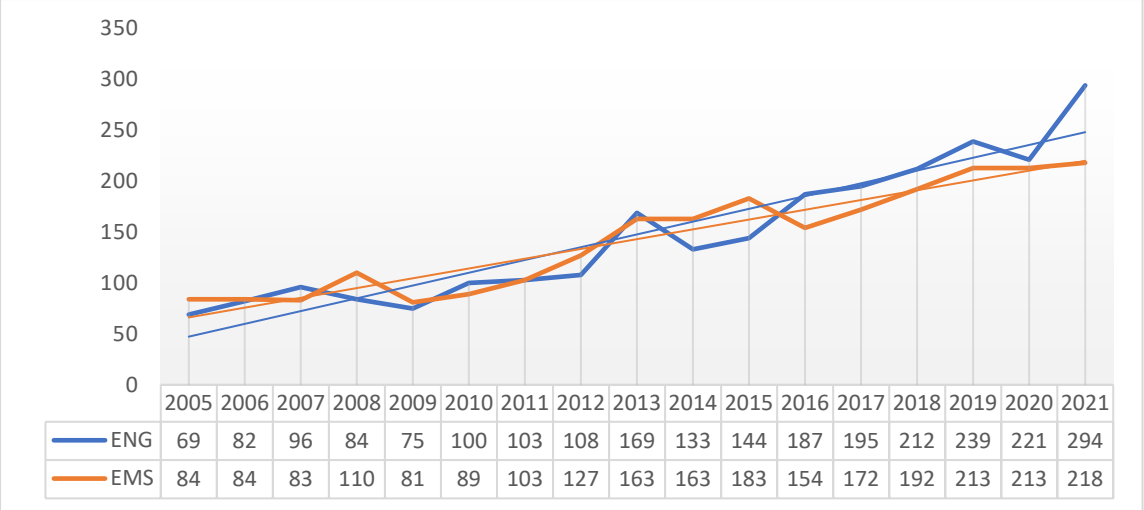

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Theology | 61 | 77 | 78 | 69 | 87 | 73 | 71 | 85 | 90 | 103 | 93 | 82 | 96 | 73 | 111 | 100 | 114 |
| Education | 35 | 34 | 47 | 47 | 49 | 50 | 55 | 59 | 32 | 56 | 42 | 42 | 58 | 62 | 50 | 46 | 63 |
| Military Science | 11 | 13 | 12 | 9 | 18 | 9 | 11 | 26 | 18 | 37 | 40 | 52 | 25 | 103 | 75 | 73 | 69 |
| Law | 33 | 33 | 26 | 29 | 25 | 20 | 23 | 39 | 44 | 46 | 39 | 42 | 38 | 32 | 41 | 45 | 35 |

The following are the salient points about article production in the first grouping of faculties:

- These faculties on average have small numbers of actively publishing individuals. In the most recent year this range from 16 in Military Science to 65 in Theology.
- Not only are the numbers small, but the trend over time also shows relatively small increases: Law doubled from 19 to 37; Military Science doubled from 8 to 16, Education increased their numbers from 25 to 35 and Theology from 35 to 65.
- The average productivity ratio in 2021 ranges from 1.3 (Law) to 2.5 (Military Science) but one should not place too much emphasis on some of these values as the overall samples (especially for Military Science) are small. Having said this, it is still worth nothing that the average per capita article output of all four faculties – although being small in size – is quite acceptable at around 1.3 to 1.5 papers per author.

## 17 Trends in the output of medium-sized and predominantly professional training faculties (ENG and EMS)

The Engineering and the Economics and Management Sciences faculties both primarily aim to produce high-level professionals for the labour market (engineers, auditors, accountants, business managers, financial managers, etc.). One could argue that Economics is a ‘basic science’ discipline in EMS and should be producing a large part of the output of the faculty. Conversely, departments such as Accountancy and Auditing are not known for producing large numbers of research articles. Both are medium-sized faculties in terms of annual article output with very similar trendlines. Engineering has a slightly higher CAGR-value (9.5%) than EMS (6.1%) which may suggest that the former has more scope for increased output in the future.

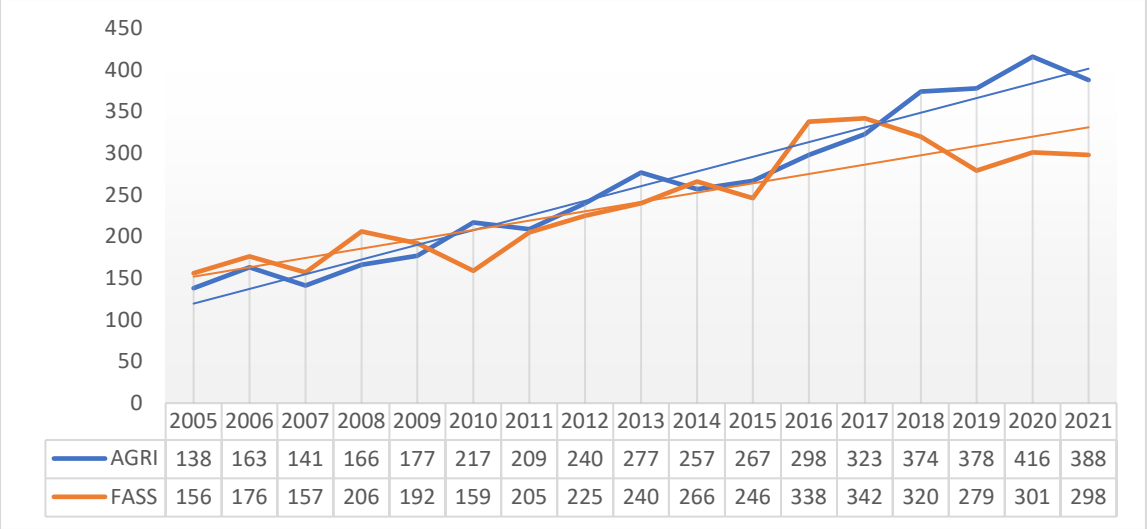



| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ENG | 69 | 82 | 96 | 84 | 75 | 100 | 103 | 108 | 169 | 133 | 144 | 187 | 195 | 212 | 239 | 221 | 294 |
| EMS | 84 | 84 | 83 | 110 | 81 | 89 | 103 | 127 | 163 | 163 | 183 | 154 | 172 | 192 | 213 | 213 | 218 |

When we compare the trends in output of these two faculties with the previous grouping of smaller faculties, we immediately see how the larger knowledge productive capacity of both these faculties enable them to produce more articles per year, but more importantly, also increase their output at a higher rate. This is a good example of the 'cumulative advantage theory. The theory 'predicts' that organisation or institutions that have significant resources (people/ funding/ infrastructure) not only has an advantage over other similar organisations in the same sector in terms of performance, but the initial advantage related to these resources is an accumulative one. Simply stated: faculties (in this case) with more initial resources (active publishing individuals) will tend to increase their output over time as they manage to increase their stock of human capital at a greater rate than smaller faculties. We clearly see in the table how Engineering has more than tripled its number of contributing authors to its article production (from 60 to 271) which resulted in the increase in article output from 69 articles to 221 articles. Although not as dramatic, EMS also managed to increase its number of contributing authors from 71 to 184 with a resultant increase in article production. What is perhaps noteworthy here is that the average paper productivity ratio within EMS is consistently slightly higher than that of Engineering. The most plausible explanation of this is that the difference in the additional authors within Engineering is more likely than not because of the increased contribution by students (and post-docs) who publish with their supervisors and other senior staff. This explains why the ratio of authors to articles is near mirror images of each other: for Engineering it is 1.22 authors per paper and for EMS it is 0.86 authors per paper.

## 18 Trends in the output of large and hybrid faculties (AGRI and FASS)

The faculties of Arts and Social Sciences and Agrisciences have both produced more than 3 000 articles over the reporting period. We have grouped them together because of the fact that they both house more professional training departments (Social Work, Geographers, Clinical Psychologists, Agronomists, Forestry and Viticulture professionals) as well as more basic scientific disciplines (Philosophy, History, Psychology, Genetics, etc.). This may explain the relatively similar bibliometric profiles in articles output below.

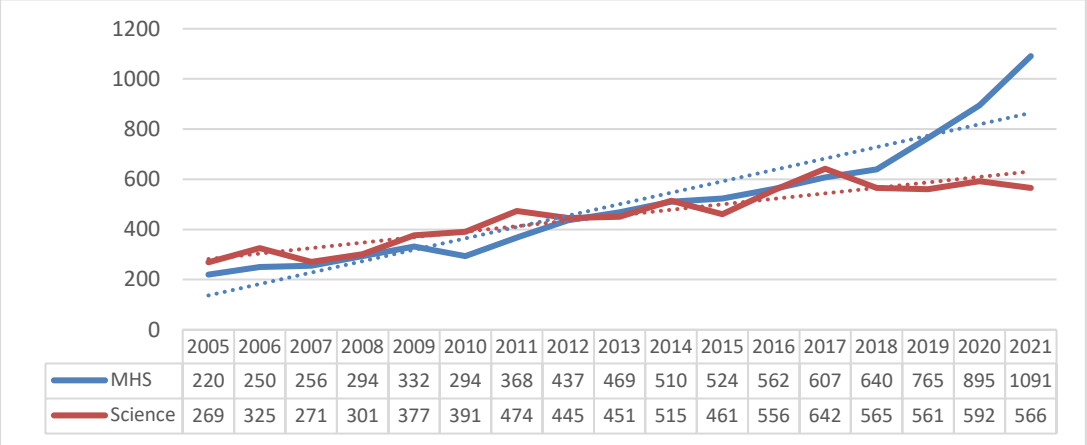



| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGRI | 138 | 163 | 141 | 166 | 177 | 217 | 209 | 240 | 277 | 257 | 267 | 298 | 323 | 374 | 378 | 416 | 388 |
| FASS | 156 | 176 | 157 | 206 | 192 | 159 | 205 | 225 | 240 | 266 | 246 | 338 | 342 | 320 | 279 | 301 | 298 |

It is interesting that Agrisciences and FASS had very similar productive capacities in terms of active publishing authors for a large period during the report period. It is only since around 2017 that Agrisciences began to 'mobilize' larger numbers of authors to contribute to their annual output. As we will see this is due to the increase in the contributions of more post-doctoral fellows as well as post-graduate students who publish. From a research planning perspective, it is clear that FASS can turn around its overall annual output and increase the number of articles significantly if it could or would investigate in appointing more post-doctoral fellows and possibly incentivize larger numbers of its post-graduate students to publish articles.

## 19 Trends in the output of the two largest faculties (SCI and MHS)

The two largest research producing faculties at SU are the Faculty of Science which produced a total of 6 210 articles since 2005 and the Faculty of Medicine and Health Sciences which produced 8 875 articles over the same period. Despite obvious differences between these two large faculties (for example the role that clinical research plays in MHS), I have grouped them together because of the similarity in output profiles.




| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHS | 220 | 250 | 256 | 294 | 332 | 294 | 368 | 437 | 469 | 510 | 524 | 562 | 607 | 640 | 765 | 895 | 1091 |
| Science | 269 | 325 | 271 | 301 | 377 | 391 | 474 | 445 | 451 | 515 | 461 | 556 | 642 | 565 | 561 | 592 | 566 |

The first interesting result is the fact that the trendlines of these two faculties are very similar up to 2017 when the sharp growth in number of papers in MHS leads to growing gap in output between the two faculties. This is reflected in the respective CAGR values of 10.5% and 4.8%. The increasing gap is the result of the aggregate effect of MHS continuing to increase its articles output especially since 2019, whilst the Faculty of Science could only manage to maintain its current annual output levels over the past 5 – 6 years. A comparison in the trends in human resources capacity over time for these two faculties perhaps best illustrates the point about cumulative advantage in research performance. Although the two faculties had very similar numbers of publishing authors in 2005 (and Science produced more articles in that year), the Faculty of Medicine and Health Sciences increasingly benefitted from a higher rate of increase in actively publishing authors over time. A more dramatic increase happened over the last three years which resulted in MHS having more than 1000 authors (especially large numbers of students and postdocs) producing their output. The Faculty of Science, on the other hand, experienced a much lower growth in contributing authors which translated in an annual production remaining at the same levels since 2016.

## 20 Mobilizing additional human resources through more post-doctoral fellows and post-graduate students publishing makes a difference!

The table below that shows the relative numbers of post-docs and publishing post-graduate students for 2019 to 2021 by faculty.

| Academic category | Agrisciences | FASS | EMS | Education | Engineering | Law | MHS | Military | Science | Theology |
|---|---|---|---|---|---|---|---|---|---|---|
| **Post-Docs** | **104** | **39** | **20** | **1** | **47** | **5** | **126** | | **139** | **7** |
| 2019 | 7 | 1 | 1 | | | | 7 | | 4 | |
| 2020 | 36 | 20 | 7 | | 14 | 3 | 55 | | 51 | 2 |
| 2021 | 61 | 18 | 12 | 1 | 33 | 2 | 64 | | 84 | 5 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Students** | **581** | **239** | **233** | **41** | **509** | **28** | **1367** | **17** | **662** | **63** |
| 2019 | 190 | 87 | 97 | 18 | 169 | 10 | 412 | 7 | 242 | 26 |
| 2020 | 240 | 91 | 89 | 15 | 172 | 15 | 494 | 3 | 249 | 24 |
| 2021 | 151 | 61 | 47 | 8 | 168 | 3 | 461 | 7 | 171 | 13 |

The results show that in some faculties (Military Science, Law and Theology) there are insignificant numbers of post-doctoral fellows. In the other faculties we can clearly see how these numbers increased over the past two to three years and now constitute a substantial part of the research productive capacity in those faculties. The same trend is clear with regard to the contribution that post-graduate students make in the article production of faculties. Given our analyses in the previous tables it is therefore not surprising to see that the Faculty of Medicine and Health Sciences has 461 student (co-) authors, and other faculties (Science, Agrisciences and Engineering) more than 150. It is very obvious that the faculties in the social sciences and humanities are not benefitting from these additional human resources. This could be due to various reasons: insufficient finances, smaller numbers of full-time students available for publication, and so on). From a strategic point of view, however, it is clear that the appointment of more post-doctoral fellows will have a direct impact on annual publication outputs and by implication on research subsidy earned.

## 21 High-level trends in the demographics of publishing authors by faculty

Gender: Over the entire reporting period of 2005 to 2021 women authors constituted about 30% of all publishing authors. But this picture is very different when we compare faculties as well as the trend over time. With the exception of the Law faculty (where women authors are well represented), all faculties show a significant increase in the contribution of women authors over this period. The fact that two faculties (Engineering and Theology) still have smaller percentages of women authors in 2021 than the university average (46%) are not unusual when we compare these figures with other universities. Perhaps the most salient finding is the fact that women now (2021) contribute majorities of outputs in five faculties (FASS, EMS, EDU, Law and Medicine and Health Sciences and are approaching parity in Agrisciences.

Race: The overall contribution of black authors to SU's research output in 2005 was only 10% and then doubled to about 20% in 2021. The faculties that have achieved more inclusive participation – compared to the university average - by black authors in 2021 are Education (61%), Law (30%), Medicine and Health Sciences (25%) and Theology (23%). The article output of the remaining faculties in 2021 remain under the corporate average of 20% by black authors. It is clear that the imperative of increasing the participation of black members of staff, post-doctoral fellows and post-graduate students remains a challenge for

the majority of the faculties.

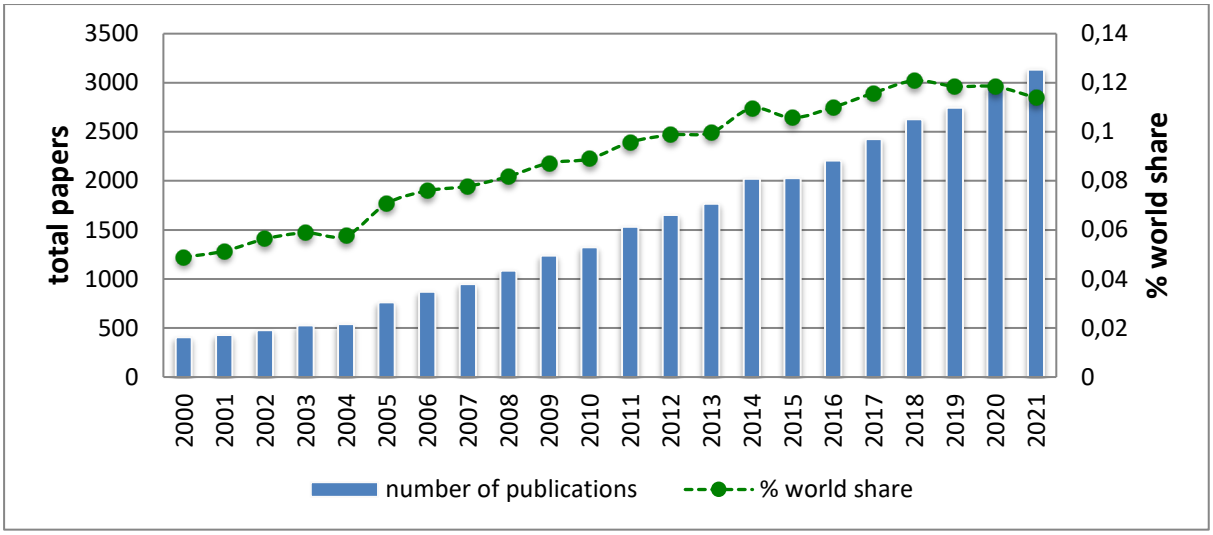
Age profile: The comparison between 2005 and 2021 reveals the following shifts:

- An overall increase of 9 percentage points in the under 40 years category (from 28% to 37%) over the reporting period. It is most likely the result of the increased contribution of post-doctoral fellows and students rather than a large shift in appointing younger academics.
- At the other end of the spectrum, we also witness a significant increase in the contribution of authors 60 years and older (from 10% to 18%).
- The 'ageing' of the contribution of authors (the category 60 years and older) has been most pronounced in the Faculties of Education (33%), Arts and Social Sciences (26) and Agrisciences (25%). In all three these faculties the percentage of authors younger than 40 have either stayed the same or increased which means that the real shift has been of staff who fell in the 40 -59 years old category in 2005 now (17 years later) in the 60+ category.
- If we focus on the under 40 category, it is noteworthy that Engineering (55%), Law (49%) and Science (44%) have the largest percentages. Further analysis is required to establish whether the increase, both in post-docs and students, are being reflected in these numbers.

The final high-level findings highlight SU's research performance based on its publication output in the CAWeb of Science. This perspective allows us to compare SU with the other top universities in the country on more advanced bibliometric indicators.

## 22 SU increases its article output in the [CA]WoS but its world share has declined in recent years.

Between 2000 and 2021, SU staff and students authored or co-authored a total of 33 689 articles and article reviews in journals that are indexed in the [CA]Web of Science collection. The figure below displays the increase in absolute numbers of article and review articles between 2000 and 2020. The CAGR over this period is healthy 10.5%. The vertical axis shows how SU's share of world papers has increased over this period from 0,048% in 2000 to 0,011%. What is particularly noteworthy is the steep increase over the past ten years. One explanation for this increase is, of course, due to the inclusion of more South African journals in the Web of Science – a development that has been to the benefit of all South African universities. However, although the number of articles has increased from 406 in 2000 to 3331 in 2021, we also see a slowing of the growth in world share (hovering around 0,011% for the past five years.




## 23 SU increases its share of South Africa's publication output.

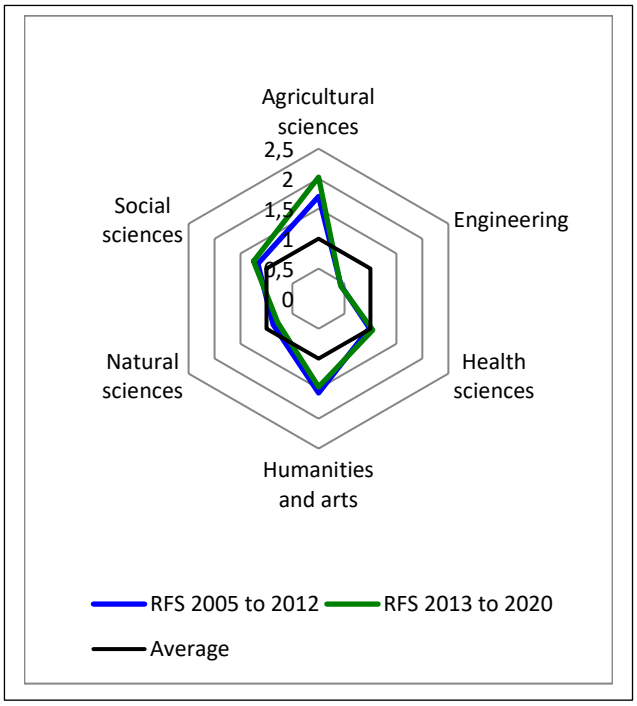
Although the information about SU's share of world output in the Web of Science is useful (up to a point), it makes more sense to compare SU's relative contribution to South Africa's publication output in the Web of Sciences for the same period with the top performing universities in the country. The table below presents the selected universities' relative country share for 2000 and 2021.

| University | Country share: 2000 | Country share: 2021 | Diff (2021-2000) |
|---|---|---|---|
| UCT | 18,49% | 14,62% | -3,87% |
| WITS | 16,46% | 13,78% | -2,68% |
| UKZN | 11,91% | 11,95% | 0,04% |
| UP | 12,52% | 11,86% | -0,66% |
| SU | 10,26% | 11,68% | 1,42% |
| UJ | 2,76% | 11,20% | 8,44% |
| NWU | 2,51% | 7,29% | 4,78% |
| UFS | 3,79% | 5,76% | 1,97% |
| UNISA | 1,67% | 5,73% | 4,06% |
| UWC | 2,46% | 3,91% | 1,45% |
| RHODES | 3,14% | 2,79% | -0,35% |

Where we have traditionally referred to the 'big five' in the SA higher education sector, it is now more correct to refer to the 'big six' with UJ making major strides in increasing its output relative to UCT, WITS, UKZN, UP and SU. The increase in the relative shares by NWU, UFS, UNISA and UWC are noteworthy, but it is clear that this has been achieved because UCT and WITS (specifically) have lost ground on this indicator of research performance.

## 24 SU maintains an overall balanced profile as far as its relative specializations or strengths in knowledge production is concerned

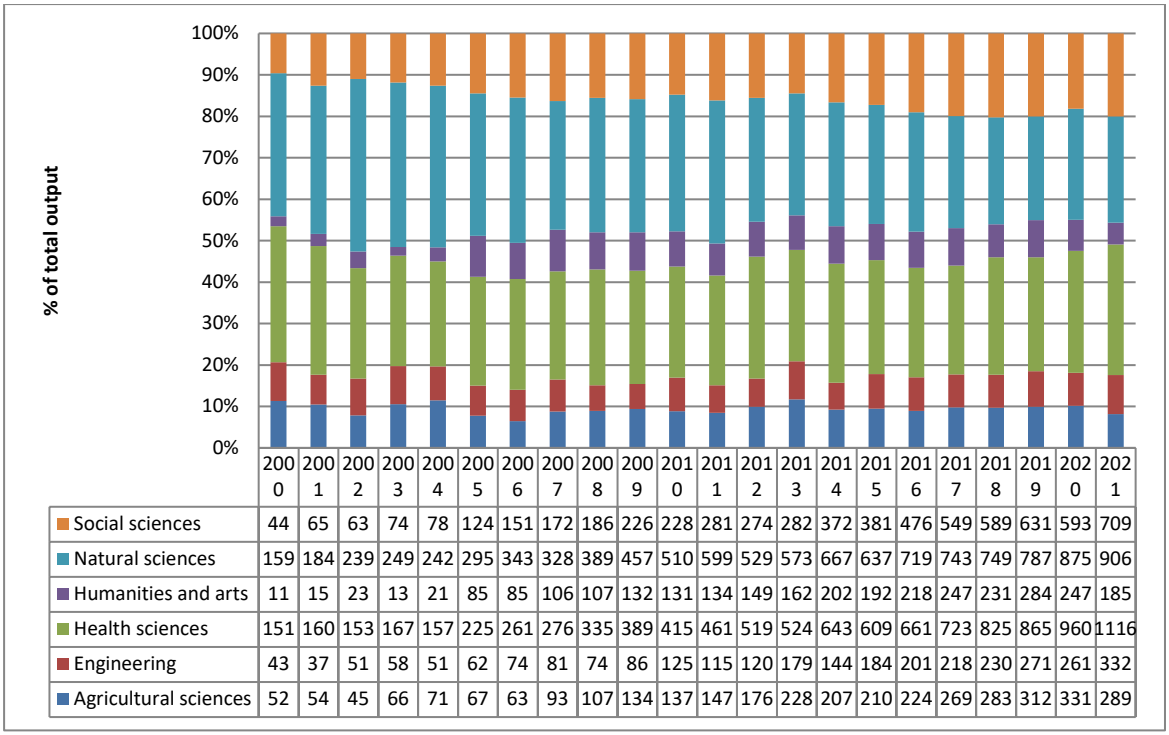
The Relative Field Strength-indicator, also known as the relative activity index or relative specialisation index, is a useful indicator of the areas of research in which a country or university– compared to the world average in those areas – are more or less active or strong. In Figure 23, the world average is indicated by the bold line at 1. Any value above 1 indicates that the university is more active in that field than the average world activity in that field (compared to other universities. The graph above compares SU's relative field strength for two periods: 2005 to 2012 (Blue line) and 2013 to 2020 (Green line). A comparison of the values on each of the lines shows, with the exception of the agricultural sciences, no significant shifts over time. The overall spider diagramme shows that SU has – relative to the proportions of these fields in the world – very strong activities in the agricultural sciences and social sciences and humanities. Our publication output in the WoS in the health sciences is commensurate to the world average, whilst we are not as strong or active in the natural sciences. This is also the case for the field of Engineering where SU, as is the case for most South African universities, do not have the same relative strength when compared to the world field output.




## 25 SU maintains a significant presence across multiple science fields which continue define the shape of knowledge production at the University.

Universities – especially large ones – are often compared to tankers. It is not easy for them to reverse their direction at short notice. This is especially true of the 'shape of knowledge production' at such institutions. The specific organisational architecture (faculty and departmental design) and programme mix, changes slowly over time. This, of course, is the direct result of the path dependency of the disciplines offered by the university and the reality of relatively slow turnover of permanent staff. Once a senior academic has tenure, he or she can in theory remain in his/her field for 30 to 40 years. In addition, in times of financial cuts and slow growth, universities do not typically have the resources to change their investment and human resources commitments in new fields. There are, of course, exceptions where the better resourced universities, especially with the injection of funding

from external sources, are able to establish and grow new centres and institutes (e.g., School on Climate Studies or on Data science). However, the relative inertia of a university to change the shape of its knowledge production is empirically validated in the figure above where we see that relatively small shifts in the relative shares in research across the six main science fields are recorded.




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Social sciences | 44 | 65 | 63 | 74 | 78 | 124 | 151 | 172 | 186 | 226 | 228 | 281 | 274 | 282 | 372 | 381 | 476 | 549 | 589 | 631 | 593 | 709 |
| Natural sciences | 159 | 184 | 239 | 249 | 242 | 295 | 343 | 328 | 389 | 457 | 510 | 599 | 529 | 573 | 667 | 637 | 719 | 743 | 749 | 787 | 875 | 906 |
| Humanities and arts | 11 | 15 | 23 | 13 | 21 | 85 | 85 | 106 | 107 | 132 | 131 | 134 | 149 | 162 | 202 | 192 | 218 | 247 | 231 | 284 | 247 | 185 |
| Health sciences | 151 | 160 | 153 | 167 | 157 | 225 | 261 | 276 | 335 | 389 | 415 | 461 | 519 | 524 | 643 | 609 | 661 | 723 | 825 | 865 | 960 | 1116 |
| Engineering | 43 | 37 | 51 | 58 | 51 | 62 | 74 | 81 | 74 | 86 | 125 | 115 | 120 | 179 | 144 | 184 | 201 | 218 | 230 | 271 | 261 | 332 |
| Agricultural sciences | 52 | 54 | 45 | 66 | 71 | 67 | 63 | 93 | 107 | 134 | 137 | 147 | 176 | 228 | 207 | 210 | 224 | 269 | 283 | 312 | 331 | 289 |

## 26 SU increases its foreign research collaboration (measured in terms of co-authorship)

SU staff have over the past two decades increasingly collaborated with foreign scientists and scholars. International collaboration (co-authored papers) in 2000 constituted 30% of all papers compared to 57% in 2021. This substantial increase in foreign collaboration has meant that national collaboration has declined (from 57% in 2000 to 36% in 2020). The percentage of single-authored papers has nearly halved over this period (from 14% in 2000 to 7% in 2021). Research collaboration with academics and scientists in Africa has increased from near zero in 2000 to 6% of all papers in 2021. Again, it should be emphasized that these trends in research collaboration show the average picture across all scientific fields which hide very substantial differences in collaboration patterns between fields.

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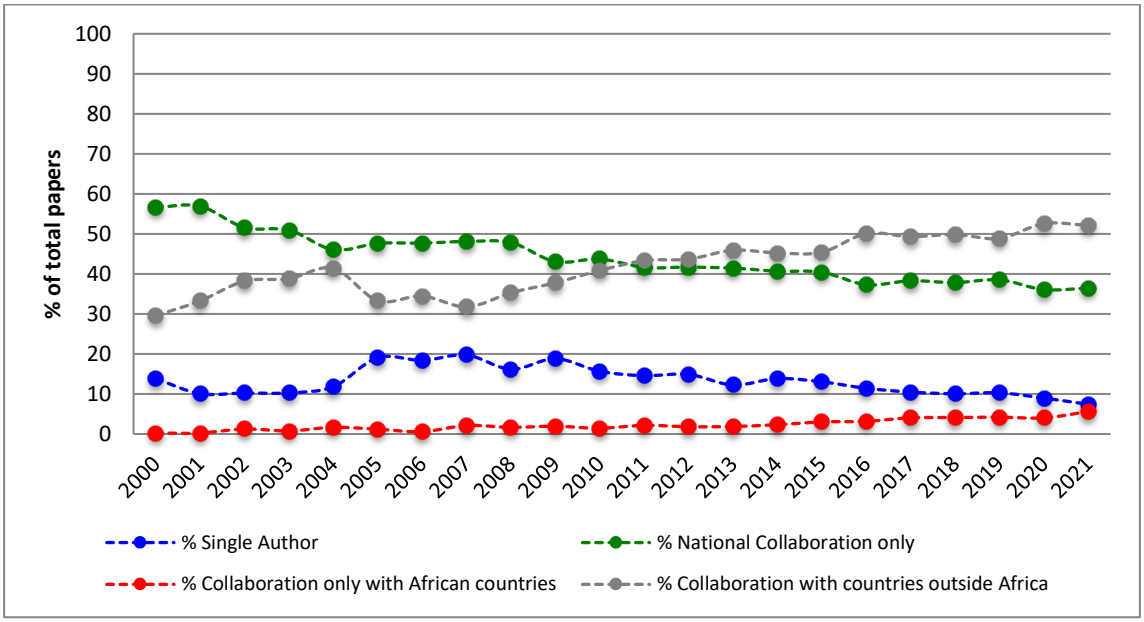
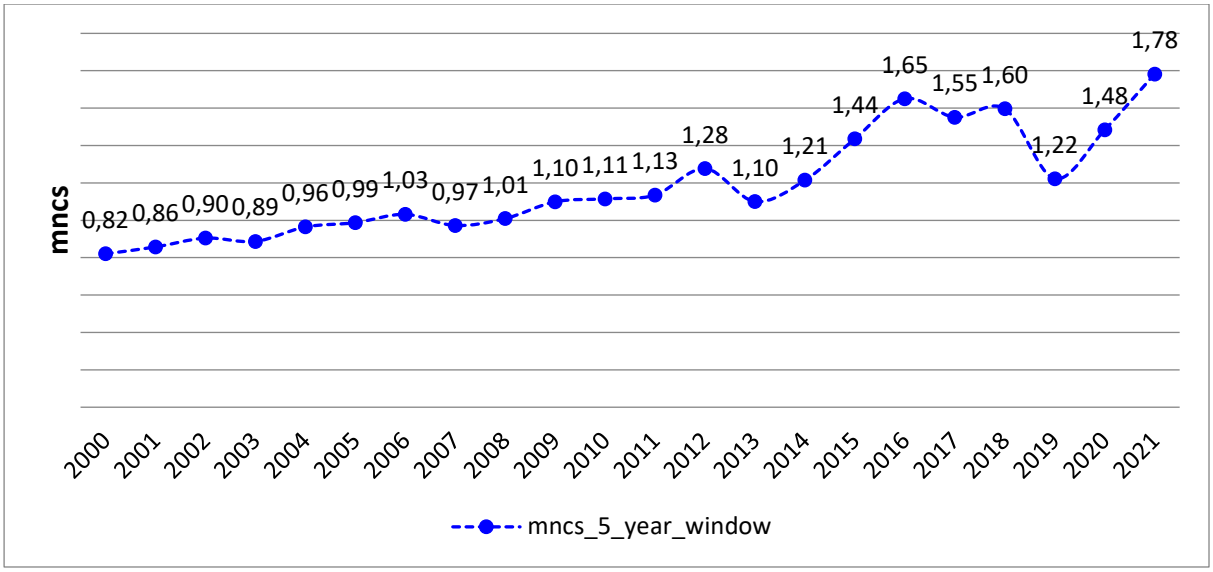



A comparison with the other top universities shows that the overall trend to increased foreign collaboration at all six universities is clear with UCT recording the highest percentage of 70% (and a declining national collaboration at 30%). This is a direct result of the dominance of the medical faculty at UCT where international collaboration is much more prevalent than in other science fields, especially engineering, humanities and social sciences.

## 27 SU increases its the citation impact of its article output significantly and achieves the second highest impact score in 2021 of all universities

An analysis of the field-normalized citation impact of SU's papers reveals very positive with an overall trend where the citation impact of the university's publication more than doubling its MNCS score between 2000 and 2021. The value of 1.78 in the most recent year (2021) in effect means that the average SU paper generated nearly 80% more citations than papers in the rest of the world (in the same fields0. A comparison of trends in citation impact across the top six universities shows that UCT's papers recorded the highest average field-normalized citation score of 1.91, followed by SU (1.79), WITS (1.7), UKZN (1,54), UJ (1.26) and UP (1.14). All but one of these universities (UJ) have medical faculties which is a main contributor to these relatively high citation impact values. Although the differences in values may look small, it must be kept in mind that if one multiplies these average scores with nearly 4 000 papers that are produced by these universities, the aggregate effect is large. These data also explain, to a large extent, why these universities are consistently the highest ranked universities in the country on most international rankings where citation impact carries a significant weight in the calculation of the rank position.




**Concluding assessment**

Any bibliometric assessment of a university's research performance must find a balance between general trends and individual differences, between what happens over short periods of time and longer term trends. The aim of this report has been to present such a balanced review.

It is fair to say that the overall conclusions that can be drawn from our analyses are more positive than negative: sustained research output in general and also in the Web of Science, positive trends in ensuring that the research enterprise at SU becomes more inclusive of gender and race, an age profile that reflects increased in younger and emerging scholars as well as recognizing the contribution of more senior and established academics. Within the South African context, the case could be made that SU remains (with UCT) the two top medium-sized research performing universities. In fact, in some areas (post-graduate production SU outperforms UCT). A comparison with UJ, UP, UKZN and WITS must take into account the differences in size between them and SU and UCT. Once we normalize for the size of all universities, SU's position as one of the two top universities in the sector remains unchallenged.

# Main Report

# INTRODUCTION AND TECHNICAL SECTION

## The Brief

The author was requested by the DVC for Research, Innovation and Post-graduate Studies, Prof. Sibusiso Moyo to undertake a comprehensive bibliometric analysis of the research performance at Stellenbosch University. Although some smaller, ad hoc analyses on research performance at SU have been done in the past, this report is the most comprehensive report of its kind for top management.

The report is organized in four Chapters. In **Chapter One** we present our analyses and findings which focus on the performance of SU over the past 17 years with regard to research publications. Our analyses and findings cover the overall publication output as well as the trends in the production of journal articles, books and book chapters and conference proceedings. Given that journal articles constitute more than 80% of the university's output we look more closely at the trends in journal article production and specifically at trends in terms of the demographics (gender, country of birth, race and age) of the authors.

In this chapter we also compare the research performance of SU with the rest of the Higher Education sector in the country on a number of normalized indicators including percentage of staff with doctoral degrees, per capita publication output and normalized knowledge output. In our discussion of these results we have selected the top ten research universities (including Stellenbosch) in the country as the 'comparator' institutions for this benchmarking.

**Chapter Two** is devoted to a discussion of the trends in terms of graduate production. The focus is specifically on the two categories of graduate output that qualify for subsidy, i.e. research Masters' and doctoral output. In addition to using the DHET data on subsidy-units earned for these two categories, our analysis goes further and investigate shifts in the demographics of the university's Masters' and doctoral students more generally.

Our analyses in these chapters are presented and discussed according to the following indicators. Following standard practice we distinguish between non-normalized and normalized indicators which are organized as outlined in the tables below.

**Table 1: Non-normalized indicators**

| Indicator Category | Indicator | Time frame | Source |
|---|---|---|---|
| Publication output | Journal articles | 2005 - 2021 | DHET/SA Knowledgebase |
| | Books | 2005 – 2021 | DHET |
| | Books chapters | 2005 – 2021 | DHET |
| | Conference proceedings | 2005 – 2021 | DHET |
| | Journal articles by journal title | 2005 – 2021 | SA Knowledgebase |

| | | | |
|---|---|---|---|
| Demographics of research output | Journal articles by gender of author | 2005 – 2021 | SA Knowledgebase |
| | Journal articles by country of birth of author | 2005 – 2021 | SA Knowledgebase |
| | Journal articles by race of author | 2005 – 2021 | SA Knowledgebase |
| | Journal articles by age (category) of author | 2005 – 2021 | SA Knowledgebase |
| Graduate output | Masters' graduates | 2002 – 2021 | HEMIS |
| | Masters' graduates disaggregated by gender | 2002 – 2020 | HEMIS |
| | Masters' graduates disaggregated by country of birth | 2002 – 2020 | HEMIS |
| | Doctoral graduates | 2002 – 2021 | HEMIS |
| | Doctoral graduates disaggregated by gender | 2002 – 2020 | HEMIS |
| | Doctoral graduates disaggregated by country of birth | 2002 – 2020 | HEMIS |

**Table 2: Normalized indicators**

| Indicator Category | Indicator | Time frame | Source |
|---|---|---|---|
| Publications | Per capita article output | 2005 – 2021 | DHET |
| | Per capita total publication output | 2005 – 2021 | DHET |
| Staff | % Of staff with doctoral degrees | 2005 – 2021 | DHET |
| Knowledge indices | Total weighted research output | 2005 – 2021 | DHET |
| | Normalized knowledge output | 2005 – 2021 | DHET |

In **Chapter 3** we disaggregate some of the analyses of journal article output as presented in the previous chapters according to the research output of the ten Faculties of the University. We present data on trends in article output as well as demographic analyses of the authors of these publications.

In the final Chapter (**Chapter 4**) of the report we view the research 'performance' of SU through the lens of the journal articles and review articles that are published in journals indexed in the [CA]Web of Science citation database. In this chapter we select standard bibliometric indicators such as percentage of country share, citation impact indicators, relative field strength scores and research collaboration trends. By way of benchmarking our performance on these indicators, we compare SU with the other 'big five' research universities in the country: UCT, UJ, UKZN, UP and WITS.

## Methodological notes and some caveats

It is always important to emphasize that this report on research performance at SU presents a very specific perspective on the state of research at the university. This analysis is a bibliometric study which is predominantly based on articles published in peer-reviewed journals – locally and overseas. Other forms of scientific publication (books, chapters in books, conference proceedings or research reports) are only included in our discussion of the official DHET-subsidized outputs.

One of the unique features of the bibliometric studies conducted at the Centre for Research on Evaluation, Science and Technology (CREST) at Stellenbosch University is that we link four crucial demographic variables – gender, country of birth, race and year – to each author. The procedure entails the following: the complete set of article output for SU for the period 2005 – 2021 was first updated and cleaned in our current SQL-database. The article tables were then transformed into an "Authorship" table where every record constitutes the contribution of a unique author to a particular article. The dataset for this study consists of 31 207 unique articles which translates in 64 426 authorships. We were able to link these variables as per below:

- 64 414 or 99.9% of all records are populated with data on the 'gender' of the author.
- 55 516 or 86.2% of all records are populated with data on the 'year of birth' of the author.
- 57 511 or 89.3% of the records are populated with data on the 'country of birth' of the author
- 44 857 of the 45 611 ( 98.3%) South African borne authors with data on their 'race' or 'population group' classification of the author

This means that the demographic profiles we report on here are based on very large "samples" of the relevant populations and that sampling errors should be small. It is also important for the reader to understand that when we report on the "age" of author that this is linked to the date of publication of the article concerned. Stated differently, this means that the "age" profiles of article output are calculated according to the actual age of the author in the year that the article was produced.

The research subsidy funding framework originated in 1988 within the then National Department of National Education. But it would only be in 2001 that a major revision and expansion of the Framework was commissioned and which resulted in a major revision which came into effect in 2003. The major difference with the original framework was that 10% of the parliamentary grant to universities was ringfenced for the purpose of incentivizing research performance. This resulted in a huge and sudden increase in the values of individual subsidy units. More recently, in 2013, a further revision of the Framework was done which came into effect in 2015. In this revision some additional databases were added (notably Scopus) and the subsidy-values for books were doubled in an effort to incentivize book publication especially in the Humanities and Social Sciences. In all the graphs below, we report on the period between 2005 up to 2021.

## Closing comments

Although we have made every attempt to ensure that the data used in this study is accurate and credible, we are quite aware that there remain some gaps in the demographic data and that some of the names of all authors in our data set could not be completely reconciled with the staff data from the university. In addition, we also accept that micro-analyses at the faculty level are more prone to error than analyses at the corporate level.

# CHAPTER 1: HISTORICAL BENCHMARKING OF RESEARCH PUBLICATION OUTPUT AT SU

## 1.1 Introduction

In this Chapter we focus on SU's research performance over the past 17 years. The focus here is on the University's performance in the three categories of publications (journal articles, books and book chapters and published conference proceedings). In addition to discussing the trends in output of each of these categories, this Chapter also includes demographic analyses of the publication output. In a final section under the heading of 'research productivity' we discuss the underlying drivers of the trends in publication output at SU and we contextualise this discussion through a comparison with the other top nine universities in the sector.

## 1.2 Overall publication output: 2005 – 2021

According to the DHET publication policy framework only staff and students that are officially employed or registered at a South African university qualifies for subsidy. Where authors of papers are either not from a South African university (for example the CSIR or HSRC) or from a foreign country, the proportional share of the eligible subsidy-amount for a specific institution is counted. Where authors from two or more South African authors produce a publication, the subsidy-amount is allocated proportionally.

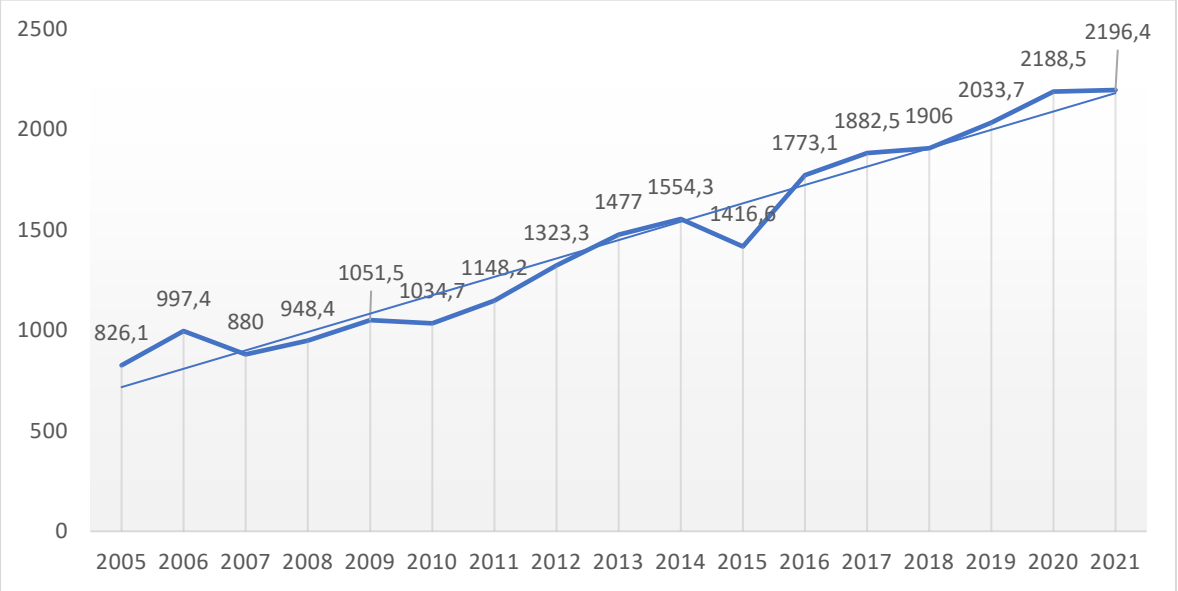
In the tables below, we present the official data as released by the DHET. In each table we report first on the data for the entire university sector, followed by the combined figures for the university of technology sector as a whole and finally the data for each university of technology separately. We also report the compound annual growth rate values over the reporting period where appropriate.

In **Table 2** we present the time series data on 'total publication output" for all 26 universities between 2005 and 2021.

**Table 2: HE's Total Publication Output Subsidy Units (2005 – 2021)**

| University | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UJ | 610,9 | 774,4 | 873,9 | 897,4 | 1074,9 | 1279,8 | 1559,5 | 1741,4 | 1691 | 2276,3 | 2305,6 | 2772,4 |
| UKZN | 1146,5 | 1250,4 | 1424,2 | 1627,2 | 1708,6 | 1763,2 | 2004,7 | 2028,8 | 2069,9 | 2286,1 | 2402,4 | 2650,2 |
| WITS | 936,1 | 1037,1 | 1114,5 | 1300,3 | 1481,7 | 1554,6 | 1821,4 | 2009,6 | 1878,4 | 1918,8 | 1924,2 | 2465 |
| UP | 1187,5 | 1314,8 | 1424,1 | 1615,3 | 1677,6 | 1837 | 2040,9 | 2062,9 | 2054,6 | 2060,6 | 2099,8 | 2385,4 |
| SU | 1034,7 | 1148,2 | 1323,3 | 1477 | 1554,3 | 1416,6 | 1773,1 | 1882,5 | 1906 | 2033,7 | 2188,5 | 2196,4 |
| UCT | 1253 | 1314,4 | 1390,9 | 1549,1 | 1623,6 | 1653,4 | 1843,9 | 1731,6 | 1826,6 | 1936 | 1886,8 | 1814,5 |
| NWU | 585,9 | 733,6 | 869,2 | 1169,5 | 1127 | 1250,2 | 1356,5 | 1300 | 1438,3 | 1541,2 | 1536,6 | 1658,5 |
| UNISA | 734,6 | 797,6 | 892,5 | 1030 | 1172,8 | 1328,6 | 1374,1 | 1283,5 | 1299,3 | 1366,6 | 1323,2 | 1398,9 |
| UFS | 496,5 | 568,5 | 643,9 | 668,6 | 759,9 | 711,2 | 927,3 | 995,2 | 992,7 | 1171,7 | 1321,4 | 1291,9 |
| UWC | 266,8 | 346,3 | 366,9 | 406,4 | 481,3 | 497,2 | 552,1 | 483 | 481,3 | 594,2 | 603,9 | 655,4 |
| RU | 325,3 | 358,5 | 409,9 | 454,4 | 491,6 | 487,2 | 497,5 | 579 | 549,4 | 548,1 | 535,1 | 594,5 |
| NMU | 255,5 | 351,4 | 311,5 | 342,1 | 366 | 398,5 | 429,2 | 389,1 | 427,3 | 459,6 | 564,4 | 580,6 |
| UL | 93,2 | 147,6 | 219,2 | 227 | 243,7 | 276,5 | 271,9 | 315,7 | 344,3 | 387,7 | 371,2 | 570,4 |
| DUT | 48,4 | 88,9 | 80,4 | 128,2 | 152,1 | 235,6 | 209,1 | 259,9 | 344,9 | 353,3 | 449 | 426,1 |
| CPUT | 155,3 | 141,8 | 167,5 | 147,3 | 171,7 | 212,6 | 216 | 256 | 217,7 | 242,7 | 231,5 | 333,5 |
| TUT | 188,1 | 242,8 | 229,9 | 278,2 | 281,3 | 301,9 | 342,8 | 321,5 | 295,5 | 361,3 | 328,9 | 277,5 |
| UFH | 142,2 | 180,8 | 208,6 | 234,9 | 280,2 | 336,6 | 244,2 | 414,7 | 329,9 | 362,2 | 275,4 | 245,2 |
| SMU | | | | | 93,2 | 110,4 | 121,1 | 94,4 | 88,6 | 106,7 | 174,3 | 238,8 |
| UNIZULU | 66,7 | 69,2 | 72,9 | 89,1 | 110,7 | 130,4 | 122,9 | 191,8 | 212,7 | 256 | 267,5 | 238,4 |
| WSU | 51,8 | 45,2 | 60,6 | 48,4 | 27,1 | 49,4 | 50,4 | 74,1 | 59,4 | 95,2 | 154,9 | 192,2 |
| CUT | 39,6 | 47,3 | 58,9 | 68,5 | 87,2 | 106,5 | 117,1 | 107,2 | 170,2 | 171 | 172,1 | 156,4 |
| VUT | 44,7 | 75,1 | 75,3 | 82,9 | 109,9 | 76,2 | 102 | 126,8 | 149,7 | 161,9 | 195,4 | 138,4 |
| UNIVEN | 76,8 | 130,8 | 127,8 | 148,8 | 225,2 | 271,6 | 188,9 | 176,2 | 179,7 | 197,6 | 223,7 | 116,2 |
| MUT | 7,6 | 26,2 | 17,7 | 18 | 15,6 | 18,6 | 16,3 | 24,2 | 42,1 | 46,2 | 105,5 | 68,9 |
| UMP | | | | | 0,5 | 16,8 | 24,9 | 23,2 | 49,3 | 70,8 | 64 | 57,8 |
| SPU | | | | | | | | | | 14,2 | 29,3 | 50,1 |

**Figure 1: SU total publication output (2005 to 2021)**




The trend in total publication outputs for SU shows a steady, linear increase (with the exception of a decline in 2015). By way of comparison, the summary table below presents the CAGR values for these universities over two periods: (a) the entire period from 2005 to 2021; (b) and the more recent time period from 2015 to 2021 which coincides with the change in the DHET funding formula with the inclusion of more databases (notably Scopus) as well as a doubling of the subsidy-unit value for books from 5 to 10.

**Table 3: Summary table: comparing annual growth rates of top ten universities.**

| University | CAGR (2005 to 2021) | CAGR (2015 to 2021) |
|---|---:|---:|
| University of Johannesburg | 14,31% | 13,75% |
| University of the Free State | 7,42% | 10,46% |
| University of the Witwatersrand | 7,63% | 7,99% |
| Stellenbosch University | 6,30% | 7,58% |
| University of KwaZulu-Natal | 6,63% | 7,03% |
| North-West University | 10,70% | 4,82% |
| University of Pretoria | 4,95% | 4,45% |
| University of Cape Town | 4,53% | 1,56% |
| University of South Africa | 6,38% | 0,86% |

The fact that UJ (and NWU to a lesser extent) has recorded the highest overall CAGR values over the entire period is partially a function of the smaller baseline values in 2000. For the remainder of the universities, these values range between 6 and 7%. As far as the latter period is concerned, the much higher growth rates of UJ and UFS are the function of exceptional growth in conference proceedings and book chapters and books.

## 1.3 Journal articles and subsidy-units: 2005 to 2021

The introduction of the revised Publication Policy Framework by the DHET in 2005 resulted in increased outputs across all document types across the university sector. This is also true for the production of journal articles which has benefitted from the inclusion of additional accredited databases – notably Scopus – which increased the number of journals in which academics and students could publish.

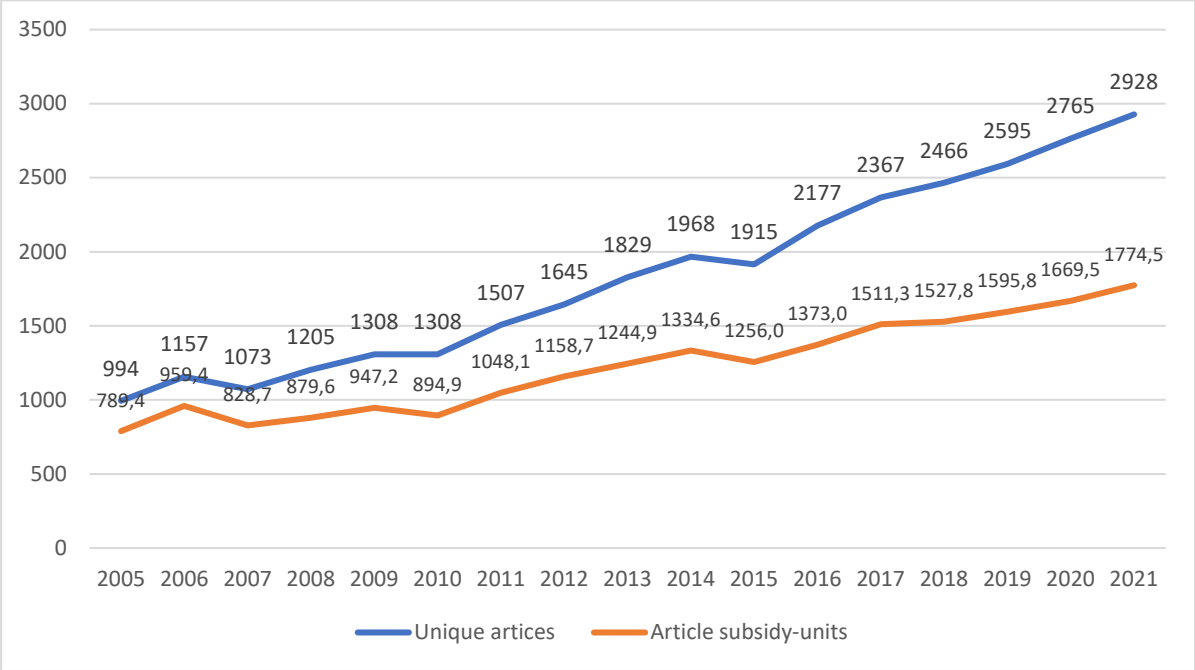
### 1.3.1 Trends in journal output

Figure 2 below displays the subsidy units awarded to SU as well as the actual number of articles (full paper count) that were produced.

**Table 4: Journal article output units (2010 to 2021)**

| University | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **UKZN** | 1030,5 | 1152 | 1325,1 | 1489,8 | 1602,5 | 1645,6 | 1668,2 | 1833,6 | 1847,2 | 2067,3 | 2242 | 2436,7 |
| **WITS** | 833,8 | 897,8 | 1011 | 1122,4 | 1272 | 1308,9 | 1500,7 | 1620,3 | 1598,5 | 1577,8 | 1638,2 | 2046,3 |
| **UP** | 1087,9 | 1178,6 | 1277,4 | 1415 | 1461,5 | 1584,9 | 1707,1 | 1713,4 | 1702,5 | 1682,4 | 1749,6 | 2036 |
| **UJ** | 515,8 | 638 | 738,6 | 656,1 | 761,9 | 899 | 1029,7 | 1111,2 | 1169,4 | 1622,6 | 1787,3 | 2006,5 |
| **SU** | 894,8 | 1048,1 | 1158,7 | 1244,9 | 1334,6 | 1256 | 1373 | 1511,3 | 1527,8 | 1595,8 | 1669,5 | 1774,5 |
| **UCT** | 1071,7 | 1124 | 1191,3 | 1315 | 1372,6 | 1389,4 | 1516,4 | 1441,2 | 1555,8 | 1636,2 | 1658,2 | 1534,4 |
| **NWU** | 510,8 | 652,6 | 790,6 | 1009,7 | 980,7 | 1074,6 | 1148,4 | 1107,6 | 1173 | 1233,2 | 1264,3 | 1366,3 |
| **UNISA** | 680,8 | 732,6 | 812,4 | 923,7 | 1027,7 | 1169,1 | 1050,8 | 1108 | 1077,6 | 1167,9 | 1135,6 | 1202,8 |
| **UFS** | 451,4 | 511,7 | 566,1 | 577,4 | 627,7 | 585,8 | 721,8 | 716,3 | 783,2 | 813,5 | 969,4 | 1015,7 |
| **UWC** | 240,5 | 330,1 | 342,8 | 360 | 445,2 | 461 | 447,3 | 422,6 | 424,6 | 513,8 | 560,7 | 553,5 |
| **UL** | 89,1 | 143,2 | 218,2 | 203,2 | 234 | 239,8 | 254,9 | 278,3 | 310,2 | 348,7 | 350,5 | 515,2 |
| **NMU** | 200,9 | 283,5 | 268,5 | 252,8 | 281,4 | 324,8 | 315,2 | 312,3 | 349,9 | 389 | 472,5 | 485,9 |
| **RU** | 292,4 | 309,3 | 350,6 | 405,5 | 405 | 404,5 | 421,3 | 456 | 441,7 | 460,5 | 474,5 | 471,6 |
| **DUT** | 41,7 | 74,3 | 67,8 | 99 | 135,8 | 187,2 | 176,9 | 210 | 276,8 | 300,1 | 370,4 | 358,2 |
| **CPUT** | 129,8 | 115,5 | 147,1 | 103 | 122,8 | 173,1 | 171,5 | 206,8 | 161,9 | 178,1 | 200,9 | 290,4 |
| **TUT** | 146,7 | 179,1 | 189,8 | 210,5 | 218,3 | 254,4 | 284,3 | 265,5 | 250,3 | 294,8 | 306,4 | 246,8 |
| **SMU** | | | | | 92,7 | 108,9 | 120,4 | 93,4 | 88 | 105,5 | 172,2 | 237,7 |
| **UNIZULU** | 64,7 | 67,8 | 69,8 | 82,1 | 103,2 | 114,6 | 111,4 | 161,3 | 187,1 | 219,7 | 244,4 | 198,9 |
| **UFH** | 132,6 | 168,2 | 201,8 | 215 | 260,1 | 324,7 | 209,6 | 382,9 | 315 | 353,1 | 262,4 | 194,2 |
| **WSU** | 46,9 | 42,6 | 57,6 | 40,1 | 27,1 | 46,8 | 47,2 | 68,9 | 54,8 | 86,7 | 132,6 | 173,7 |
| **CUT** | 31,7 | 40,1 | 54,3 | 55 | 72,8 | 74,5 | 66,8 | 59,8 | 105,1 | 112,4 | 128,7 | 128,9 |
| **UNIVEN** | 65,2 | 113,9 | 112,9 | 132 | 204,4 | 251,8 | 152,7 | 158,9 | 163,5 | 189,5 | 209,9 | 109,1 |
| **VUT** | 36,5 | 64,1 | 66,6 | 69,9 | 80,1 | 62,9 | 79,7 | 103,9 | 106,4 | 127,3 | 172,5 | 106,3 |
| **MUT** | 7 | 23,7 | 16,7 | 15,3 | 13,5 | 17,4 | 12,1 | 23,2 | 40,2 | 45,3 | 103,8 | 55,2 |
| **UMP** | | | | | 0,5 | 16,8 | 24,9 | 21,7 | 45,2 | 65,9 | 60,6 | 52,7 |
| **SPU** | | | | | | | | | | 7,2 | 24 | 35,9 |
| | | | | | | | | | | | | |

**Figure 2: SU article and article subsidy units (2005 to 2021)**




Note: The number of articles and subsidy-units for 2021 are provisional as these are not the officially verified figures from DHET.

In total, SU authors have produced 31 207 articles in accredited journals which translates into 20 793 article subsidy units over the past seventeen years. The comparison between the two lines is interesting as the increasing gap between article and subsidy-units can be interpreted as a proxy of the fact that more articles are now being produced with higher numbers of authors than seventeen years ago.

In the table below we compare the annual growth rates in article subsidy-units across the top ten performing universities

**Table 5: Comparison of growth rates in journal article output of top ten universities**

| University | CAGR (2005 to 2021) | CAGR (2015 to 2021) |
|---|---|---|
| University of Johannesburg | 12,59% | 14,32% |
| University of the Free State | 6,06% | 9,61% |
| University of the Witwatersrand | 6,82% | 7,73% |
| University of KwaZulu-Natal | 6,73% | 6,76% |
| Stellenbosch University | 5,19% | 5,93% |
| University of Pretoria | 4,50% | 4,26% |
| North-West University | 9,53% | 4,08% |
| University of Cape Town | 4,53% | 1,67% |
| University of South Africa | 5,61% | 0,47% |

The comparative results reveal the following salient points:

- That UJ has performed exceptionally well over the overall time period as well as in the most recent period.
- The majority of universities (SU included) maintain an annual growth rates of between5 and 9%
- One of the more surprising results is the decline in output at UCT with the second lowest annual growth rate recorded for the more recent period of 1.67%.

In the final section of this Chapter, we offer some explanations to account for some of these trends.

### 1.3.2 Journal articles disaggregated by journal title.

The 31 207 articles that were produced by SU academics and other staff and students were published in 5 662 unique journals. As the table below shows, the number of journals in which SU authors publish has increased nearly threefold from 524 in 2005 to 1 555. This increase reflects the fact that the number of accredited journals, especially those indexed in the [CA]Web of Science and Scopus (since 2015), has continued to increase every year. In addition, it could also be that – given the increasing competition to publish in the top and high-impact journals and the pressure to earn a publication subsidy – has 'forced' academics and students to search more widely for journals to submit their papers and possibly even journals where the turnround time from submission to acceptance of a manuscript is shorter than in the top journals in a field.

**Table 6: Count of journals in which SU authors have published disaggregated by year.**

| Year | Nr of unique journals |
|---|---|
| 2005 | 524 |
| 2006 | 593 |
| 2007 | 540 |
| 2008 | 655 |
| 2009 | 691 |
| 2010 | 717 |
| 2011 | 743 |
| 2012 | 832 |
| 2013 | 911 |
| 2014 | 1005 |
| 2015 | 1001 |
| 2016 | 1170 |
| 2017 | 1208 |
| 2018 | 1268 |
| 2019 | 1394 |
| 2020 | 1461 |
| 2021 | 1555 |

The 31 207 SU articles appeared in 5 662 unique journals but of course are not evenly distributed across these journals. One quarter of these articles appeared in the 84 journals listed in Table 2

below (we present similar lists in Chapter 4 where we present these data by Faculty). The data presented in Table 7 reveals some interesting trends:

1. It is not surprising that Plos One tops the list of journals in which most articles have been published. Plos One is one of the mega-journals in the publishing world and is now commonly found at the top of most frequently published in journals at most SA universities.
2. Out of the 84 journals, more than half are South African journals. Although many of these journals are now indexed in international bibliometric databases such as Web of Science and Scopus, there are still a sizeable number that are not. Again, we have found this trend to be consistent across the HE sectors where most academics still publishes the larger numbers of their papers in SA journals. However, this statement should be qualified as the distribution of foreign vs. local journals do vary significantly by discipline.
3. One of the 84 journals in the table (highlighted in green) was identified as a predatory journal and remains on the list of predatory journals by the DHET.

**Table 7: Journals in which the majority of SU articles were published**

| Journal | Nr of papers | Share | Cumulative share |
|---|---|---|---|
| PLoS ONE | 408 | 1,3% | 1,3% |
| South African Medical Journal (SAMJ) | 389 | 1,2% | 2,6% |
| Stellenbosch Theological Journal (STJ) | 305 | 1,0% | 3,5% |
| South African Journal of Higher Education | 226 | 0,7% | 4,3% |
| Scriptura | 190 | 0,6% | 4,9% |
| South African Journal of Science | 178 | 0,6% | 5,4% |
| International Journal of Tuberculosis and Lung Disease | 176 | 0,6% | 6,0% |
| HTS Teologiese Studies-Theological Studies | 171 | 0,5% | 6,5% |
| Cochrane Database of Systematic Reviews | 156 | 0,5% | 7,0% |
| South African Journal of Industrial Engineering | 154 | 0,5% | 7,5% |
| South African Family Practice: Official Journal of the South African Academy of Family Physicians | 146 | 0,5% | 8,0% |
| South African Journal of Botany | 145 | 0,5% | 8,5% |
| South African Journal of Enology and Viticulture | 144 | 0,5% | 8,9% |
| LitNet Akademies / Academic | 136 | 0,4% | 9,4% |
| Physical Review C - Nuclear Physics | 133 | 0,4% | 9,8% |
| Biological Invasions | 111 | 0,4% | 10,2% |
| African Entomology | 109 | 0,3% | 10,5% |
| Tydskrif Vir Geesteswetenskappe | 109 | 0,3% | 10,9% |
| South African Journal of Animal Science | 106 | 0,3% | 11,2% |
| Stellenbosch Law Review | 106 | 0,3% | 11,5% |
| Scientific Reports | 105 | 0,3% | 11,9% |
| African Journal of Primary Health Care and Family Medicine | 103 | 0,3% | 12,2% |
| Acta Horticulturae | 102 | 0,3% | 12,5% |
| South African Journal of Business Management | 98 | 0,3% | 12,8% |

| | | | |
|---|---|---|---|
| Lexikos | 92 | 0,3% | 13,1% |
| Defect and Diffusion Forum | 91 | 0,3% | 13,4% |
| BMJ Open | 87 | 0,3% | 13,7% |
| Pediatric Infectious Disease Journal | 84 | 0,3% | 14,0% |
| Meat Science | 82 | 0,3% | 14,2% |
| Old Testament Essays (New Series): Journal of the Old Testament Society of South Africa | 82 | 0,3% | 14,5% |
| South African Journal of Psychology | 81 | 0,3% | 14,8% |
| Corporate Ownership and Control | 80 | 0,3% | 15,0% |
| South African Journal of Plant and Soil | 80 | 0,3% | 15,3% |
| Water SA | 77 | 0,2% | 15,5% |
| Management Dynamics: Journal of the South African Institute for Management Scientists/Bestuursdinamika | 74 | 0,2% | 15,8% |
| Clinical Infectious Diseases | 72 | 0,2% | 16,0% |
| Scientia Militaria: South African Journal of Military Studies | 72 | 0,2% | 16,2% |
| South African Journal of Clinical Nutrition | 72 | 0,2% | 16,4% |
| South African Journal of Economics | 71 | 0,2% | 16,7% |
| AIDS Care - Psychological and Socio - medical Aspects of Aids/hiv | 69 | 0,2% | 16,9% |
| Journal of Economic and Financial Sciences | 69 | 0,2% | 17,1% |
| AIDS | 68 | 0,2% | 17,3% |
| Lecture Notes in Computer Science | 68 | 0,2% | 17,6% |
| Acta Crystallographica Section E: Structure Reports Online | 67 | 0,2% | 17,8% |
| Current Allergy and Clinical Immunology | 67 | 0,2% | 18,0% |
| Diversity And Distributions | 67 | 0,2% | 18,2% |
| Molecular Phylogenetics and Evolution | 66 | 0,2% | 18,4% |
| Stellenbosch Papers In Linguistics Plus / Spil Plus | 66 | 0,2% | 18,6% |
| Tuberculosis | 66 | 0,2% | 18,8% |
| South African Journal for Research in Sport, Physical Education and Recreation | 65 | 0,2% | 19,0% |
| Verbum Et Ecclesia | 64 | 0,2% | 19,2% |
| Journal of the SA Institution of Civil Engineering | 63 | 0,2% | 19,4% |
| Minerals Engineering | 63 | 0,2% | 19,6% |
| South African Journal of Physiotherapy | 63 | 0,2% | 19,8% |
| South African Journal of Psychiatry | 62 | 0,2% | 20,0% |
| Development Southern Africa | 60 | 0,2% | 20,2% |
| Acta Theologica | 59 | 0,2% | 20,4% |
| Biological Conservation | 59 | 0,2% | 20,6% |
| Scientia Horticulturae | 59 | 0,2% | 20,8% |
| Administratio Publica | 58 | 0,2% | 21,0% |
| Antimicrobial Agents and Chemotherapy | 57 | 0,2% | 21,2% |
| BMC Public Health | 57 | 0,2% | 21,4% |
| Journal For Studies in Economics and Econometrics | 57 | 0,2% | 21,5% |
| Journal of Agricultural and Food Chemistry | 56 | 0,2% | 21,7% |

| | | | |
|---|---|---|---|
| Journal of Chromatography A | 56 | 0,2% | 21,9% |
| South African Journal of Economic and Management Sciences | 56 | 0,2% | 22,1% |
| BMC Infectious Diseases | 55 | 0,2% | 22,3% |
| Studia Historiae Ecclesiasticae: Journal of the Church History Society of Southern Africa | 55 | 0,2% | 22,4% |
| Journal of Clinical Microbiology | 54 | 0,2% | 22,6% |
| Plant Disease | 54 | 0,2% | 22,8% |
| PLOS MEDICINE | 54 | 0,2% | 22,9% |
| Southern Forests: A Journal of Forest Science | 53 | 0,2% | 23,1% |
| Stellenbosch Theological Journal | 53 | 0,2% | 23,3% |
| African Journal of Health Professions Education | 52 | 0,2% | 23,5% |
| Agrekon | 52 | 0,2% | 23,6% |
| Applied Microbiology and Biotechnology | 52 | 0,2% | 23,8% |
| In Die Skriflig/in Luce Verbi | 52 | 0,2% | 24,0% |
| Journal of Acquired Immune Deficiency Syndromes (JAIDS) | 52 | 0,2% | 24,1% |
| Journal of Physics A: Mathematical and Theoretical | 52 | 0,2% | 24,3% |
| South African Law Journal | 52 | 0,2% | 24,5% |
| Precambrian Research | 51 | 0,2% | 24,6% |
| Acta Academica | 50 | 0,2% | 24,8% |
| Metabolic Brain Disease | 50 | 0,2% | 24,9% |
| Postharvest Biology and Technology | 50 | 0,2% | 25,1% |

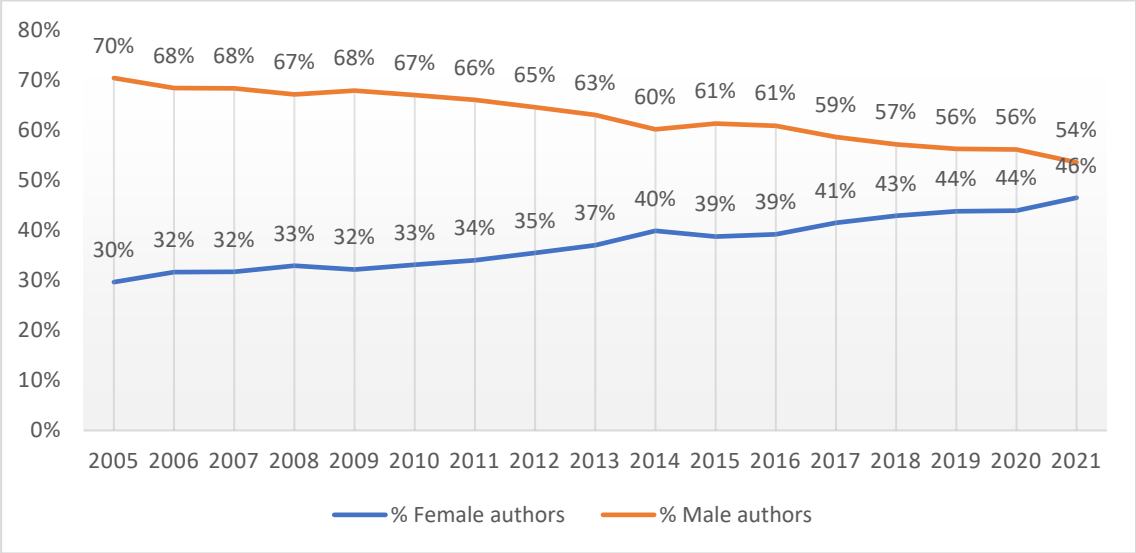
### 1.3.3 Trends in the demographics of journal article authors

Under a data sharing agreement with the DHET, CREST has over the years built a database (*SA Knowledgebase*) which contains all of the publications submitted to the DHET which qualify for subsidy. In SA Knowledgebase we have managed to link to the majority of authors key demographic variables (gender, race, country of birth, year of birth, academic title). This allows us to undertake analyses of the extent to which there are shifts in the participation and inclusion of especially black and women academics, scientists and students in the production of publications at SA universities. The figures below present the trends for these variables for SU.

#### *1.3.3.1 Gender of author*

The results of our analysis of the gender of all SU-authored papers over the past seventeen years shows a significant positive change over this period. Although the goal of reaching representative shares of men and women authors according to the distribution of academic staff in the HE sector (which is closer to 50:50) has not been reached, the trend is clearly in that direction. A comparison with the national percentages also shows that the percentage of 46% of women-authored papers at SU in 2021 is two percentage points higher than the sector average of 44%.

**Figure 3: Trends in the gender of SU-authors (2005 to 2021)**



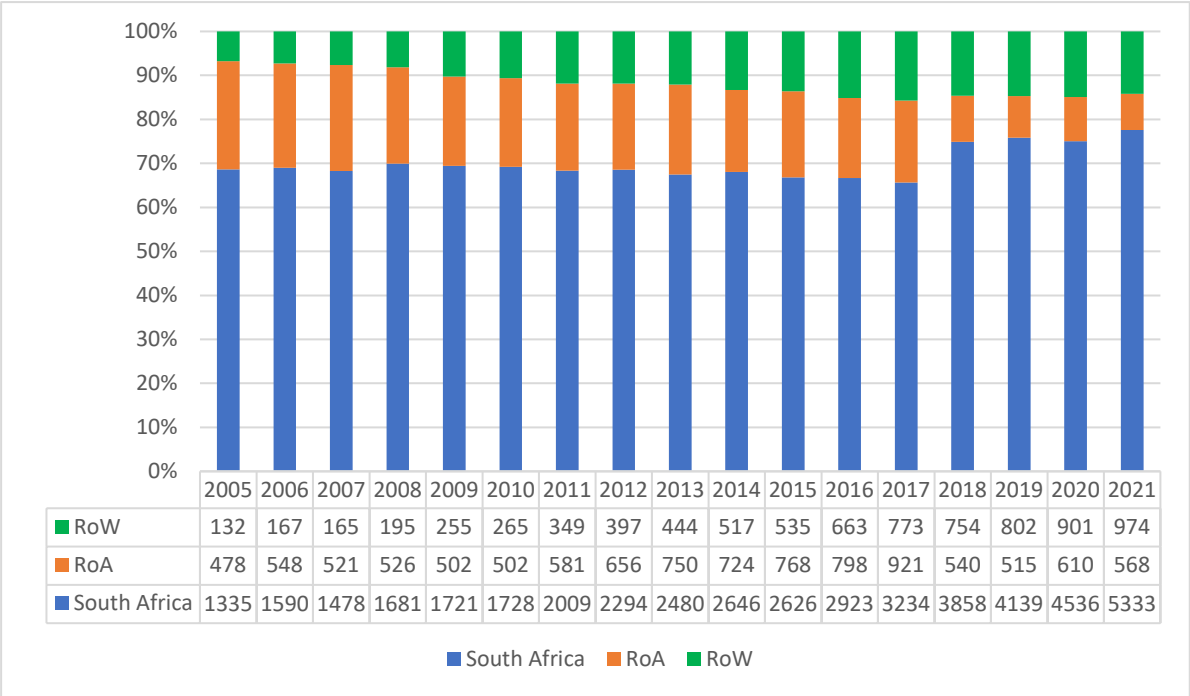

### *1.3.3.2 Country of birth of author*

The current available data in our database (even though more recently augmented from data received from the DHET) does not allow us to produce very accurate data on the race or population category of South African authors. This is due to two restrictions in the data: missing data on the country of birth of many authors and – more importantly – missing data on the residency status or nationality (citizenship) of the individual. According to the employment equity act, a classification of an individual in South African according to one of the four population categories (Black African, coloured, Indian/Asian or white) only applies to South African nationals. An individual that was born in a country other than South Africa can therefore not be assigned a 'race' classification unless he or she has been granted South African citizenship and self-identifies with one of the four categories above.

In this and the following section, we therefore only report (**Figure 3**) on the country of birth of SU authors (we have data for 89% of all authors) and the race of those who were born in South Africa (n = 3577). For the former, we recode the country of birth into three new categories: **South Africa**, **Rest of Africa** (all other recorded countries of birth on the African continent) and **Rest the World** (any author whose country of birth is outside Africa).

The findings presented in Figure 4 shows a significant contribution of staff members at SU to the overall publication output of the university by individuals from other countries. However, the trend also shows a more recent decline in their contribution to 8 % in 2021 compared to 25 % in 2005 Table 4 lists the most frequently listed countries of publishing authors at SU.

**Figure 4: Trends in the country of birth of SU-authors (2005 to 2021)**




| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RoW | 132 | 167 | 165 | 195 | 255 | 265 | 349 | 397 | 444 | 517 | 535 | 663 | 773 | 754 | 802 | 901 | 974 |
| RoA | 478 | 548 | 521 | 526 | 502 | 502 | 581 | 656 | 750 | 724 | 768 | 798 | 921 | 540 | 515 | 610 | 568 |
| South Africa | 1335 | 1590 | 1478 | 1681 | 1721 | 1728 | 2009 | 2294 | 2480 | 2646 | 2626 | 2923 | 3234 | 3858 | 4139 | 4536 | 5333 |

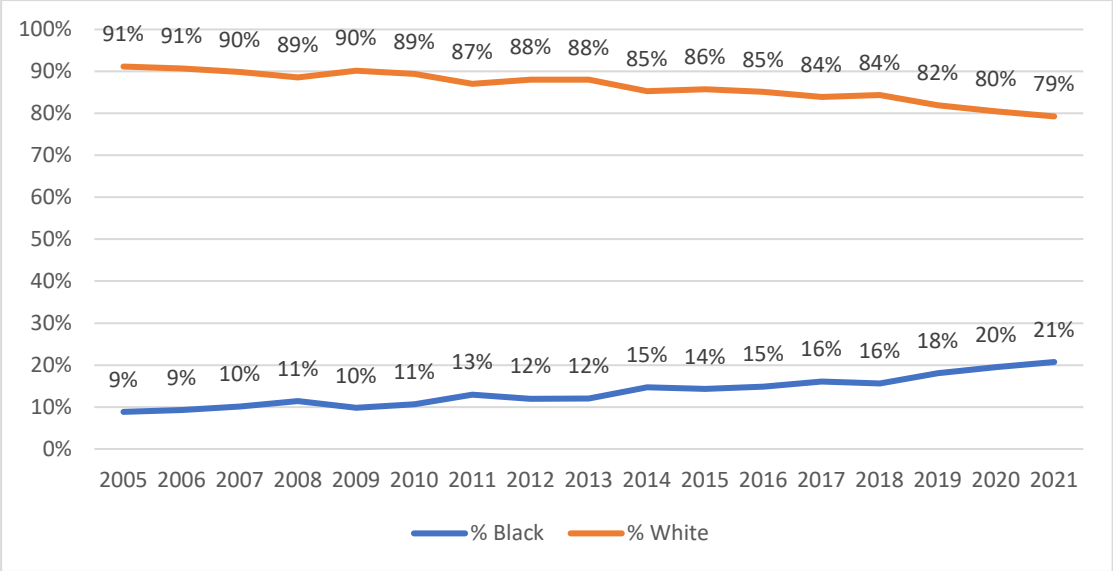
**Table 8: List of foreign countries with biggest contributions (more than 2% of total articles)**

| Country of birth | Number of authors | Share |
|---|---|---|
| Germany | 1408 | 12% |
| United Kingdom of Great Britain and Northern Ireland | 1014 | 9% |
| Nigeria | 960 | 8% |
| Zimbabwe | 877 | 7% |
| United States of America | 772 | 6% |
| Netherlands | 640 | 5% |
| China | 426 | 4% |
| Austria | 422 | 4% |
| France | 381 | 3% |
| Switzerland | 362 | 3% |
| India | 339 | 3% |
| Australia | 318 | 3% |

### *1.3.3.3 Race of author*

As explained in the previous section, the disaggregation by race only applies to South African nationals. The results in Figure 5 shows a slow but steady increase in the percentage of Black (Black African, Coloured, Indian) authors from 10% in 2005 to 20% in 2021. Although this a positive trend, the challenge remains that SU should continue to aim to produce publications that are more inclusive of Black academics and students.

**Figure 5: Share of black and white SU authors (2005 to 2021)**




### *1.3.3.4 Age of author*

The age of each author at the date (year) of publication of an article is calculate based on the year of birth which is captured in SA Knowledgebase. For ease of analysis, we subsequently recoded all records into six cage categories as presented in Figure 6 below.

**Figure 6: Production of articles by age category (2005 – 2021)**

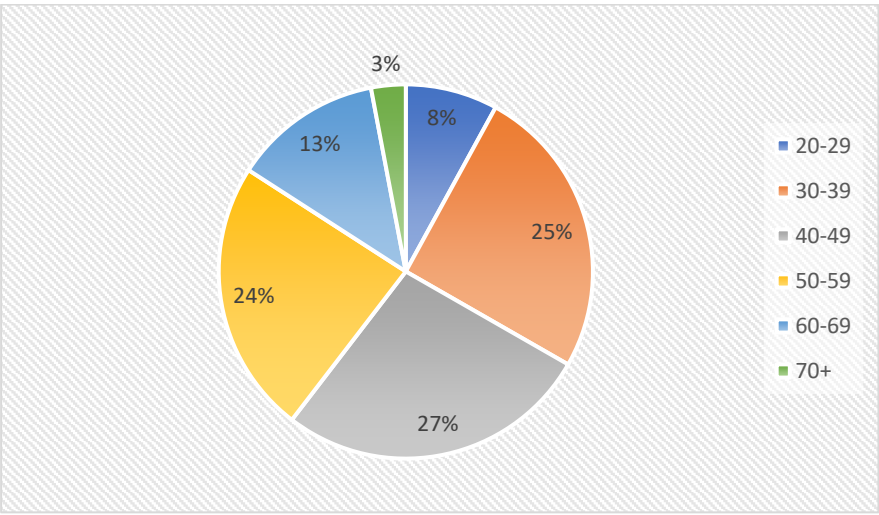
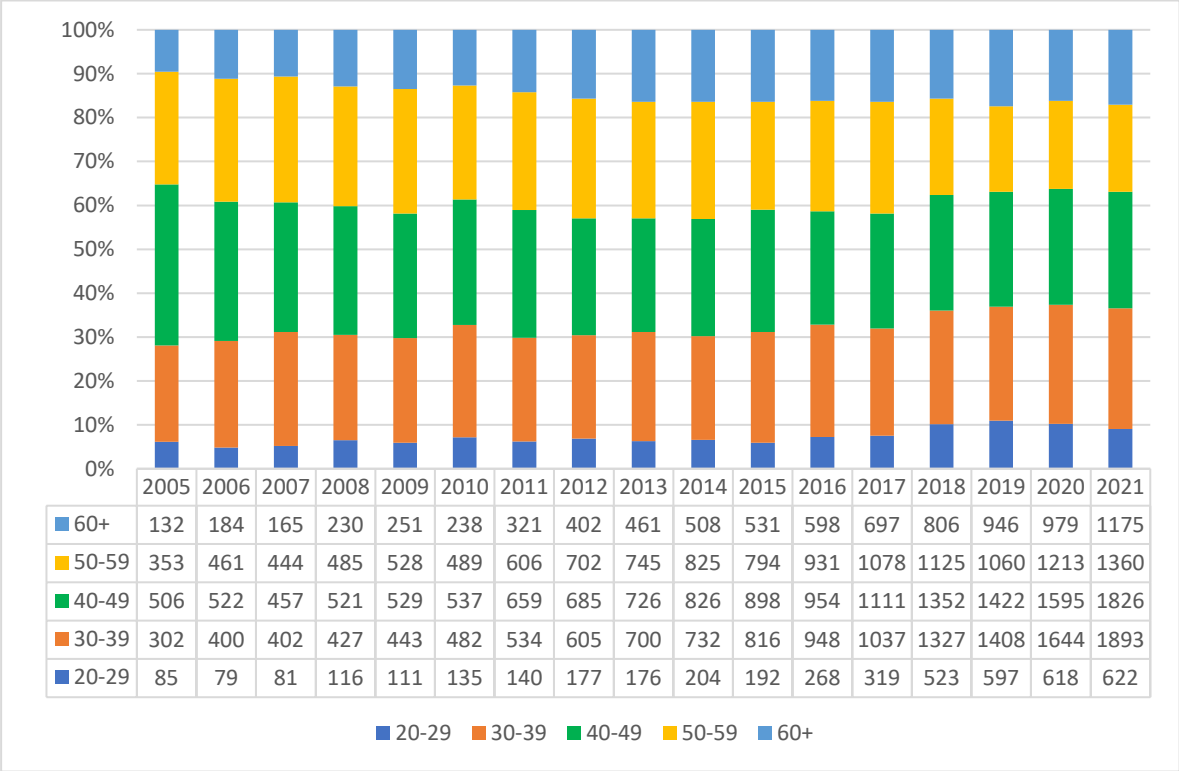


**Figure 7: Article shares of SU authors in ascending age categories (2005 to 2021)**




| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60+ | 132 | 184 | 165 | 230 | 251 | 238 | 321 | 402 | 461 | 508 | 531 | 598 | 697 | 806 | 946 | 979 | 1175 |
| 50-59 | 353 | 461 | 444 | 485 | 528 | 489 | 606 | 702 | 745 | 825 | 794 | 931 | 1078 | 1125 | 1060 | 1213 | 1360 |
| 40-49 | 506 | 522 | 457 | 521 | 529 | 537 | 659 | 685 | 726 | 826 | 898 | 954 | 1111 | 1352 | 1422 | 1595 | 1826 |
| 30-39 | 302 | 400 | 402 | 427 | 443 | 482 | 534 | 605 | 700 | 732 | 816 | 948 | 1037 | 1327 | 1408 | 1644 | 1893 |
| 20-29 | 85 | 79 | 81 | 116 | 111 | 135 | 140 | 177 | 176 | 204 | 192 | 268 | 319 | 523 | 597 | 618 | 622 |

**Salient points on the demographic trends in journal article output:**

- The contribution of women academics and students at SU has increased significantly over the reporting period to reach 46% in 2020. This is higher than the average percentage across all universities (44%) in the sector.
- As is the case with all SA universities, SU has also benefitted from the contribution to its knowledge production from staff and students who were not born in South Africa. Over the entire period foreign-born academics and staff contributed 29% to SU's publications. Authors from countries in Africa specifically contributed 16%. However, the most significant trend is the rapid decline in contributions from foreign-born authors and specifically from Africa (only 8%) in 2021.
- As far as population group or race is concerned, the data shows a steady increase in Black-authored papers: from producing 9% of all scientific articles in 2005, this percentage has more than doubled to 21% in 2021.
- The analysis of article production by age category has revealed a number of interesting trends as is the case in most universities in the world the most 'productive' age category is those between the ages of 40 and 49 (contributing 27% to SU output). What is interesting though is the significant contribution (16%) by authors 60 years and older (with 3% of articles produced by authors older then70 years). If we define an early career academic (as the DSI and DHET) as younger than 40, our data shows a positive trend. In 2005 28% of authors were 40 and younger; by 2021 this percentage has increased to 35%. Elsewhere in the report we analyse to what extent this shift is due to an increase in the number of post-graduate students and post-doctoral fellows contributing to the university's publication output.

## 1.4 Book, book chapters and conference proceedings

With the 2003 revision to the Publication Policy Framework, the DHET began awarding subsidies for books, book chapters and published conference proceedings. Universities would submit claims for these document types, not according to an accredited list, but according to the guidelines of the department which emphasized that all such claims need to be accompanied by evidence of peer review. Panels of experts appointed by the department would then review the submission and make a decision to approve or not.

**Table 9: Book and book chapter output units (2010 – 2021)**

| University | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UJ | 22,6 | 18,3 | 31,4 | 58,8 | 59,5 | 92,4 | 228,2 | 326,5 | 220,4 | 359 | 344,6 | 510,5 |
| WITS | 62,2 | 81 | 54,1 | 109,4 | 131,7 | 159,4 | 241,7 | 286,4 | 196,5 | 272,4 | 235,2 | 338,5 |
| SU | 54,9 | 34,2 | 91,6 | 105,4 | 116,2 | 78 | 284,9 | 266 | 280,5 | 327,7 | 444,5 | 304,6 |
| UP | 23,6 | 37,7 | 72,5 | 80,7 | 69,1 | 101,1 | 195,2 | 237,7 | 266,8 | 296 | 301,1 | 244,7 |
| NWU | 22,1 | 10,5 | 28,5 | 39,9 | 38,9 | 48,8 | 119 | 110 | 131,8 | 189,2 | 233,4 | 222,9 |
| UCT | 65 | 61,4 | 93,4 | 111,6 | 133,8 | 161,5 | 223,6 | 186 | 169,6 | 220 | 165,6 | 212,2 |
| UFS | 13,8 | 27,2 | 49,6 | 58,2 | 92,6 | 79,1 | 178,2 | 239,2 | 182,6 | 305,9 | 320,7 | 211,1 |
| UKZN | 68,1 | 53,1 | 64,6 | 79,1 | 53,8 | 66,5 | 275,5 | 128,1 | 176 | 156,8 | 131,2 | 201,0 |
| UNISA | 15,8 | 19,4 | 32,4 | 38,2 | 66,6 | 71,8 | 238,7 | 117,6 | 146,6 | 125,6 | 149,9 | 141,5 |
| RU | 9,6 | 25 | 35,5 | 20,2 | 56,8 | 48,1 | 47,2 | 99,2 | 94,9 | 65,8 | 54,5 | 105,8 |
| UWC | 21,5 | 10,3 | 12,4 | 29,6 | 26 | 29,3 | 94,3 | 53,2 | 45,4 | 68 | 32,2 | 90,1 |
| NMU | 9 | 8 | 4,2 | 5,1 | 7,2 | 10 | 30,8 | 22,5 | 35,5 | 21 | 67,1 | 55,7 |
| UL | 0 | 2,5 | 0,4 | 0 | 0,5 | 3,7 | 1,6 | 21,4 | 2,7 | 13,1 | 13,2 | 44,2 |
| DUT | 0 | 3,7 | 0,5 | 11,8 | 5,4 | 16,6 | 23,8 | 28,6 | 49,7 | 33,7 | 48,4 | 43,8 |
| UFH | 4,3 | 3,6 | 2,2 | 8,6 | 5,4 | 3 | 18,6 | 13,8 | 12 | 7,6 | 11 | 40 |
| UNIZULU | 0,5 | 0 | 0 | 0 | 0,7 | 4,5 | 5,2 | 24,9 | 17,4 | 19,1 | 16,2 | 36,4 |
| CPUT | 1 | 1 | 0,1 | 2,5 | 2,4 | 6 | 11,9 | 25,8 | 13,9 | 32 | 12,3 | 28,1 |
| VUT | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 2,7 | 4,7 | 8,1 | 18,4 |
| SPU | | | | | | | | | | 4,6 | 2,3 | 12,4 |
| MUT | 0 | 0 | 0 | 0,5 | 0,5 | 0 | 1,3 | 0,8 | 0 | 0,5 | 0,4 | 12,3 |
| TUT | 0,7 | 4,2 | 0,3 | 2,3 | 4,4 | 3 | 10,5 | 6,5 | 3,9 | 8,2 | 0,4 | 6,7 |
| UNIVEN | 6,7 | 9,5 | 7,1 | 7,6 | 7,1 | 10,8 | 23,3 | 8,4 | 10,8 | 6,7 | 12,6 | 5,9 |
| WSU | 0,3 | 1,6 | 0 | 4,3 | 0 | 0,1 | 1 | 1,1 | 0,7 | 4,5 | 12,8 | 5,8 |
| UMP | | | | | 0 | 0 | 0 | 0 | 3,3 | 1,7 | 2,9 | 3,5 |
| CUT | 0 | 0,4 | 0 | 0,4 | 0,7 | 1,1 | 9,9 | 3,2 | 6,2 | 9,5 | 4,6 | 1,6 |
| SMU | | | | | 0,2 | 0 | 0,6 | 1 | 0 | 1,2 | 1 | 0 |

In Figure 8 we present the data on subsidy-units awarded for SU for books/chapters and conference proceedings over the reporting period. Because of the relatively small samples, the year-to-year fluctuations are relatively large with overall CAGR of 19.8%. However, the general trend shows an increase in these categories.

**Figure 8: Publication of books and book chapters: 2005 – 2021 (CAGR = 19.8%)**

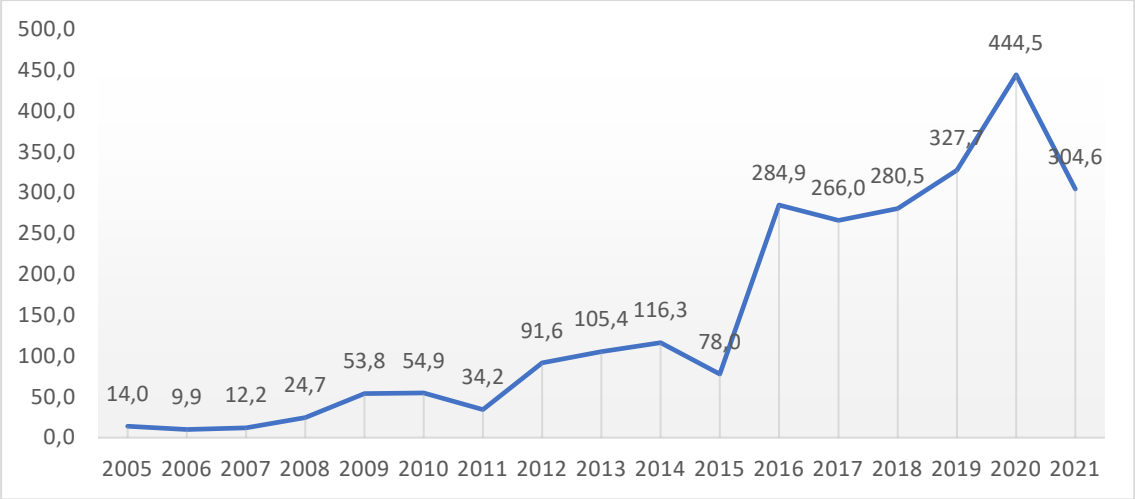
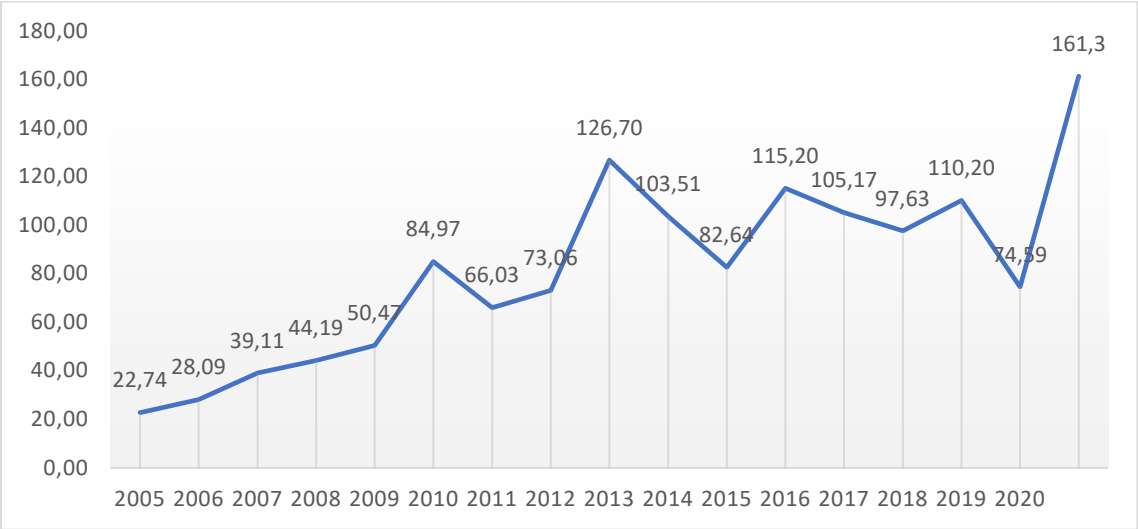



**Figure 9: Production of published conference proceedings (CAGR = 12,13%)**



# CHAPTER 2: HISTORICAL BENCHMARKING OF MASTERS' AND DOCTORAL OUTPUT AT SU

## 2.1 Introduction

In this Chapter we present the results of our analyses of the 'production' of two other categories of knowledge outputs under the DHET subsidy-framework, viz. research masters' and doctoral graduates. In each case, we first present the overall trend in output of these two categories for the period 2005 to 2021, followed by further analyses where we disaggregate the results by gender, region (coded on the basis of country of birth) and race. The disaggregated data was sourced from HEMIS and cover the period 2000 to 2020.

## 2.2 Overall production of Masters' graduates

We first present the data on the research masters' graduate subsidy-units (rounded off) awarded to SU in Figure 10 as reported under the DHET publication output framework. Masters' graduates whose research thesis does not constitute 100% of the credit, are calculated proportionally.

These figures need to be compared with the total headcount of Masters' graduates that SU produced between 2000 and 2020. This data is summarized in Figure 10 (overleaf) which also includes the data on new and total enrolments. A comparison between these two graphs suggests that the number of research Masters' may have stabilized around 900 per year (with 2021 being an exceptionally good year). For all Masters' students the overall number of graduates may be declining (which suggest that the decline is actually in the number of course work (fully or partially) Masters. What is promising is the recent growth in new Masters' enrolments.

**Figure 10: SU Research masters' graduates (DHET publications data): 2005 to 2021**

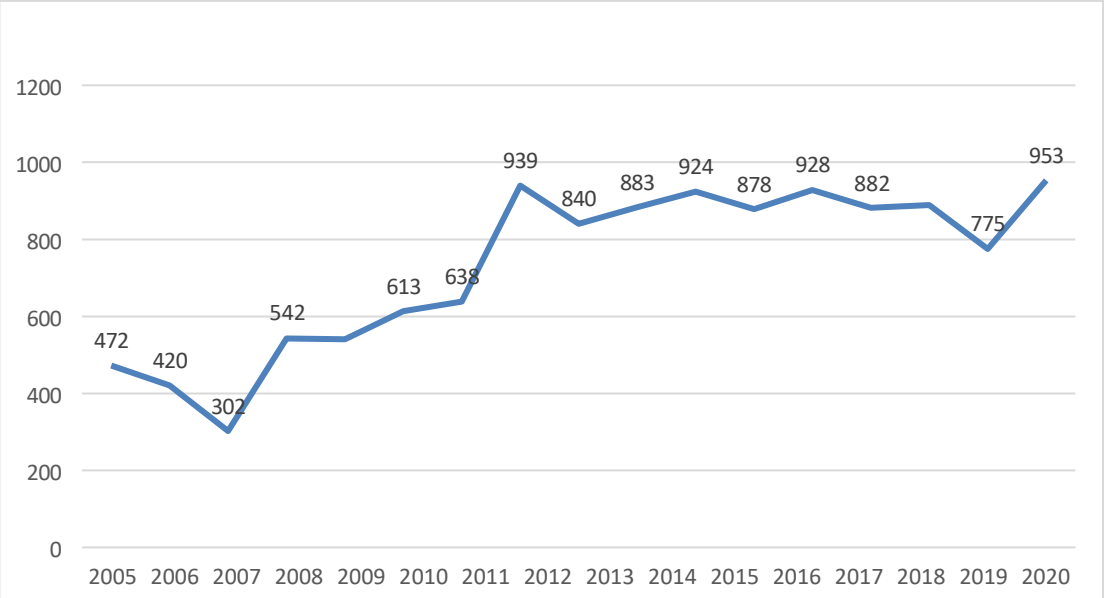
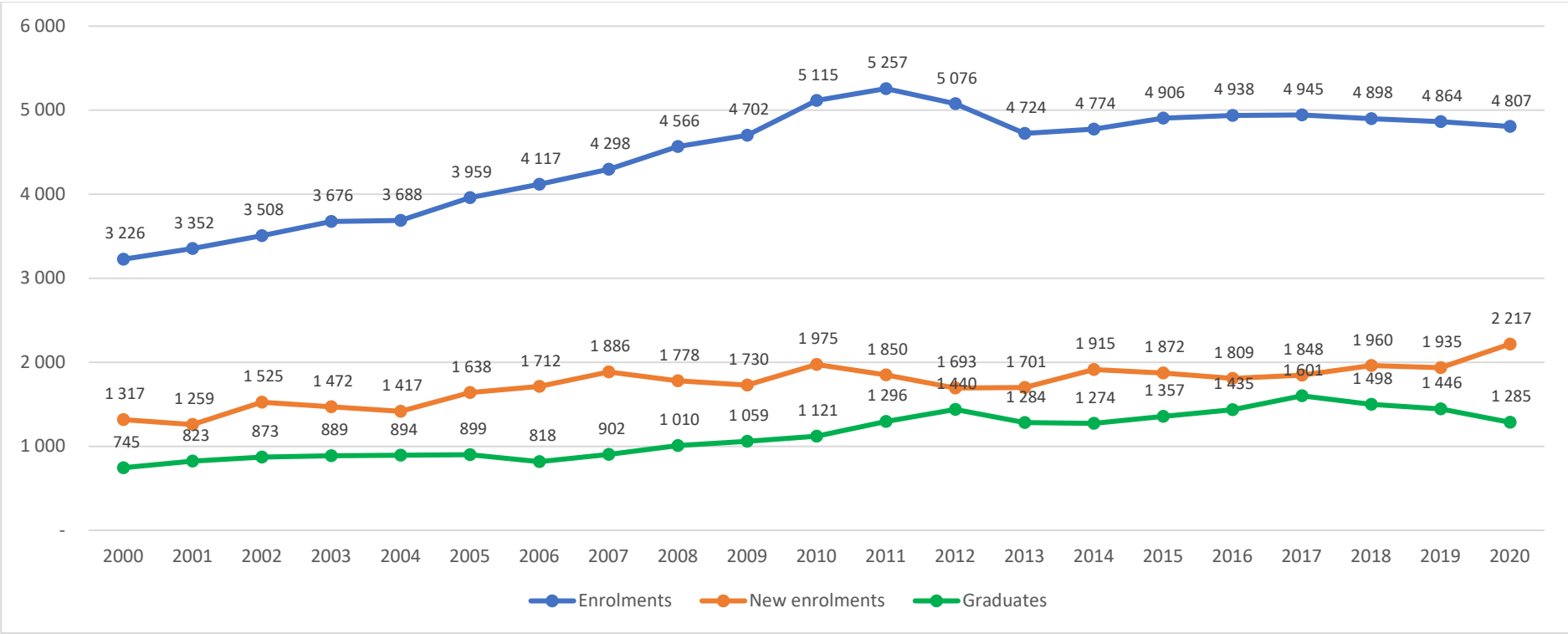
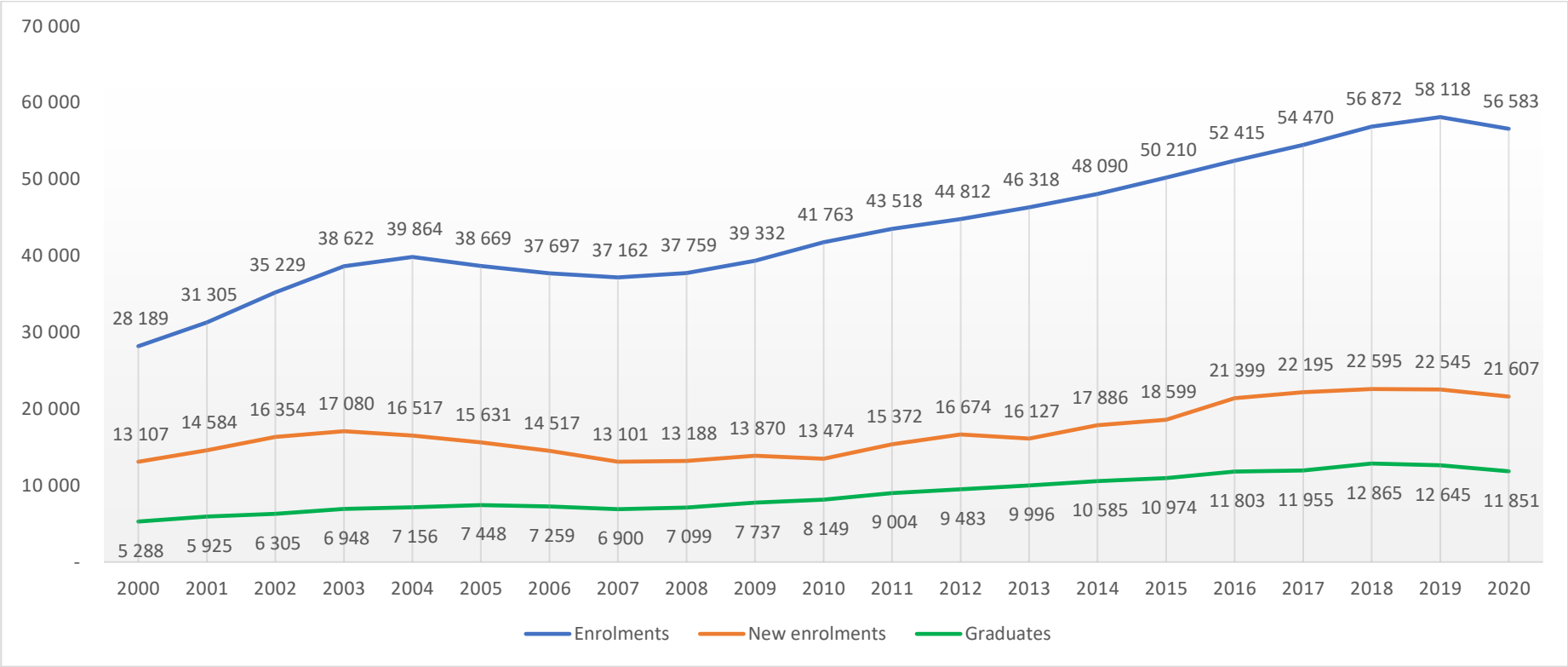


**Figure 11: SU Masters' enrolments and graduates (2000 to 2020)**




The profile of SU should be interpreted within the larger context of the HE sector's production of Masters' students. In Figure 11 below we present the long-term trends in national Masters' enrolments and graduates. It is clear that the trends as far as new enrolments should be cause for concern with no real growth recorded since 2017. In the case of SU, it is very clear that there is an increasingly worrying declining trend in Masters' graduates since 2017. The only small consolation is that the increase in new enrolments in 2020 (if continued) may reverse this trend in the next year or two. The possible reasons behind this trend at SU and the sector at large can be multiple (increased cost of PG studies, decline in number of students from the rest of Africa enrolling at SA universities, and so on). Given the national picture, the fact that SU is still attracting increased numbers of Masters' enrolments is noteworthy and laudable.

**Figure 12: Long term trends in enrolments and graduations of all Masters' students at all South African universities**[1]



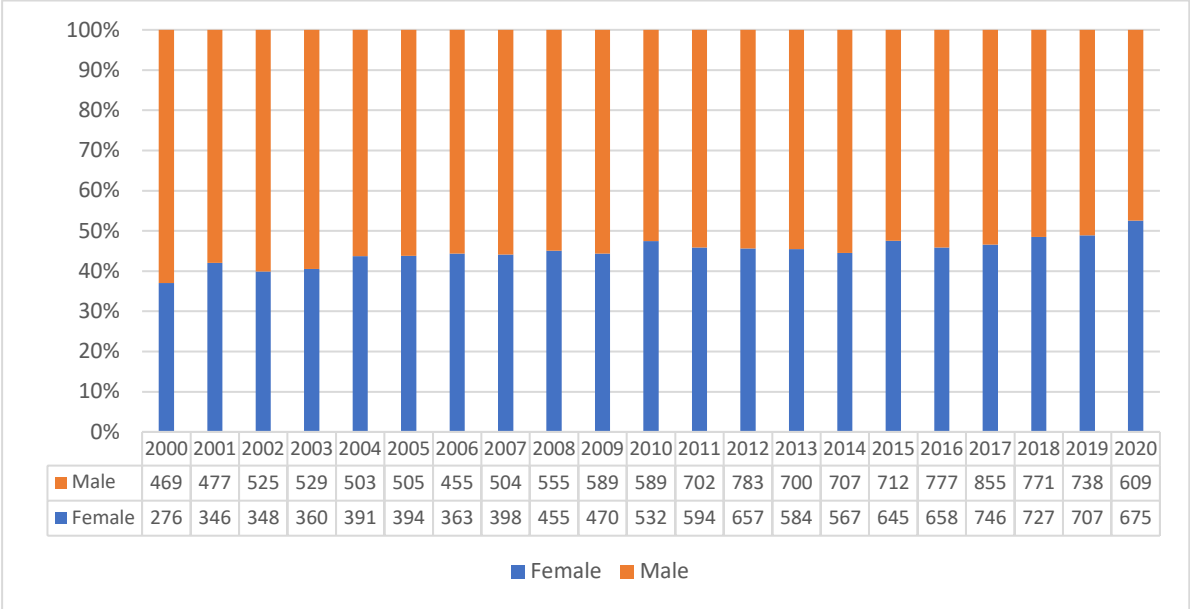

In the next graphs, we disaggregate the trends in the number of Masters' graduates at SU by gender, region and population group.

[1] Because of serious data errors in the data from UNISA, this graph excluded the UNISA data

## 2.3 Demographic profile of all Masters' graduates at SU: Gender

The recent decline in Masters' graduates (from a high of 1601 in 2017 to 1285 in 2021) has not had the same impact across female and male graduates. For the first time in 2021, the number of female Masters' graduates exceeded that of their male counterparts (675 women versus 609 men). However, this result is mostly a function of the steeper decline in the number of male versus female graduates and not because of a sustained growth in the number of female graduates since 2018.

**Figure 13: SU Masters graduates by gender: 2000 - 2020**

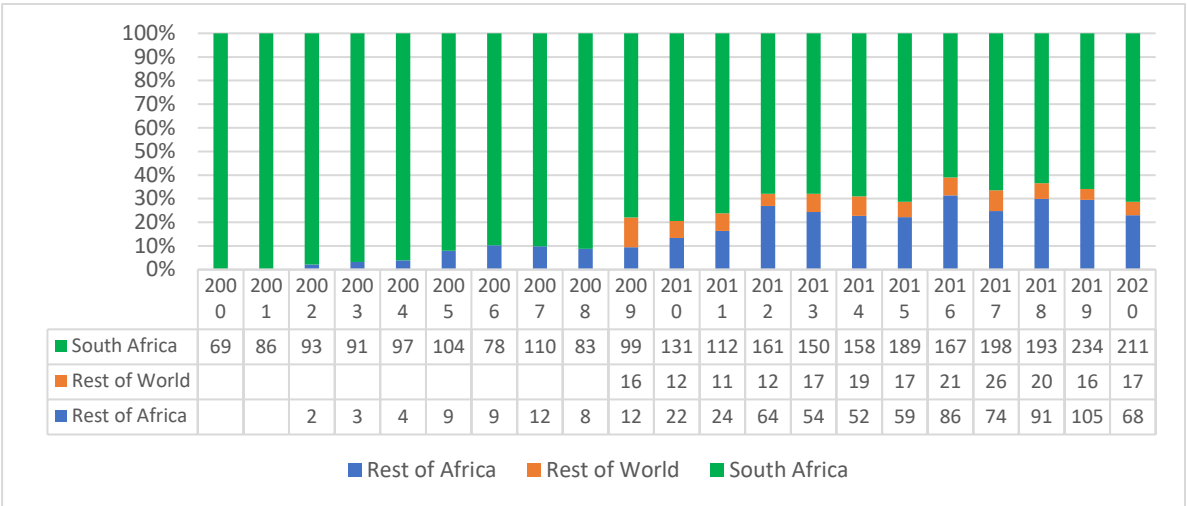



| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Male | 469 | 477 | 525 | 529 | 503 | 505 | 455 | 504 | 555 | 589 | 589 | 702 | 783 | 700 | 707 | 712 | 777 | 855 | 771 | 738 | 609 |
| Female | 276 | 346 | 348 | 360 | 391 | 394 | 363 | 398 | 455 | 470 | 532 | 594 | 657 | 584 | 567 | 645 | 658 | 746 | 727 | 707 | 675 |

## 2.4 Demographic profiles of Masters' graduates at SU: Region

SU, like most other South African universities, benefit from post-graduate enrolments from foreign students. The trend in Figure 14 shows that SU attracted significant number of students from Africa and the rest of the world which peaked around 2016 at 40% of total number of graduates. Since then, there has been a slow decline in foreign graduates. It is possible that financial reasons as well as the difficulties in getting study visas may drive this decline. It is also likely that this trend may continue as the potential negative effect of COVID is not yet evident in these data.

**Figure 14: SU Masters' graduates by region of origin (2000 to 2020)**

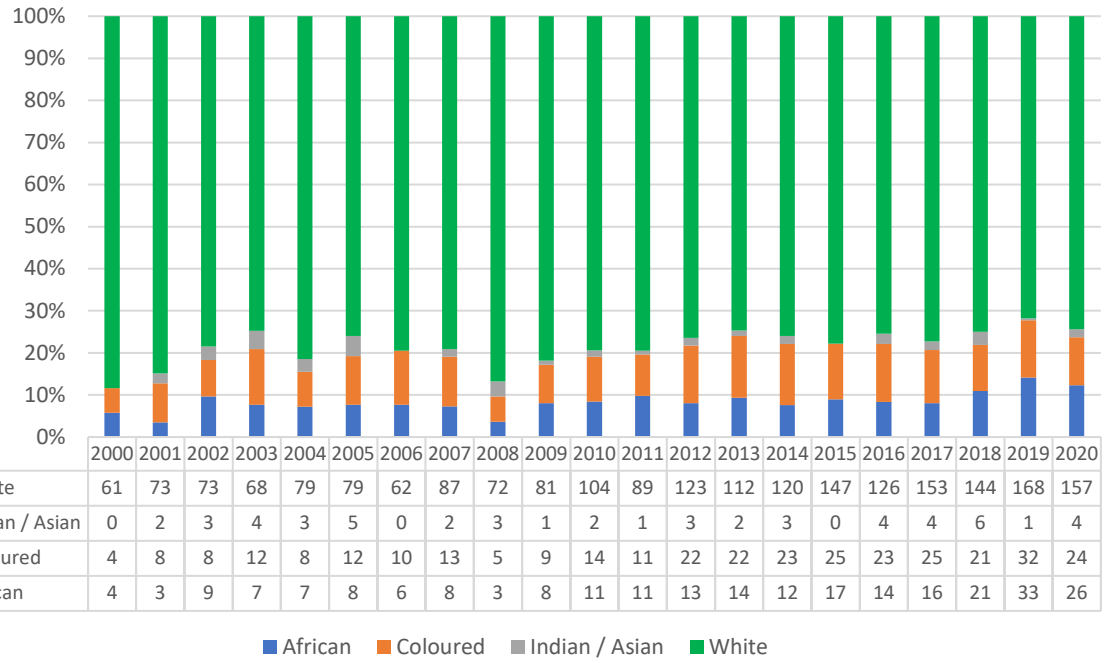



| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South Africa | 69 | 86 | 93 | 91 | 97 | 104 | 78 | 110 | 83 | 99 | 131 | 112 | 161 | 150 | 158 | 189 | 167 | 198 | 193 | 234 | 211 |
| Rest of World | | | | | | | | | | 16 | 12 | 11 | 12 | 17 | 19 | 17 | 21 | 26 | 20 | 16 | 17 |
| Rest of Africa | | | 2 | 3 | 4 | 9 | 9 | 12 | 8 | 12 | 22 | 24 | 64 | 54 | 52 | 59 | 86 | 74 | 91 | 105 | 68 |

## 2.5 Demographic profile of Masters' graduates at SU: Race (SA Nationals only)

The overall trend in terms of the race of our Masters' graduates over the past 21 years is a positive one with the percentage of Black (Africa, Coloured and Indian) students increasing their share of the total number of graduates from 10% in 2000 to 24% in 2020.

**Figure 15: Race of SU Masters' graduates (2000 – 2020)**




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| White | 61 | 73 | 73 | 68 | 79 | 79 | 62 | 87 | 72 | 81 | 104 | 89 | 123 | 112 | 120 | 147 | 126 | 153 | 144 | 168 | 157 |
| Indian / Asian | 0 | 2 | 3 | 4 | 3 | 5 | 0 | 2 | 3 | 1 | 2 | 1 | 3 | 2 | 3 | 0 | 4 | 4 | 6 | 1 | 4 |
| Coloured | 4 | 8 | 8 | 12 | 8 | 12 | 10 | 13 | 5 | 9 | 14 | 11 | 22 | 22 | 23 | 25 | 23 | 25 | 21 | 32 | 24 |
| African | 4 | 3 | 9 | 7 | 7 | 8 | 6 | 8 | 3 | 8 | 11 | 11 | 13 | 14 | 12 | 17 | 14 | 16 | 21 | 33 | 26 |

**Concluding comments**

Our analysis of the trends in both research Masters' and all categories of Masters' students presents a mixed picture. As far as the number of graduates are concerned, overall production of Masters' graduates has been declining in recent years, although the most recent count of research Masters' has increased. This may be because of a trend in many academic departments to move away from coursework or taught Masters' programmes to research degrees in order to qualify for the research output subsidy of the DHET. The demographic trends as far as gender and race are concerned are most positive and needs to be maintained where possible. More detailed analyses at the Faculty and Departmental level (which falls outside the scope of this study) will increasingly be required to provide the required evidence for targeted interventions for our Masters' students. It is also clear from the trends at the national level that the competition of high quality Maters' students may be increasing. This fact, coupled with the rather negative and in some cases, devastating effects, of the NRF Funding Policy, will require a strategic and systematic plan of action to ensure that SU maintains sufficient levels of growth whilst increasing the inclusivity of our students.

## 2.6 Doctoral graduate production: Doctoral students

In this section we produce the results of trends in the production of doctoral graduates at SU. However, in order to contextualise the trends at SU within the bigger national picture, we present the trends in doctoral enrolments and graduations for the sector first.

### *2.6.1 Sectoral doctoral enrolments and graduates (2005 to 2020)*

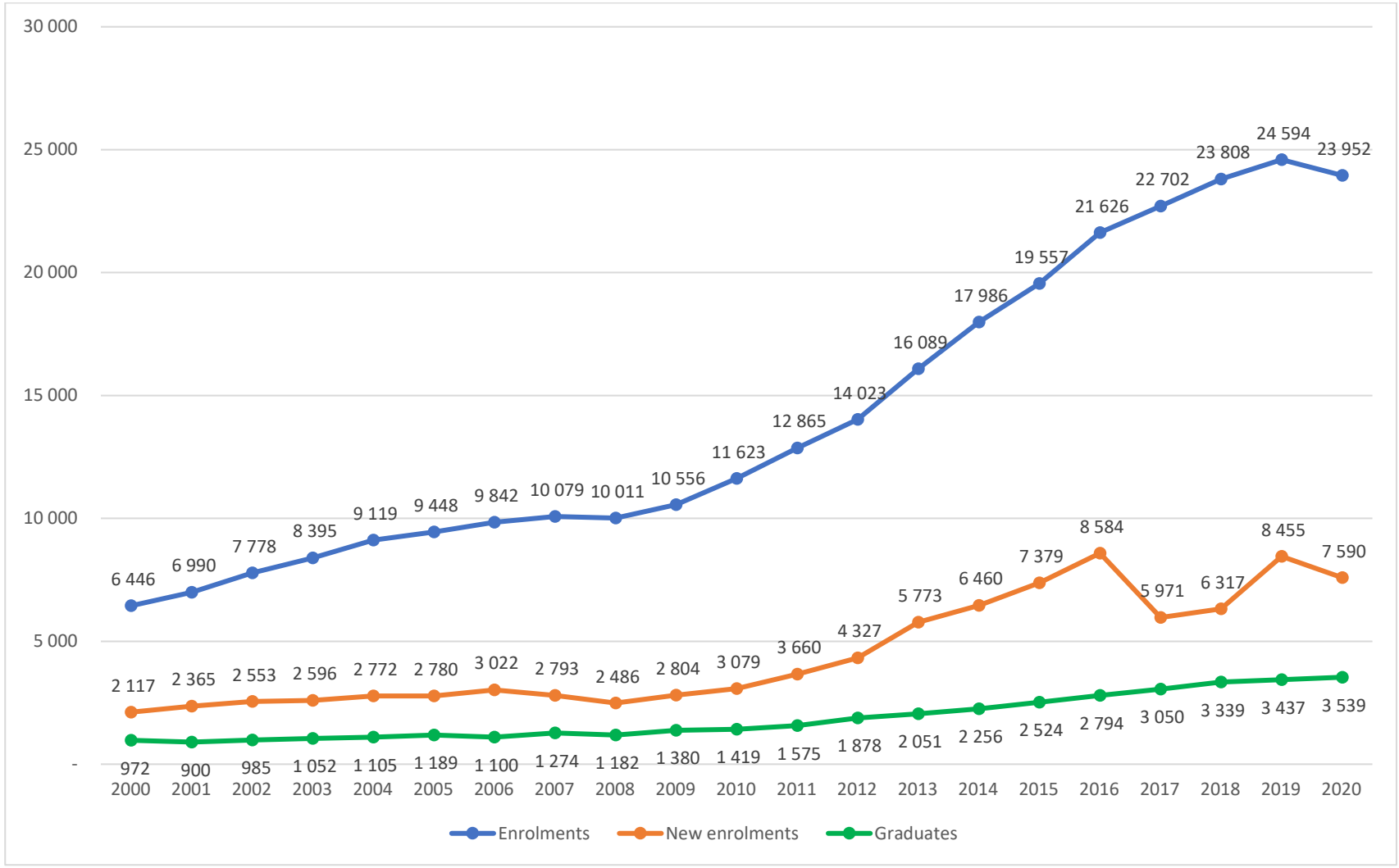
In a number of national policy documents including the 2019 White Paper on STI Policy and the recently released Decadal Plan for 2021 – 2031, a target of 5 000 doctoral graduates for the country has been set. Until 3 – 4 years ago, it seemed as if this target may in fact be reached as the rate of growth in doctoral graduates (as well as new doctoral enrolments) had been increasing for some time.

However, this picture has changed dramatically since 2016. In Figure 15 (overleaf) we see that the number of new doctoral enrolments has been declining steadily and has reached a new low of 5 864 in 2020[2]. Because of the fact that the average doctoral student takes about 4.5 years to complete his or her doctoral studies, this decline is only now starting to show at the level of graduates where the rate of increase has cleared slowed down considerably since 2018 and is effectively stagnating.

The most recent figures released by the DHET to CREST shows that the number of doctoral graduates in 2021 stood at 3 532 which in fact is less than the figure for 2020 (3539). This is the first year in the past two decades that the number of doctoral graduates has shown a decline – even if very small. Given the decline in the new enrolments, it now seems likely that the number of doctoral graduates in the new future will in all likelihood also start to decline (keeping in mind again that the full impact of COVID, loss of students from the rest of Africa and continued economic recession are not reflected in the most recent data.

[2] There is a major problem about the data reported from UNISA for new enrolments that seems to be embedded in the HEMIS data. The data for the number of doctoral graduates seem to be correct.

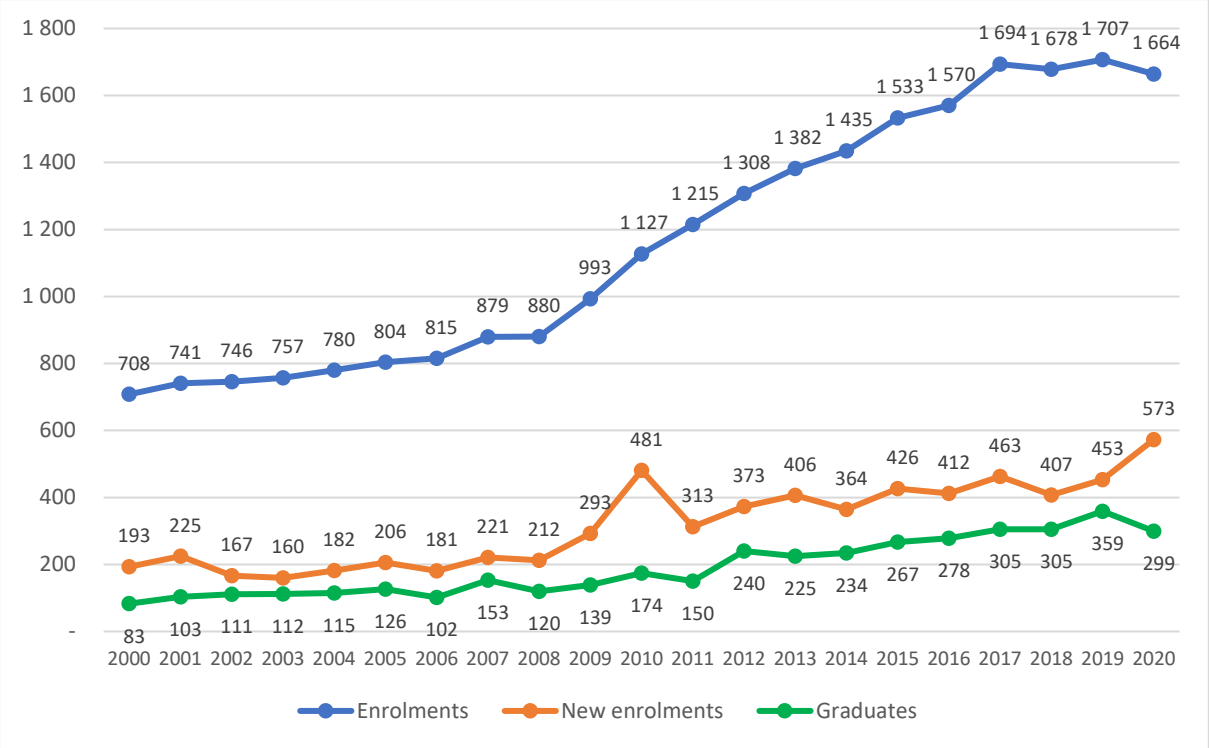
**Figure 16: HE Sector doctoral enrolments and graduates (2000 to 2020)**



### *2.6.2 Production of doctoral graduates at SU: Overall trend 2000 to 2020)*

When we turn to SU, the overall trend – both in enrolments and graduates – is more positive. The exception is the decline in doctoral graduates in 299. Data that CREST received from DHET recently showed that SU will receive subsidy for 307 students which reflects a small improvement. We do not as yet have the official numbers of new doctoral enrolments.

**Figure 17: SU doctoral enrolments and graduates: 2005 to 2021**




It is insightful to compare the recent trends in doctoral graduates for the top universities to see whether there are any large shifts. The result displayed in Table 10 show that the year-to-year changes at the majority of the universities are not extreme. UJ is the exception with sustained growth over this period. UNISA also displays some larger year to year fluctuations but there are some questions about the quality of the HEMIS data for UNISA.

The annual output of SU which hovers around 300 compares well with the much larger universities above it on the table and is consistently higher than UCT which is of a similar size.

**Table 10: Trends in doctoral graduates of the top universities (2017 to 2021)**

| University | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|
| UKZN | 388 | 497 | 451 | 487 | 445 |
| UNISA | 286 | 296 | 334 | 422 | 421 |
| UP | 354 | 424 | 399 | 374 | 367 |
| WITS | 283 | 280 | 291 | 321 | 316 |
| SU | 305 | 305 | 359 | 299 | 307 |
| UCT | 277 | 195 | 261 | 276 | 274 |
| UJ | 126 | 189 | 223 | 224 | 266 |
| NWU | 235 | 248 | 314 | 251 | 264 |
| UFS | 127 | 138 | 128 | 113 | 161 |
| UWC | 120 | 124 | 126 | 123 | 123 |

### *2.6.3 Demographic profile of SU doctoral graduates: Gender*

In the next two figures we first show the trend for SU doctoral graduates when disaggregated gender for the period 2000 and 2020 (Figure 18). The next Figure (Figure 19) presents the national picture. The results for Stellenbosch – 47% female graduates – are higher than the sector percentage of 43% in 2021. A comparison of the past three years also shows that SU performs consistently better in terms of the representation of women doctoral graduates.

**Figure 18: SU doctoral graduates disaggregated by gender: 2005 to 2020.**

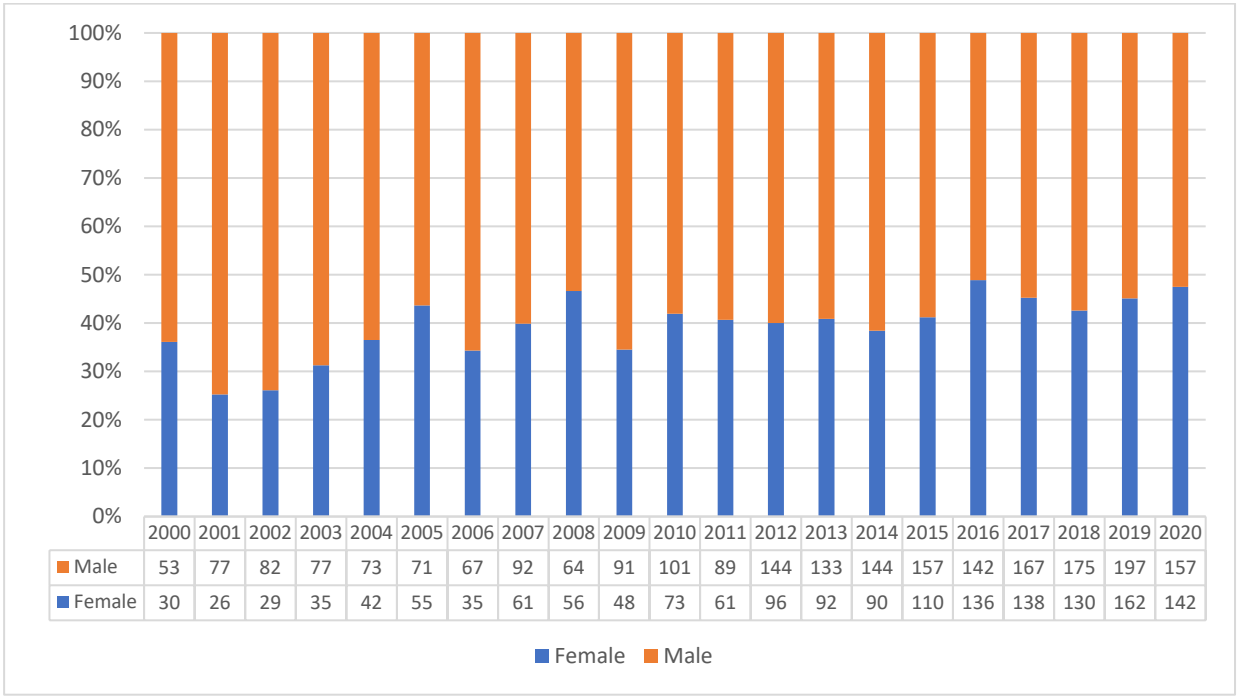
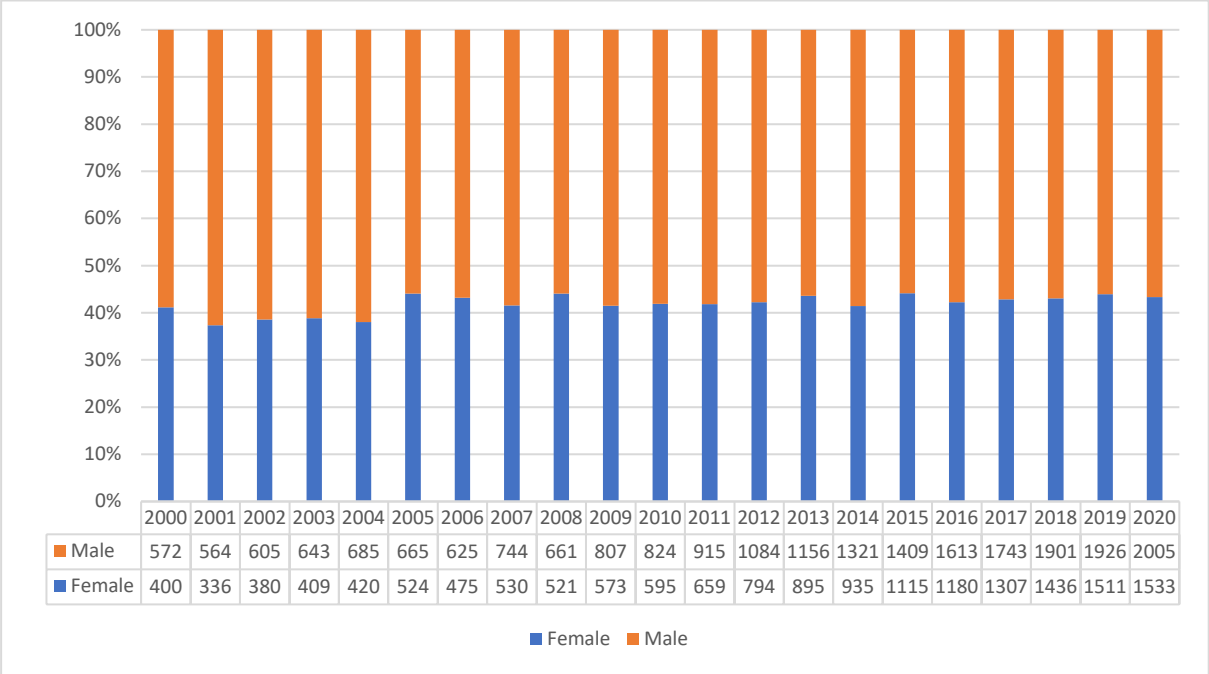


**Figure 19: Sector numbers of doctoral graduates disaggregated by gender: 2005 to 2020.**

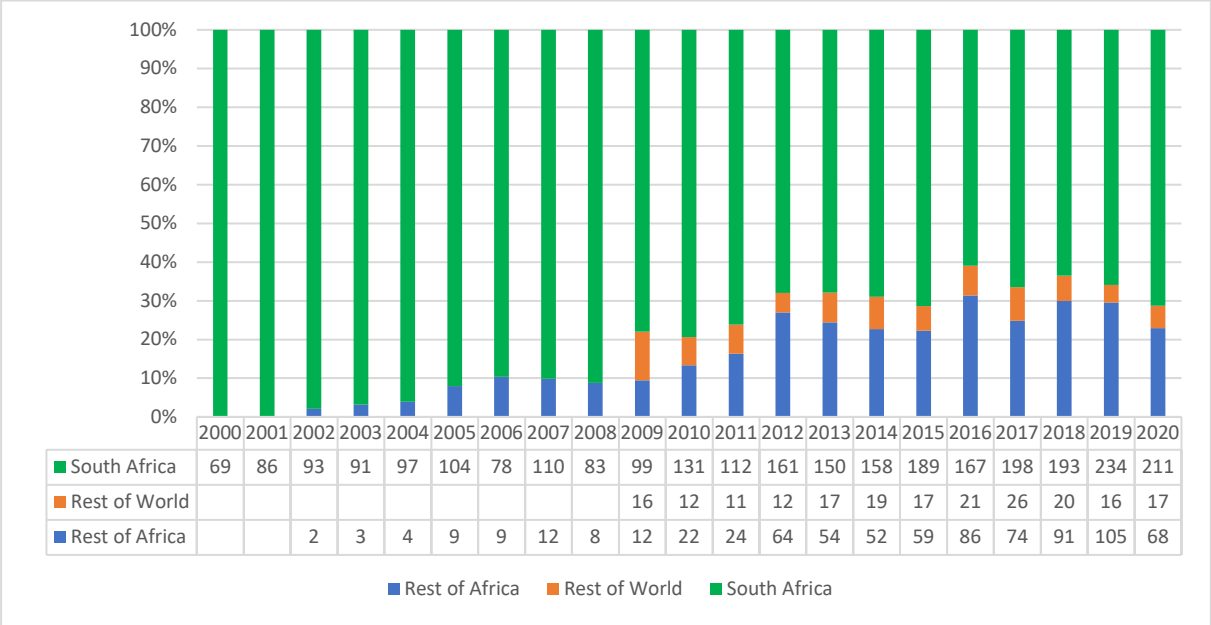



| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Male | 572 | 564 | 605 | 643 | 685 | 665 | 625 | 744 | 661 | 807 | 824 | 915 | 1084 | 1156 | 1321 | 1409 | 1613 | 1743 | 1901 | 1926 | 2005 |
| Female | 400 | 336 | 380 | 409 | 420 | 524 | 475 | 530 | 521 | 573 | 595 | 659 | 794 | 895 | 935 | 1115 | 1180 | 1307 | 1436 | 1511 | 1533 |

### *2.6.4 Demographic profile of SU doctoral graduates: Region*

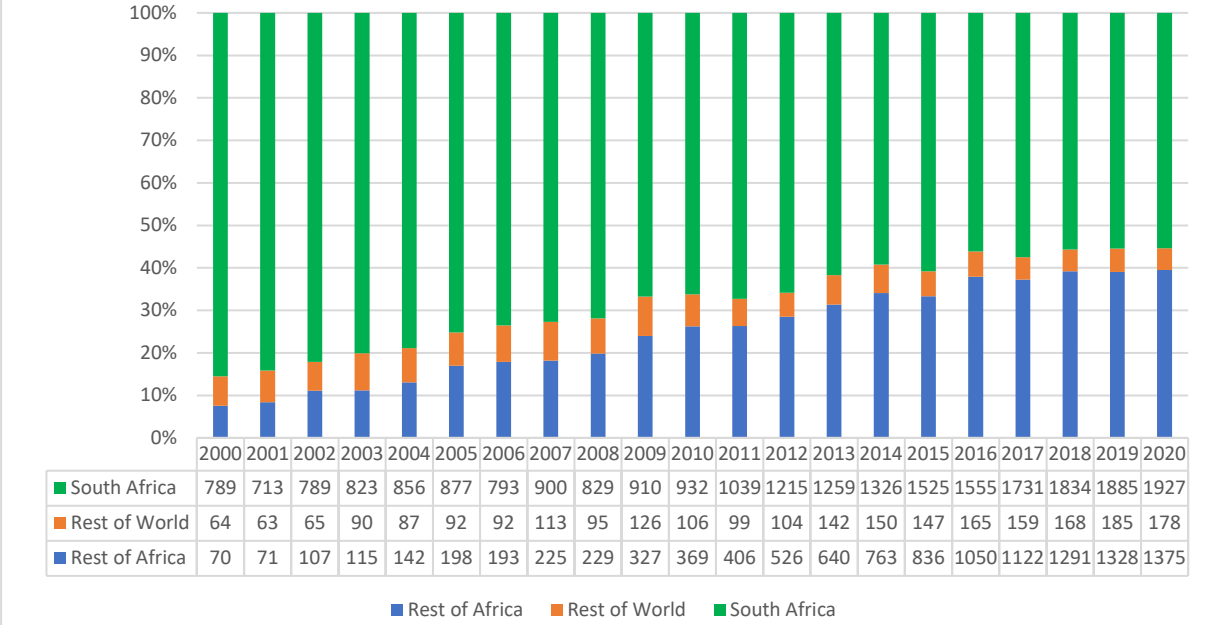
In the next two figures we first show the trend for SU doctoral graduates when disaggregated by region (recoded from country of birth) for the period 2000 and 2020 (Figure 20). The next Figure (Figure 21) presents the national picture. The results for Stellenbosch are interesting as it shows and increasing gain of student graduates from the rest of African and the world up to 2016 which has been followed by a steady decline to less than 30% in 2020. A comparison with the national trends shows that the trend at SU is quite different from the rest of the country where the number of doctoral graduates from outside South Africa continues to increase albeit at a slower rate in recent years. Further analysis by scientific field (amongst others) is required to establish what may be the cause of this.

**Figure 20: SU doctoral graduates disaggregated by region: 2005 to 2020.**




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South Africa | 69 | 86 | 93 | 91 | 97 | 104 | 78 | 110 | 83 | 99 | 131 | 112 | 161 | 150 | 158 | 189 | 167 | 198 | 193 | 234 | 211 |
| Rest of World | | | | | | | | | | 16 | 12 | 11 | 12 | 17 | 19 | 17 | 21 | 26 | 20 | 16 | 17 |
| Rest of Africa | | | 2 | 3 | 4 | 9 | 9 | 12 | 8 | 12 | 22 | 24 | 64 | 54 | 52 | 59 | 86 | 74 | 91 | 105 | 68 |

**Figure 21: Sector trends in number of doctoral graduates disaggregated by region: 2005 to 2020**

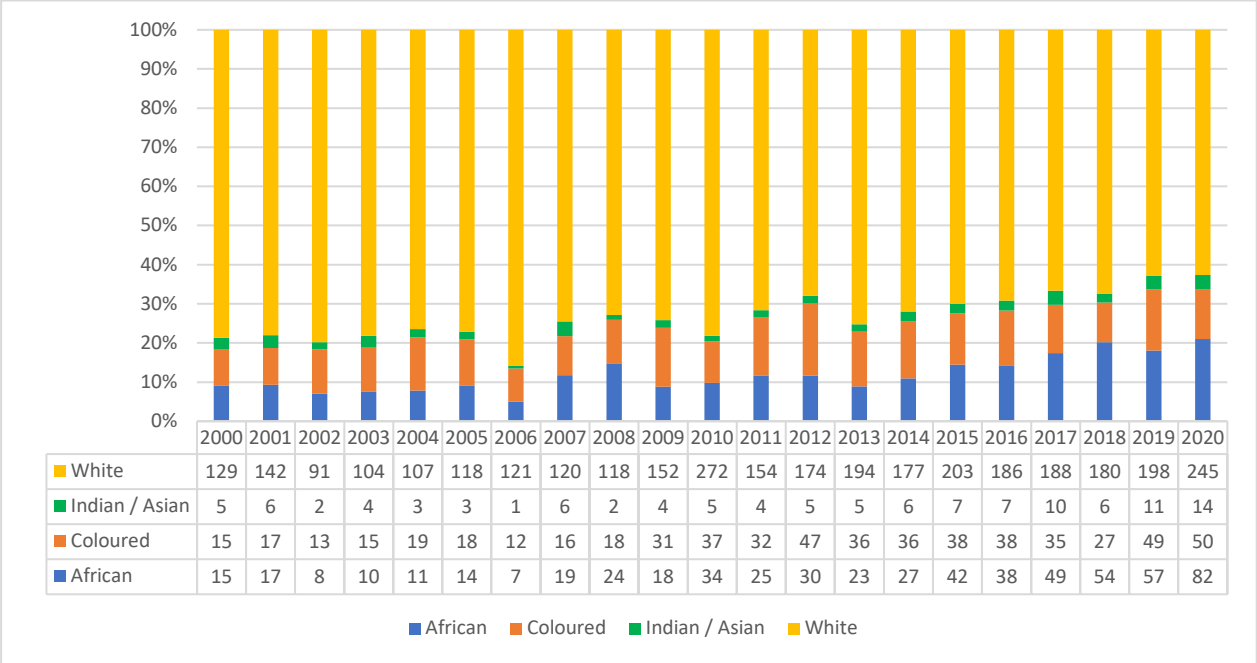



| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South Africa | 789 | 713 | 789 | 823 | 856 | 877 | 793 | 900 | 829 | 910 | 932 | 1039 | 1215 | 1259 | 1326 | 1525 | 1555 | 1731 | 1834 | 1885 | 1927 |
| Rest of World | 64 | 63 | 65 | 90 | 87 | 92 | 92 | 113 | 95 | 126 | 106 | 99 | 104 | 142 | 150 | 147 | 165 | 159 | 168 | 185 | 178 |
| Rest of Africa | 70 | 71 | 107 | 115 | 142 | 198 | 193 | 225 | 229 | 327 | 369 | 406 | 526 | 640 | 763 | 836 | 1050 | 1122 | 1291 | 1328 | 1375 |

### *2.6.5 Demographic profile of SU graduates: Race (SA nationals)*

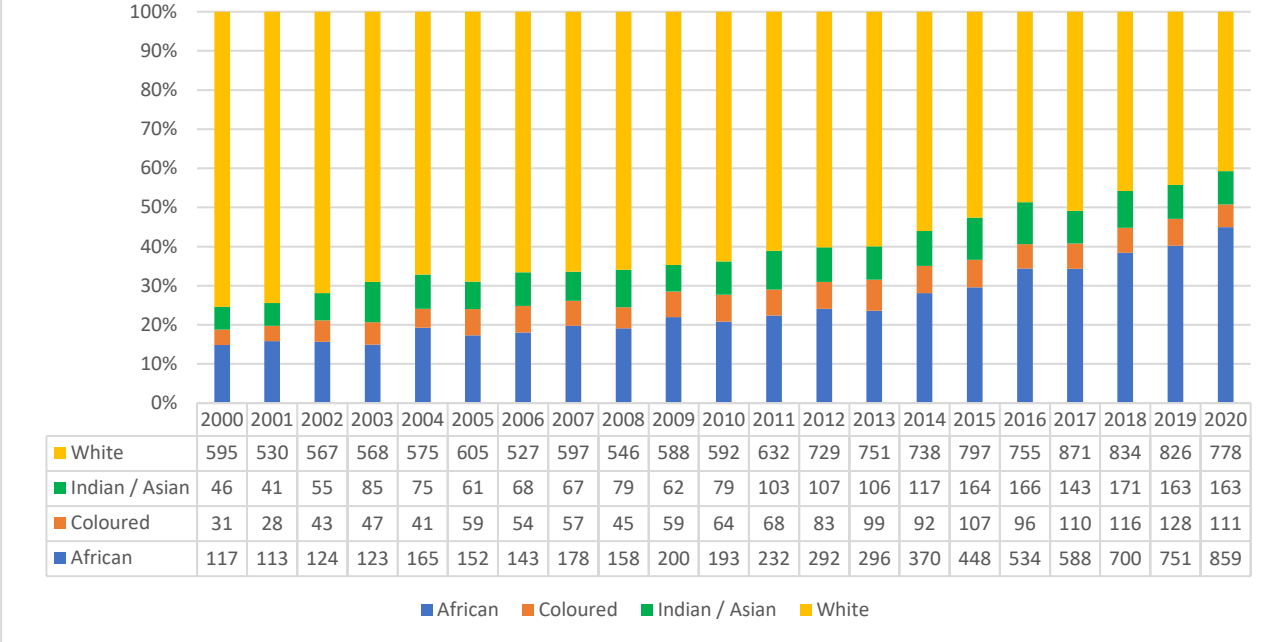
The results show that SU has managed to increase the percentage of black doctoral graduates from 20% in 2000 to 35% in 2020. Although this is a significant achievement, the comparison with the national picture shows that there is still some room for improvement. In 2021 the percentage of Black doctoral graduates nearly reached 60%. Again, further analysis of the distribution of these black graduates by scientific field and university is required in order to have more robust evidence to design interventions to improve the representation of black students at SU at this level.

**Figure 22: SU doctoral graduates disaggregated by race (2000 to 2020)**




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| White | 129 | 142 | 91 | 104 | 107 | 118 | 121 | 120 | 118 | 152 | 272 | 154 | 174 | 194 | 177 | 203 | 186 | 188 | 180 | 198 | 245 |
| Indian / Asian | 5 | 6 | 2 | 4 | 3 | 3 | 1 | 6 | 2 | 4 | 5 | 4 | 5 | 5 | 6 | 7 | 7 | 10 | 6 | 11 | 14 |
| Coloured | 15 | 17 | 13 | 15 | 19 | 18 | 12 | 16 | 18 | 31 | 37 | 32 | 47 | 36 | 36 | 38 | 38 | 35 | 27 | 49 | 50 |
| African | 15 | 17 | 8 | 10 | 11 | 14 | 7 | 19 | 24 | 18 | 34 | 25 | 30 | 23 | 27 | 42 | 38 | 49 | 54 | 57 | 82 |

**Figure 23: Sector number of doctoral graduates disaggregated by race (2000 to 2020)**




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| White | 595 | 530 | 567 | 568 | 575 | 605 | 527 | 597 | 546 | 588 | 592 | 632 | 729 | 751 | 738 | 797 | 755 | 871 | 834 | 826 | 778 |
| Indian / Asian | 46 | 41 | 55 | 85 | 75 | 61 | 68 | 67 | 79 | 62 | 79 | 103 | 107 | 106 | 117 | 164 | 166 | 143 | 171 | 163 | 163 |
| Coloured | 31 | 28 | 43 | 47 | 41 | 59 | 54 | 57 | 45 | 59 | 64 | 68 | 83 | 99 | 92 | 107 | 96 | 110 | 116 | 128 | 111 |
| African | 117 | 113 | 124 | 123 | 165 | 152 | 143 | 178 | 158 | 200 | 193 | 232 | 292 | 296 | 370 | 448 | 534 | 588 | 700 | 751 | 859 |

# CHAPTER 3: SU RESEARCH PERFORMANCE BY FACULTY

## 3.1 Introduction

Research performance in all its forms – publication practices, research collaborations and citation strategies – varies significantly across scientific fields and disciplines. Within universities faculties or schools house more cognate disciplines where teaching and research are more closely linked. However, even within Faculty boundaries, vast differences in the research activities of the departments and centres remain. A good example is the Faculty of Arts and Social Sciences (FASS) which houses eighteen departments that range from the visual and performing arts, to humanities and more empirical social sciences. In addition, these disciplines can also be distinguished between more 'basic' disciplines such as History, Philosophy and Sociology and the more professional disciplines such as Social Work and Clinical Psychology.

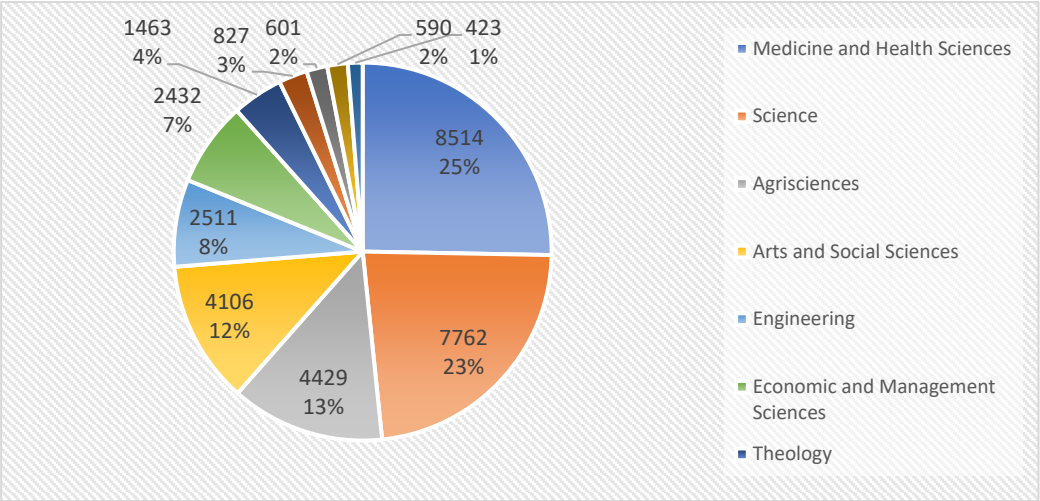
In this chapter we discuss the research performance of the university through the lens of the faculties which can be interpreted as the 'administrative' or 'organisational' lens. Such a perspective is often useful for the strategic research planning that happens within the faculties. But as we will see even within faculties disciplinary differences matter. It would have been ideal to disaggregate our data to the level of individual departments and research centres. Unfortunately, the time to do this was not available neither is the quality of the data at the departmental level of such a nature (at this stage) sufficient to conduct such more granular analyses.

Out of the 64 426 individual authorship records for the university, we did manage to link the authors of these articles to 63 586 (or 98.7%) to a faculty. The initial quality of the data was such that it took three assistants more than a month to clean the data and look up department names to enable the linking to Faculty. This was a specific challenge for articles published before 2015. In addition, it is worth noting that names of departments and centre change over time, departments merged and, in some case, move to other faculties.

## 3.2 Research output by Faculty at a glance

The working file for this Chapter consists of the 63 586 authorships which translates into 33 658 unique articles. Figure 23 overleaf presents the breakdown by Faculty in descending order from highest to lowest. In assigning papers to Faculty, we had to create a category (General) for articles which were not produced within Faculties. A significant percentage of this category are articles produced by fellows at STIAS, but also includes articles produced by units such as the Language Centre, the Centre for Teaching and Learning, Student Counselling and so on. In the remainder of the chapter, we have excluded this small number of articles from our analyses.

**Figure 24: Number of unique articles by Faculty (2005 to 2021)**




It is clear from Figure 24 that two faculties (Medicine and Health Sciences and the Science Faculty) dominate research publication output at the university. Together with two other 'medium-sized' research faculties (Agriscience and Arts and Social Sciences) they produced nearly 75% of total output over the past seventeen years. It is not surprising that the more 'profession-orientated' faculties such as Engineering, Economic and Management Sciences, Education, Law and Theology all make smaller contributions to the overall research output. It is worth stating that this distribution of articles by Faculty is typical universities which have a comprehensive academic offering. At most SA universities with a Medical Faculty or School, papers in the field of Medicine and Health Sciences would predominate followed by the natural sciences faculties.

The article output by Faculty by year for the period 2005 to 2021 is presented in Table 12 overleaf. An inspection of the data shows that the overall compound annual growth rate in articles across the university for this period was 6.91%. But very different growth rates were recorded for individual Faculties. The very high rate of growth of Military Science is due to a very low base of output in 2005. The two Faculties which performed extremely well (Medicine and Health Sciences and Engineering) with CAGR scores above the university average. We present the individual trendlines for each Faculty (grouped by size) below the summary table on the next page.

**Table 11: CAGR-values in descending order by Faculty (2005 – 2021)**

| Faculty | CAGR |
|---|---|
| Military Science | 12,16% |
| Medicine and Health Sciences | 10,53% |
| Engineering | 9,48% |
| Average across all faculties | 6,91% |
| Agrisciences | 6,67% |
| Economic and Management Sciences | 6,14% |
| Science | 4,76% |
| Arts and Social Sciences | 4,13% |
| Theology | 3,99% |
| Education | 3,74% |
| Law | 0,37% |

**Table 12: Article output by Faculty and Year (2005 to 2021)**

| Faculty | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | Total | CAGR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Medicine and Health Sciences | 220 | 250 | 256 | 294 | 332 | 294 | 368 | 437 | 469 | 510 | 524 | 562 | 607 | 640 | 765 | 895 | 1091 | 8514 | 10,53% |
| Science | 269 | 325 | 271 | 301 | 377 | 391 | 474 | 445 | 451 | 515 | 461 | 556 | 642 | 565 | 561 | 592 | 566 | 7762 | 4,76% |
| Agrisciences | 138 | 163 | 141 | 166 | 177 | 217 | 209 | 240 | 277 | 257 | 267 | 298 | 323 | 374 | 378 | 416 | 388 | 4429 | 6,67% |
| Arts and Social Sciences | 156 | 176 | 157 | 206 | 192 | 159 | 205 | 225 | 240 | 266 | 246 | 338 | 342 | 320 | 279 | 301 | 298 | 4106 | 4,13% |
| Engineering | 69 | 82 | 96 | 84 | 75 | 100 | 103 | 108 | 169 | 133 | 144 | 187 | 195 | 212 | 239 | 221 | 294 | 2511 | 9,48% |
| Economic and Management Sciences | 84 | 84 | 83 | 110 | 81 | 89 | 103 | 127 | 163 | 163 | 183 | 154 | 172 | 192 | 213 | 213 | 218 | 2432 | 6,14% |
| Theology | 61 | 77 | 78 | 69 | 87 | 73 | 71 | 85 | 90 | 103 | 93 | 82 | 96 | 73 | 111 | 100 | 114 | 1463 | 3,99% |
| Education | 35 | 34 | 47 | 47 | 49 | 50 | 55 | 59 | 32 | 56 | 42 | 42 | 58 | 62 | 50 | 46 | 63 | 827 | 3,74% |
| Military Science | 11 | 13 | 12 | 9 | 18 | 9 | 11 | 26 | 18 | 37 | 40 | 52 | 25 | 103 | 75 | 73 | 69 | 601 | 12,16% |
| Law | 33 | 33 | 26 | 29 | 25 | 20 | 23 | 39 | 44 | 46 | 39 | 42 | 38 | 32 | 41 | 45 | 35 | 590 | 0,37% |
| **Grand Total** | **1076** | **1237** | **1167** | **1315** | **1413** | **1402** | **1622** | **1791** | **1953** | **2086** | **2039** | **2313** | **2498** | **2573** | **2712** | **2902** | **3136** | **33235** | **6,91%** |

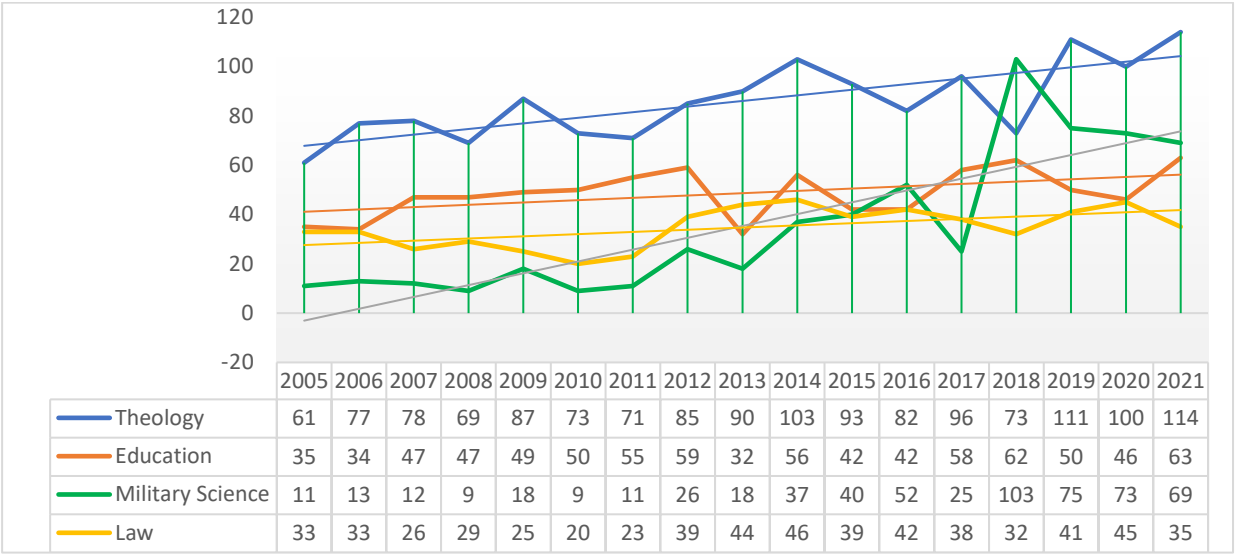
## 3.3 In-depth analysis of the research performance (articles only) of faculty groupings

### 3.3.1 Small and predominantly professional training faculties

In this section I look more closely at trends in the publication of journal articles by grouping of faculties where these groupings are more homogenous. More specifically I distinguish between smaller and larger faculties (in terms of article output and numbers of authors) as well as between faculties that are predominantly if not exclusively devoted to high-level professional education and those where the majority of departments house the basic or more fundamental scientific disciplines.

The first grouping consists of the Faculties of Law, Military Science, Education and Theology. The graph presents the trends in article output over time and then look more closely at the trends in productivity rates (paper per author output) over time.

**Figure 25: Trends in article output (Smaller/Professional Education Faculties)**




| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Theology | 61 | 77 | 78 | 69 | 87 | 73 | 71 | 85 | 90 | 103 | 93 | 82 | 96 | 73 | 111 | 100 | 114 |
| Education | 35 | 34 | 47 | 47 | 49 | 50 | 55 | 59 | 32 | 56 | 42 | 42 | 58 | 62 | 50 | 46 | 63 |
| Military Science | 11 | 13 | 12 | 9 | 18 | 9 | 11 | 26 | 18 | 37 | 40 | 52 | 25 | 103 | 75 | 73 | 69 |
| Law | 33 | 33 | 26 | 29 | 25 | 20 | 23 | 39 | 44 | 46 | 39 | 42 | 38 | 32 | 41 | 45 | 35 |

The first grouping of Faculties is all nearly predominantly dedicated to train professionals (Lawyers/ Dominees/ Teachers/School principals/Military personnel). They are also the four smallest faculties in terms of research output and – with the exception of Military Science which started at a very low base of 11 articles in 2005 – all recorded the smallest CAGR-values. The trend lines for the faculties would suggest that, unless there are fundamental changes in the organisational design of these faculties – for example the establishment of more dedicated research centres or the addition of more staff, post-doctoral fellows and post-graduate students – it is more than likely that the current fairly low growth trajectories will be maintained in the near future.

What is common to these Faculties, is that the available human resources or knowledge-productive capacity is relatively small. In science and specifically in research publication output size matters! In the table below we show how many authors (academics, post-docs, students, visiting fellows) produced the annual article output of each faculty over the reporting period.

**Table 13: Nr of unique contributing authors and articles by Faculty by year: Law, Military Science, Education and Theology**

| Faculty | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAW_Authors | 19 | 18 | 18 | 14 | 15 | 13 | 13 | 27 | 26 | 24 | 26 | 30 | 25 | 23 | 29 | 37 | 28 |
| LAW_Articles | 33 | 33 | 26 | 29 | 25 | 20 | 23 | 39 | 44 | 46 | 39 | 42 | 38 | 32 | 41 | 45 | 35 |
| Article productivity ratio | 1,7 | 1,8 | 1,4 | 2,1 | 1,7 | 1,5 | 1,8 | 1,4 | 1,7 | 1,9 | 1,5 | 1,4 | 1,5 | 1,4 | 1,4 | 1,2 | 1,3 |
| | | | | | | | | | | | | | | | | | |
| MIL_Authors | 8 | 9 | 13 | 9 | 13 | 6 | 10 | 20 | 11 | 13 | 14 | 21 | 19 | 27 | 30 | 16 | 28 |
| MIL_Articles | 11 | 13 | 12 | 9 | 18 | 9 | 11 | 26 | 18 | 37 | 40 | 52 | 25 | 103 | 75 | 73 | 69 |
| Article productivity ratio | 1,4 | 1,4 | 0,9 | 1,0 | 1,4 | 1,5 | 1,1 | 1,3 | 1,6 | 2,8 | 2,9 | 2,5 | 1,3 | 3,8 | 2,5 | 4,6 | 2,5 |
| | | | | | | | | | | | | | | | | | |
| EDU_Authors | 25 | 22 | 26 | 25 | 32 | 32 | 40 | 39 | 28 | 36 | 29 | 31 | 44 | 45 | 39 | 35 | 43 |
| EDU_Articles | 35 | 34 | 47 | 47 | 49 | 50 | 55 | 59 | 32 | 56 | 42 | 42 | 58 | 62 | 50 | 46 | 63 |
| Article productivity ratio | 1,4 | 1,5 | 1,8 | 1,9 | 1,5 | 1,6 | 1,4 | 1,5 | 1,1 | 1,6 | 1,4 | 1,4 | 1,3 | 1,4 | 1,3 | 1,3 | 1,5 |
| | | | | | | | | | | | | | | | | | |
| THEOL_Authors | 35 | 41 | 36 | 35 | 44 | 40 | 39 | 45 | 49 | 52 | 52 | 54 | 61 | 58 | 68 | 65 | 75 |
| THEOL_Articles | 61 | 77 | 78 | 69 | 87 | 73 | 71 | 85 | 90 | 103 | 93 | 82 | 96 | 73 | 111 | 100 | 114 |
| Article productivity ratio | 1,7 | 1,9 | 2,2 | 2,0 | 2,0 | 1,8 | 1,8 | 1,9 | 1,8 | 2,0 | 1,8 | 1,5 | 1,6 | 1,3 | 1,6 | 1,5 | 1,5 |

There are a number of points to highlight about the trends in this table:

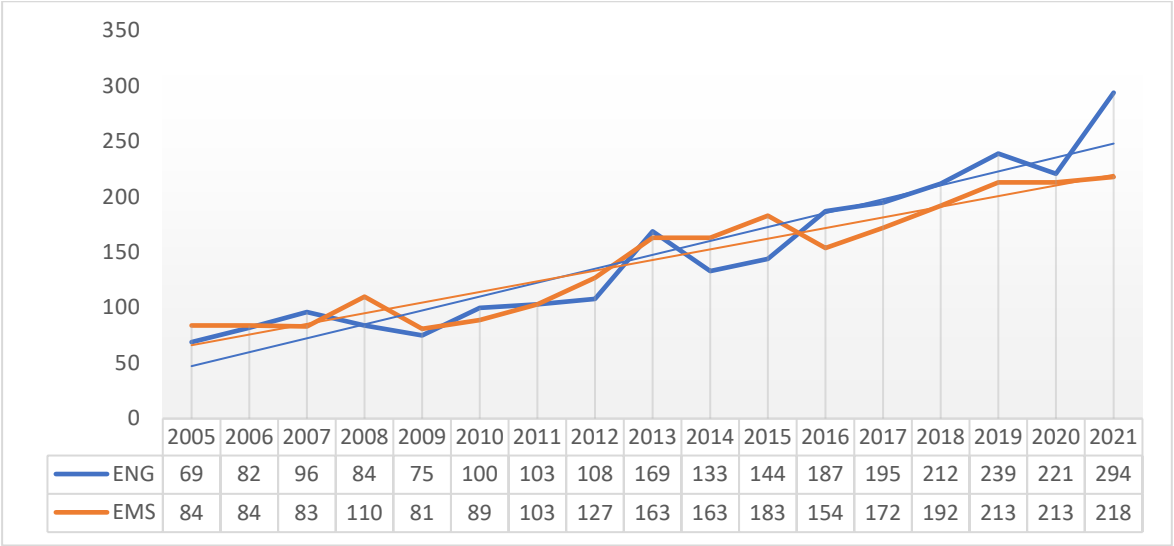
- These faculties on average have small numbers of actively publishing individuals. In the most recent year this range from 16 in Military Science to 65 in Theology.
- Not only are the numbers small, but the trend over time also shows relatively small increases: Law doubled from 19 to 37; Military Science doubled from 8 to 16, Education increased their numbers from 25 to 35 and Theology from 35 to 65.
- The average productivity ratio in 2021 ranges from 1.3 (Law) to 2.5 (Military Science) but one should not place too much emphasis on some of these values as the overall samples (especially for Military Science) are small. Having said this, it is still worth nothing that the average per capita article output of all four faculties – although being small in size – is quite acceptable at around 1.3 to 1.5 papers per author.

- It should be emphasized that these data refer to the ‘average paper productivity’ of authors affiliated with the respective faculties and may not necessarily correlate with the article subsidy-units earned under the DHET framework. I do not have access to the subsidy-units earned by each Faculty since 2005 which would have made such a comparison interesting. This is something that each Faculty could presumably do themselves.

### 3.3.2 Medium-sized and predominantly professional training faculties

Two larger faculties that are also mainly devoted to training highly-skilled professionals in their respective areas, are the Faculties of Engineering and Economic and Management Sciences. As the graph below shows, their bibliometric profiles in terms of article production are not too dissimilar.

**Figure 26: Trends in article output (Medium-sized professional faculties)**




| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ENG | 69 | 82 | 96 | 84 | 75 | 100 | 103 | 108 | 169 | 133 | 144 | 187 | 195 | 212 | 239 | 221 | 294 |
| EMS | 84 | 84 | 83 | 110 | 81 | 89 | 103 | 127 | 163 | 163 | 183 | 154 | 172 | 192 | 213 | 213 | 218 |

The Engineering and the Economics and Management Sciences faculties both primarily aim to produce high-level professionals for the labour market (engineers, auditors, accountants, business managers, financial managers, etc.). One could argue that Economics is a 'basic science' discipline in EMS and should be producing a large part of the output of the faculty. Conversely, departments such as Accountancy and Auditing are not known for producing large numbers of research articles.

Both are medium-sized faculties in terms of annual article output with very similar trendlines. Engineering has a slightly higher CAGR-value (9.5%) than EMS (6.1%) which may suggest that the former has more scope for increased output in the future.

In the Table (overleaf) we again look more closely at the available human resources capacity in each Faculty and how that relates to annual output and author-level productivity.

**Table 14: Nr of unique contributing authors and articles by Faculty by year: Engineering and Economic and Management Sciences**

| Faculty | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ENG_Authors | 60 | 68 | 90 | 94 | 91 | 99 | 111 | 117 | 175 | 154 | 166 | 200 | 221 | 234 | 267 | 271 | 324 |
| ENG_Articles | 69 | 82 | 96 | 84 | 75 | 100 | 103 | 108 | 169 | 133 | 144 | 187 | 195 | 212 | 239 | 221 | 294 |
| Article productivity ratio | 1,2 | 1,2 | 1,1 | 0,9 | 0,8 | 1,0 | 0,9 | 0,9 | 1,0 | 0,9 | 0,9 | 0,9 | 0,9 | 0,9 | 0,9 | 0,8 | 0,9 |
| | | | | | | | | | | | | | | | | | |
| EMS_Authors | 71 | 61 | 69 | 91 | 73 | 77 | 91 | 107 | 125 | 127 | 142 | 129 | 143 | 193 | 196 | 184 | 199 |
| EMS_Articles | 84 | 84 | 83 | 110 | 81 | 89 | 103 | 127 | 163 | 163 | 183 | 154 | 172 | 192 | 213 | 213 | 218 |
| Article productivity ratio | 1,2 | 1,4 | 1,2 | 1,2 | 1,1 | 1,2 | 1,1 | 1,2 | 1,3 | 1,3 | 1,3 | 1,2 | 1,2 | 1,0 | 1,1 | 1,2 | 1,1 |

When we compare the trends in output of these two faculties with the previous grouping of smaller faculties, we immediately see how the larger knowledge productive capacity of both these faculties enable them to produce more articles per year, but more importantly, also increase their output at a higher rate. This is a good example of the 'cumulative advantage theory' which was originally formulated by Robert Merton in the 1940's. This theory simply predicts that organisation or institutions that have significant resources (people/ funding/ infrastructure) not only has an advantage over other similar organisations in the same sector in terms of performance, but the initial advantage related to these resources is an accumulative one. Simply stated: faculties (in this case) with more initial resources (active publishing individuals) will tend to increase their output over time as they manage to increase their stock of human capital at a greater rate than smaller faculties. We clearly see in the Table how Engineering has more than tripled its number of contributing authors to its article production (from 60 to 271) which resulted in the increase in article output from 69 articles to 221 articles. Although not as dramatic, EMS also managed to increase its number of contributing authors from 71 to 184 with a resultant increase in article production.

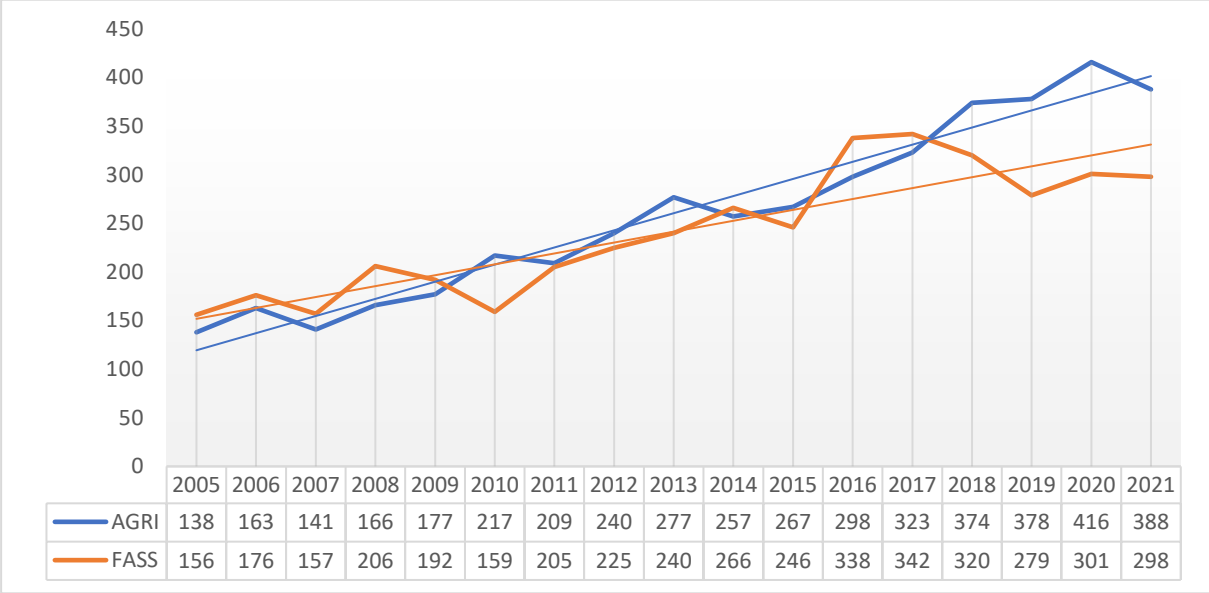
What is perhaps noteworthy here is that the average paper productivity ratio within EMS is consistently slightly higher than that of Engineering. The most plausible explanation of this is that the difference in the additional authors within Engineering is more likely than not because of the increased contribution by students (and possibly post-docs) who publish with their supervisors and other senior staff. This explains why the ratio of authors to articles is near mirror images of each other: for Engineering it is 1.22 authors per paper and for EMS it is 0.86 authors per paper.

It is again worth emphasizing that these trends do not reflect the subsidy earned for these articles under the DHET framework since that is calculated in terms of the proportion of SU authors divided by the total number of authors of a paper. Where the number of authors per paper is very high and SU authors only contribute partially to the output, the subsidy earned may be less.

### 3.3.3 Large and 'hybrid' faculties

The faculties of Arts and Social Sciences and Agrisciences have both produced more than 3 000 articles over the reporting period. We have grouped them together because of the fact that they both house more professional training departments (Social Work, Geographers, Clinical Psychologists, Agronomists, Forestry and Viticulture professionals) as well as more basic scientific disciplines (Philosophy, History, Psychology, Genetics, Plant Pathology, etc.). This may explain the relatively similar bibliometric profiles in articles output below, but I would caution against emphasizing these similarities in all cases. There are other differences in publication practices that are not represented in the graph below such as the dominance of book publications in the Humanities and creative outputs for the Fine and Performing Arts. Conversely, the more technologically based disciplines in Agrisciences (Biotechnology, Viticulture) also produce other scientific outputs such as technologies and new seed varieties that can be patented or otherwise protected.

**Figure 27: Trends in article output (Large 'hybrid' Faculties)**




| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGRI | 138 | 163 | 141 | 166 | 177 | 217 | 209 | 240 | 277 | 257 | 267 | 298 | 323 | 374 | 378 | 416 | 388 |
| FASS | 156 | 176 | 157 | 206 | 192 | 159 | 205 | 225 | 240 | 266 | 246 | 338 | 342 | 320 | 279 | 301 | 298 |

As the results show their annual output is quite similar with not too dissimilar CAGR-values (AGR = 6.7% and FASS=4.1%). It is clear that the differences in the growth rates is due to the decline in numbers of papers in FASS since 2017. This may coincide with an increase in creative outputs or more publications in books and book chapters. Unfortunately I did not have access to these outputs at the Faculty level for the purpose of the report.

The shifts in human resources capacity of the two faculties are presented in Table XX overleaf.

**Table 15: Nr of unique contributing authors and articles by Faculty by year: Agrisciences and Arts and Social Sciences**

| Faculty | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGRI_Authors | 120 | 130 | 118 | 140 | 135 | 208 | 187 | 198 | 219 | 228 | 219 | 242 | 282 | 344 | 332 | 400 | 358 |
| AGRI_Articles | 138 | 163 | 141 | 166 | 177 | 217 | 209 | 240 | 277 | 257 | 267 | 298 | 323 | 374 | 378 | 416 | 388 |
| Productivity ratio | 1,2 | 1,3 | 1,2 | 1,2 | 1,3 | 1,0 | 1,1 | 1,2 | 1,3 | 1,1 | 1,2 | 1,2 | 1,1 | 1,1 | 1,1 | 1,0 | 1,1 |
| | | | | | | | | | | | | | | | | | |
| FASS_Authors | 115 | 138 | 121 | 144 | 136 | 104 | 160 | 173 | 189 | 216 | 199 | 227 | 248 | 246 | 219 | 227 | 215 |
| FASS_Articles | 156 | 176 | 157 | 206 | 192 | 159 | 205 | 225 | 240 | 266 | 246 | 338 | 342 | 320 | 279 | 301 | 298 |
| Productivity ratio | 1,4 | 1,3 | 1,3 | 1,4 | 1,4 | 1,5 | 1,3 | 1,3 | 1,3 | 1,2 | 1,2 | 1,5 | 1,4 | 1,3 | 1,3 | 1,3 | 1,4 |

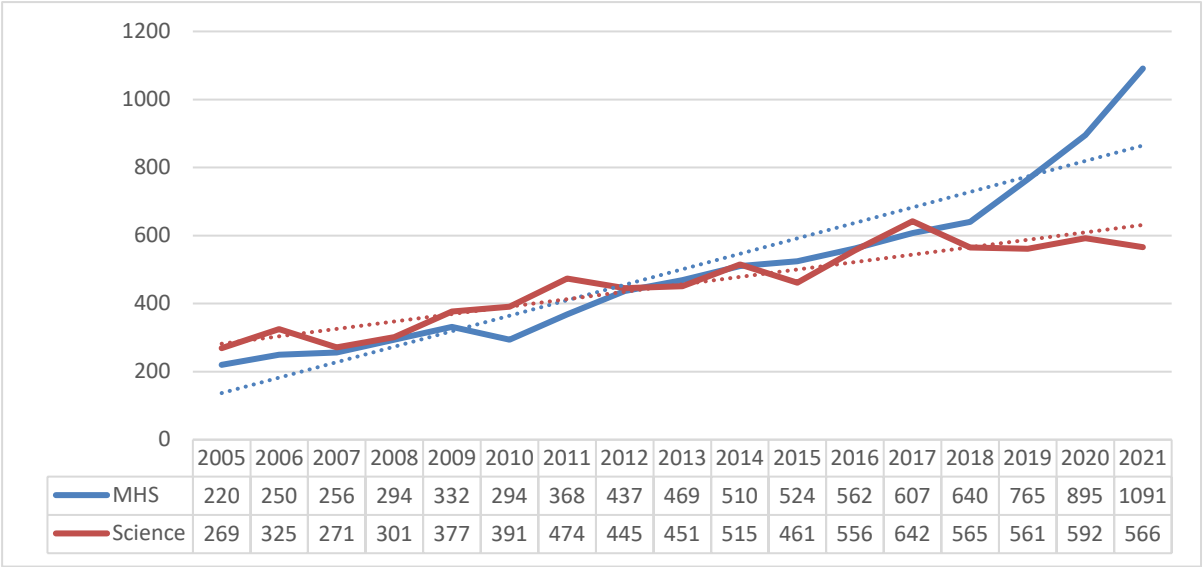
Salient points:

- It is interesting that Agrisciences and FASS had very similar productive capacities in terms of active publishing authors for a large period during the report period. It is only since around 2017 that Agrisciences began to 'mobilize' larger numbers of authors to contribute to their annual output. This increase from 242 authors in 2016 to 400 in 2020 is large and requires further investigation. Presumably the Faculty would have the information about whether this increase is due to larger numbers of publishing students, post-docs and visiting fellows. At the same time, the number of contributing authors in FASS continue to increase at a slower rate and then in 2019 actually began to decline. Again, this trend needs to be explained and the causes for this investigated.
- As in the previous analyses, it is still worthwhile to emphasize that the individual paper productivity of contributing authors in each Faculty remained at consistently acceptable levels, with FASS doing better on this indicator than Agrisciences. Stated differently, despite the decline in contributing authors in FASS in the recent past, those authors who did publish papers remained as productive and even slightly more so than before.
- From a research planning perspective, it is clear that FASS can turn around its overall annual output and increase the number of articles significantly if it could or would investigate in appointing more post-doctoral fellows and possibly incentivize larger numbers of its post-graduate students to publish articles.

### 3.3.4 Large faculties (Science and Medicine and Health Sciences)

The two largest research producing faculties at SU are the Faculty of Science which produced a total of 6 210 articles since 2005 and the Faculty of Medicine and Health Sciences which produced 8 875 articles over the same period. Despite obvious differences between these two large faculties (for example the role that clinical research plays in MHS), I have grouped them together because of the similarity in output profiles.

**Figure 28: Trends in article output (Science and Medicine and Health Sciences)**




| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHS | 220 | 250 | 256 | 294 | 332 | 294 | 368 | 437 | 469 | 510 | 524 | 562 | 607 | 640 | 765 | 895 | 1091 |
| Science | 269 | 325 | 271 | 301 | 377 | 391 | 474 | 445 | 451 | 515 | 461 | 556 | 642 | 565 | 561 | 592 | 566 |

The first interesting result is the fact that the trendlines of these two faculties are very similar up to 2017 when the sharp growth in number of papers in MHS leads to growing gap in output between the two faculties. This is reflected in the respective CAGR values of 10.5% and 4.8%. The increasing gap is the result of the aggregate effect of MHS continuing to increase its articles output especially since 2019, whilst the Faculty of Science could only manage to maintain its current annual output levels over the past 5 – 6 years.

In the Table overleaf, we again compare the trends in active publishing authors for these faculties over the past seventeen years.

**Table 16: Nr of unique contributing authors and articles by Faculty by year: Science and Medicine and Health Sciences**

| Faculty | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCI_Authors | 226 | 260 | 261 | 274 | 285 | 305 | 325 | 355 | 348 | 385 | 387 | 425 | 455 | 451 | 481 | 504 | 483 |
| SCI_Articles | 269 | 325 | 271 | 301 | 377 | 391 | 474 | 445 | 451 | 515 | 461 | 556 | 642 | 565 | 561 | 592 | 566 |
| Article productivity ratio | 1,2 | 1,3 | 1,0 | 1,1 | 1,3 | 1,3 | 1,5 | 1,3 | 1,3 | 1,3 | 1,2 | 1,3 | 1,4 | 1,3 | 1,2 | 1,2 | 1,2 |
| | | | | | | | | | | | | | | | | | |
| MHS_Authors | 243 | 306 | 308 | 335 | 358 | 325 | 417 | 446 | 515 | 495 | 533 | 556 | 629 | 685 | 783 | 888 | 1053 |
| MHS_Articles | 220 | 250 | 256 | 294 | 332 | 294 | 368 | 437 | 469 | 510 | 524 | 562 | 607 | 640 | 765 | 895 | 1091 |
| Article productivity ratio | 0,9 | 0,8 | 0,8 | 0,9 | 0,9 | 0,9 | 0,9 | 1,0 | 0,9 | 1,0 | 1,0 | 1,0 | 1,0 | 0,9 | 1,0 | 1,0 | 1,0 |

A comparison in the trends in human resources capacity over time for these two faculties perhaps best illustrates the point about cumulative advantage in research performance. Although the two faculties had very similar numbers of publishing authors in 2005 (and Science produced more articles in that year), the Faculty of Medicine and Health Sciences increasingly benefitted from a higher rate of increase in actively publishing authors over time. A more dramatic increase happened over the last three years which resulted in MHS having more than 1000 authors (presumably large numbers of staff, students, visiting fellows, extraordinary appointments, postdocs) producing their output. The Faculty of Science, on the other hand, experienced a much lower growth in contributing authors which translated in an annual production remaining at the same levels since 2016.

In order to test the hypothesis about the differential contributions especially of post-doctoral fellows and students to the output of different Faculties, I compiled the table below that shows the relative numbers in these two categories for 2019 to 2021 (the only years for which we have relatively comprehensive and accurate information).

**Table 17: Contribution of post-docs and students to Faculty output (2019 – 2021)**

| Academic category | Agrisciences | FASS | EMS | Education | Engineering | Law | MHS | Military | Science | Theology |
|---|---|---|---|---|---|---|---|---|---|---|
| **Post-Docs** | **104** | **39** | **20** | **1** | **47** | **5** | **126** | | **139** | **7** |
| 2019 | 7 | 1 | 1 | | | | 7 | | 4 | |
| 2020 | 36 | 20 | 7 | | 14 | 3 | 55 | | 51 | 2 |
| 2021 | 61 | 18 | 12 | 1 | 33 | 2 | 64 | | 84 | 5 |
| | | | | | | | | | | |
| **Students** | **581** | **239** | **233** | **41** | **509** | **28** | **1367** | **17** | **662** | **63** |
| 2019 | 190 | 87 | 97 | 18 | 169 | 10 | 412 | 7 | 242 | 26 |
| 2020 | 240 | 91 | 89 | 15 | 172 | 15 | 494 | 3 | 249 | 24 |
| 2021 | 151 | 61 | 47 | 8 | 168 | 3 | 461 | 7 | 171 | 13 |

The result presented in the previous table support our hypothesis about the increasing contributions of post-doctoral fellows and post-graduate students in many of the faculties. In some faculties (Military Science, Law and Theology) there are insignificant numbers of post-doctoral fellows. In the other faculties we can clearly see how these numbers increased over the past two to three years and now constitute a substantial part of the research productive capacity in those faculties.

The same trend is clear with regard to the contribution that post-graduate students play in the article production of faculties. Given our analyses in the previous tables it is therefore not surprising to see that the Faculty of Medicine and Health Sciences has 461 student (co-) authors, and other faculties (Science, Agrisciences and Engineering) more than 150.

It is very obvious that the faculties in the social sciences and humanities are not benefitting from these additional human resources. This could be due to various reasons: insufficient finances, smaller numbers of full-time students available for publication, and so on). From a strategic point of view, however, it is clear that the appointment of more post-doctoral fellows will have a direct impact on annual publication outputs and by implication on research subsidy earned. The differences between the faculties on their current numbers of post-doctoral fellows and post-graduate students who co-author articles are shown in the two pie-charts below.

**Figure 29: Number and percentages of contributing post-doctoral fellows by Faculty (2019 – 201)**

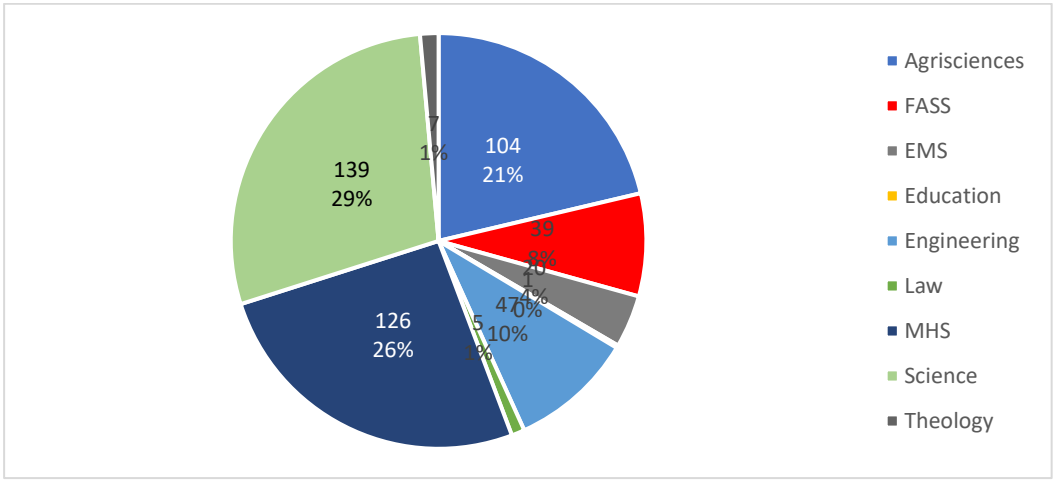
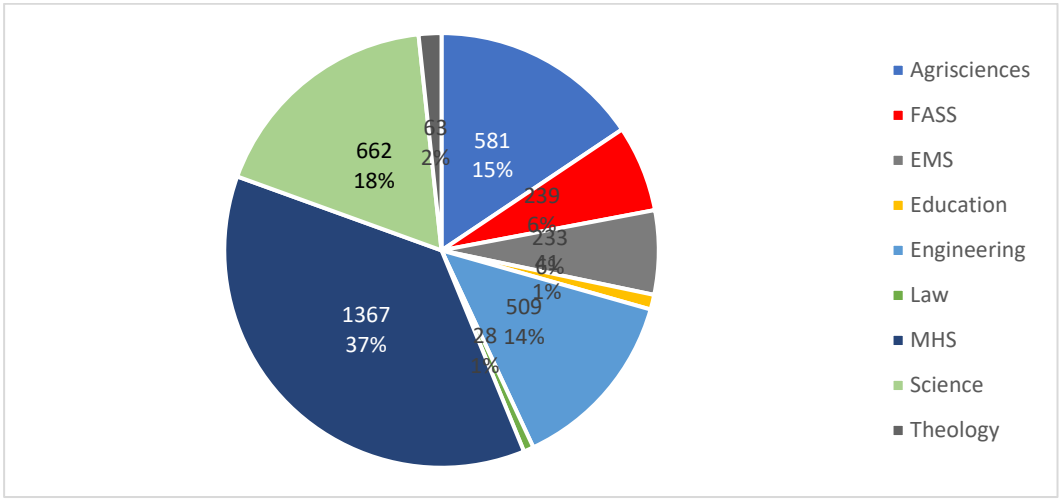



**Figure 30: Number and percentages of contributing students by Faculty (2019 – 201)**

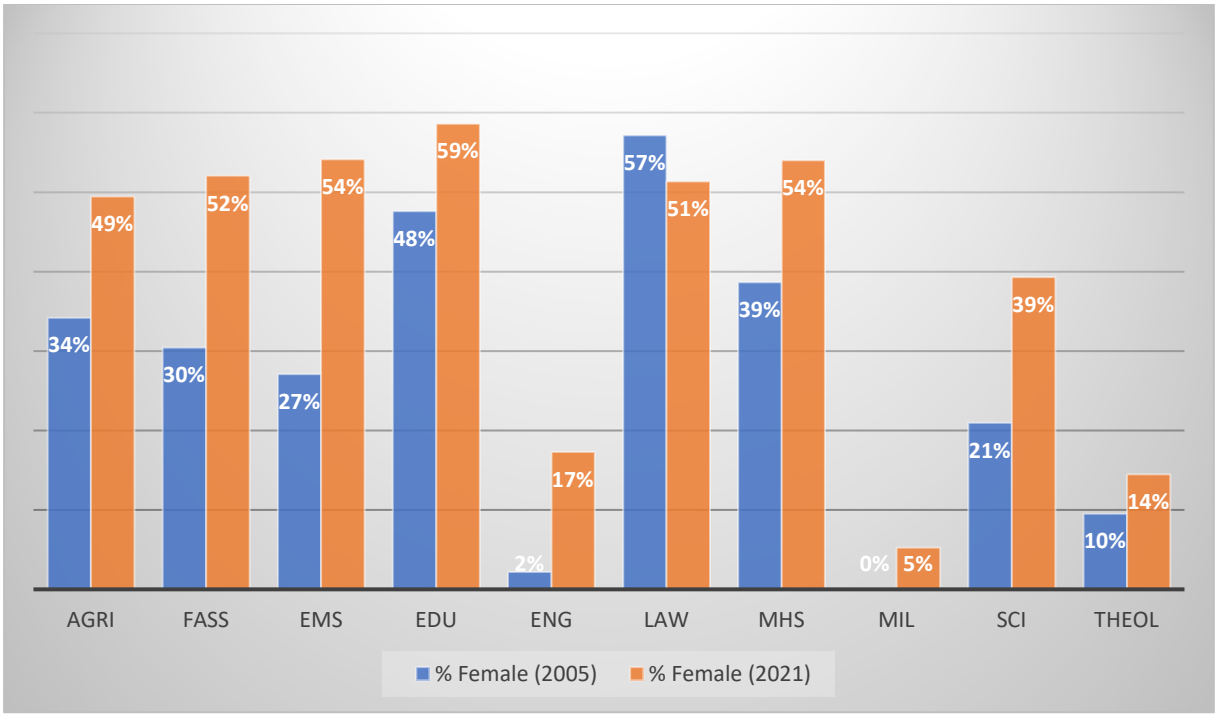


## 3.4 Demographic analyses of authors producing article output by faculty.

### 3.4.1 Gender of authors by faculty

Over the entire reporting period of 2005 to 2021 women authors constituted about 30% of all publishing authors. But this picture is very different when we compare faculties as well as the trend over time. Figure 30 below compares the shares of women authors for 2005 and 2021 by faculty.

**Figure 31: Percentage women authors: A comparison between 2005 and 2021 by Faculty**




With the exception of the Law faculty (where women authors are well represented), all faculties show a significant increase in the contribution of women authors over this period. The fact that two faculties (Engineering and Theology) still have smaller percentages of women authors in 2021 than the university average (46%) are not unusual when we compare these figures with other universities. Perhaps the most salient finding is the fact that women now (2021) contribute majorities of outputs in five faculties (FASS, EMS, EDU, Law and Medicine and Health Sciences and are approaching parity in Agrisciences.

### 3.4.2 Race of authors by Faculty

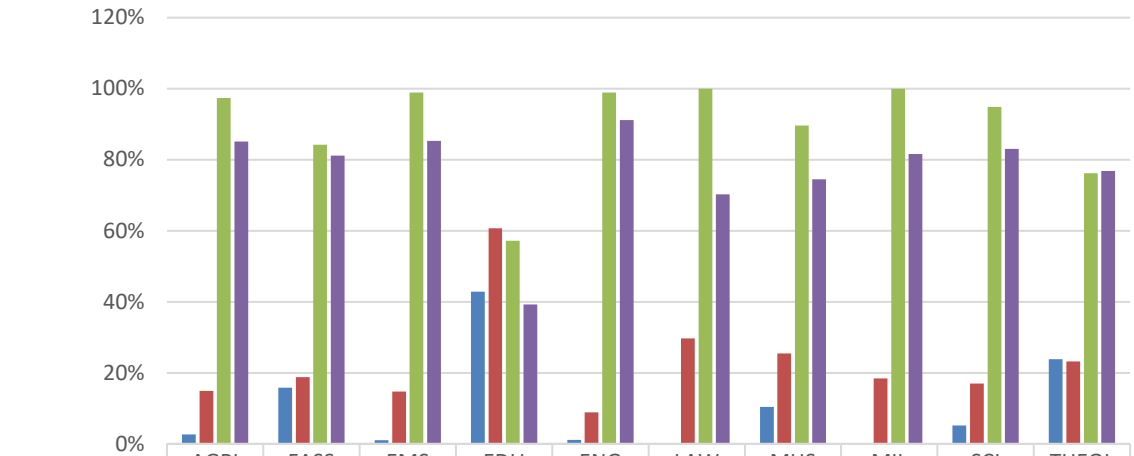
As indicated in the Introduction to the report, we comply with the Employment Equity act and only count South African born or naturalized citizens of South Africa when reporting on the 'population group' or 'race' classification of academics and students. In the graph below we compare the breakdown by race of author for 2005 with the most recently available data in 2021 and by Faculty.

The detailed results are presented in Table 18 and the breakdown by Black (generic) and White in Figure 32.

**Table 18: Race of author: A comparison between 2005 and 2021 and by Faculty**

| Faculty | African (2005) | African (2021) | Coloured (2005) | Coloured (2021) | Indian/Asian (2005) | Indian/Asian (2021) | Black (2005) | Black (2021) | White (2005) | White (2021) |
|---|---|---|---|---|---|---|---|---|---|---|
| Agrisciences | 1,3% | 7,2% | 1,3% | 7,2% | 0,0% | 0,5% | 2,6% | 14,9% | 97,4% | 85,1% |
| Arts and Social Sciences | 4,5% | 4,0% | 7,5% | 8,9% | 3,8% | 5,9% | 15,8% | 18,8% | 84,2% | 81,2% |
| Economic and Management Sciences | 0,0% | 5,7% | 1,0% | 5,3% | 0,0% | 3,8% | 1,0% | 14,7% | 99,0% | 85,3% |
| Education | 0,0% | 5,4% | 40,5% | 46,4% | 2,4% | 8,9% | 42,9% | 60,7% | 57,1% | 39,3% |
| Engineering | 1,1% | 2,4% | 0,0% | 5,3% | 0,0% | 1,1% | 1,1% | 8,8% | 98,9% | 91,2% |
| Law | 0,0% | 0,0% | 0,0% | 24,3% | 0,0% | 5,4% | 0,0% | 29,7% | 100,0% | 70,3% |
| Medicine and Health Sciences | 0,2% | 4,8% | 6,5% | 11,4% | 3,6% | 9,3% | 10,4% | 25,5% | 89,6% | 74,5% |
| Military Science | 0,0% | 15,8% | 0,0% | 2,6% | 0,0% | 0,0% | 0,0% | 18,4% | 100,0% | 81,6% |
| Science | 0,0% | 6,8% | 4,8% | 8,6% | 0,3% | 1,6% | 5,2% | 17,0% | 94,8% | 83,0% |
| Theology | 2,4% | 4,3% | 21,4% | 14,5% | 0,0% | 4,3% | 23,8% | 23,2% | 76,2% | 76,8% |

**Figure 32: Race of author (Black/White): A comparison between 2005 and 2021 and by Faculty**




| | AGRI | FASS | EMS | EDU | ENG | LAW | MHS | MIL | SCI | THEOL |
|---|---|---|---|---|---|---|---|---|---|---|
| Black (2005) | 3% | 16% | 1% | 43% | 1% | 0% | 10% | 0% | 5% | 24% |
| Black (2021) | 15% | 19% | 15% | 61% | 9% | 30% | 25% | 18% | 17% | 23% |
| White (2005) | 97% | 84% | 99% | 57% | 99% | 100% | 90% | 100% | 95% | 76% |
| White (2021) | 85% | 81% | 85% | 39% | 91% | 70% | 75% | 82% | 83% | 77% |

Salient points:

- We need to look at the breakdown by Faculty keeping in mind that the overall contribution of black authors to SU's research output in 2005 was only 10% and then doubled to about 20% in 2021.
- The faculties that have achieved more inclusive participation – compared to the university average - by black authors in 2021 are Education (61%), Law (30%), Medicine and Health Sciences (25%) and Theology (23%).
- The article output of the remaining faculties in 2021 remain under the corporate average of 20% by black authors.

It is clear that the imperative of increasing the participation of black members of staff, post-doctoral fellows and post-graduate students remains a challenge for the majority of the faculties.

### 3.4.3 The age profile of publishing authors by Faculty

Our final demographic analysis focus on the distribution of the active contributing staff and students by their age by year and by Faculty. There are few (if any) rules or guidelines that can be applied when assessing what the ideal age profile of a university should be. In addition, differences across faculties which often correspond with labour market demands, impact strongly on the age distribution of authors. With the increasing contributions of post-doctoral research fellows and post-graduate students one would expect that there would be a shift towards the younger age categories (under the age of 40) at the University over time.

**Table 19: Age profile of authors by faculty for 2005**

| Faculty | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 |
|---|---|---|---|---|---|
| Agrisciences | 8,70% | 25,36% | 34,78% | 25,36% | 5,80% |
| Arts and Social Sciences | 1,48% | 21,48% | 33,33% | 38,52% | 5,19% |
| Economic and Management Sciences | 3,23% | 26,88% | 16,13% | 37,63% | 16,13% |
| Education | 2,38% | 2,38% | 52,38% | 40,48% | 2,38% |
| Engineering | 15,38% | 20,88% | 36,26% | 18,68% | 8,79% |
| Law | 5,88% | 26,47% | 50,00% | 14,71% | 2,94% |
| Medicine and Health Sciences | 3,67% | 21,78% | 38,06% | 25,46% | 11,02% |
| Military Science | 0,00% | 25,00% | 75,00% | 0,00% | 0,00% |
| Science | 8,43% | 18,77% | 44,06% | 14,94% | 13,79% |
| Theology | 17,50% | 22,50% | 25,00% | 17,50% | 17,50% |
| **Grand Total** | **6,30%** | **21,34%** | **37,29%** | **24,86%** | **10,22%** |

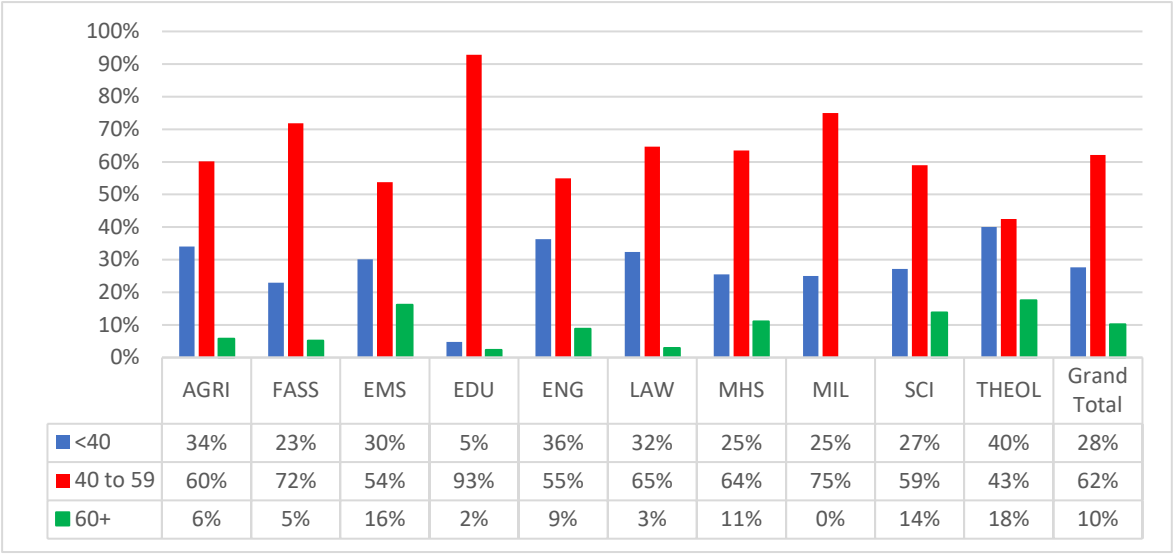
**Table 20: Age profile of authors by faculty for 2010**

| Faculty | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 |
|---|---|---|---|---|---|---|
| Agrisciences | 8,16% | 39,59% | 31,02% | 14,69% | 6,12% | 0,41% |
| Arts and Social Sciences | 4,96% | 23,14% | 32,23% | 28,93% | 9,92% | 0,83% |
| Economic and Management Sciences | 11,83% | 22,58% | 15,05% | 39,78% | 8,60% | 2,15% |
| Education | 0,00% | 8,62% | 27,59% | 58,62% | 5,17% | 0,00% |
| Engineering | 8,66% | 23,62% | 25,20% | 24,41% | 12,60% | 5,51% |
| Law | 0,00% | 28,57% | 38,10% | 19,05% | 0,00% | 14,29% |
| Medicine and Health Sciences | 5,54% | 20,20% | 28,91% | 32,87% | 11,68% | 0,79% |
| Military Science | 0,00% | 11,11% | 22,22% | 66,67% | 0,00% | 0,00% |
| Science | 10,63% | 26,72% | 25,57% | 23,56% | 11,21% | 2,30% |
| Theology | 6,82% | 15,91% | 38,64% | 15,91% | 20,45% | 2,27% |
| **Grand Total** | **7,38%** | **24,82%** | **27,94%** | **27,88%** | **10,25%** | **1,72%** |

**Table 21: Age profile of authors by faculty for 2021**

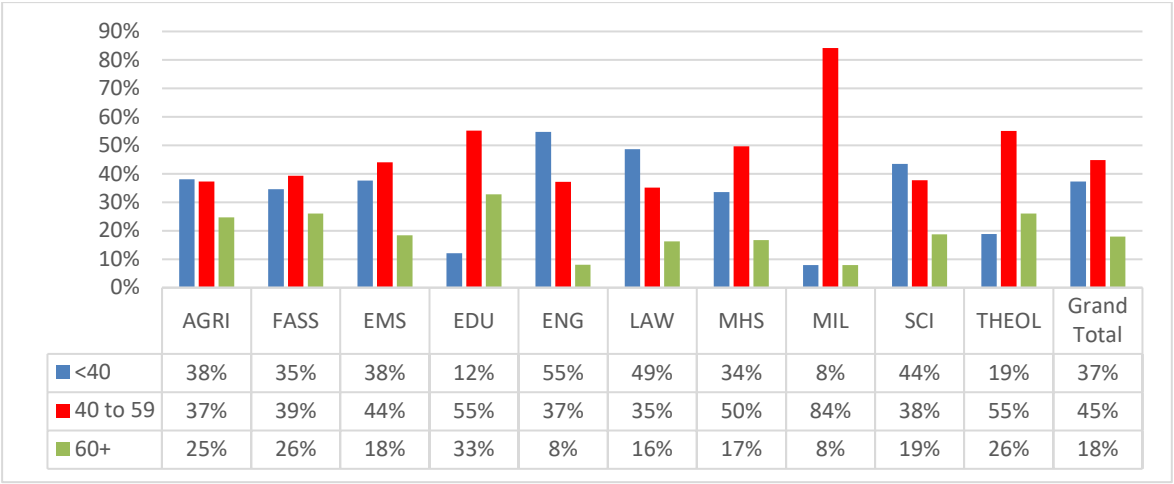
| Faculty | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80+ |
|---|---|---|---|---|---|---|---|
| Agrisciences | 15,34% | 22,71% | 20,60% | 16,69% | 18,65% | 4,96% | 1,05% |
| Arts and Social Sciences | 10,16% | 24,44% | 18,10% | 21,27% | 22,86% | 2,86% | 0,32% |
| Economic and Management Sciences | 7,52% | 30,08% | 29,70% | 14,29% | 16,17% | 2,26% | 0,00% |
| Education | 0,00% | 12,07% | 3,45% | 51,72% | 29,31% | 3,45% | 0,00% |
| Engineering | 25,56% | 29,14% | 21,99% | 15,23% | 6,77% | 1,13% | 0,19% |
| Law | 8,11% | 40,54% | 13,51% | 21,62% | 0,00% | 8,11% | 8,11% |
| Medicine and Health Sciences | 5,50% | 28,13% | 28,01% | 21,68% | 12,94% | 3,60% | 0,16% |
| Military Science | 1,32% | 6,58% | 15,79% | 68,42% | 7,89% | 0,00% | 0,00% |
| Science | 18,61% | 24,90% | 20,58% | 17,17% | 14,81% | 2,88% | 1,05% |
| Theology | 2,90% | 15,94% | 27,54% | 27,54% | 18,84% | 5,80% | 1,45% |
| **Grand Total** | **10,87%** | **26,41%** | **24,35%** | **20,44%** | **14,15%** | **3,32%** | **0,47%** |

**Figure 33: Age profile in 2005 by Faculty**




| | AGRI | FASS | EMS | EDU | ENG | LAW | MHS | MIL | SCI | THEOL | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| <40 | 34% | 23% | 30% | 5% | 36% | 32% | 25% | 25% | 27% | 40% | 28% |
| 40 to 59 | 60% | 72% | 54% | 93% | 55% | 65% | 64% | 75% | 59% | 43% | 62% |
| 60+ | 6% | 5% | 16% | 2% | 9% | 3% | 11% | 0% | 14% | 18% | 10% |

**Figure 33: Age profile in <u>2021</u> by Faculty**




| | AGRI | FASS | EMS | EDU | ENG | LAW | MHS | MIL | SCI | THEOL | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| <40 | 38% | 35% | 38% | 12% | 55% | 49% | 34% | 8% | 44% | 19% | 37% |
| 40 to 59 | 37% | 39% | 44% | 55% | 37% | 35% | 50% | 84% | 38% | 55% | 45% |
| 60+ | 25% | 26% | 18% | 33% | 8% | 16% | 17% | 8% | 19% | 26% | 18% |

The comparison between 2005 and 2021 reveals the following shifts:

- An overall increase of 9 percentage points in the under 40 years category (from 28% to 37%) over the reporting period. It is most likely the result of the increased contribution of post-doctoral fellows and students rather than a large shift in appointing younger academics.
- At the other end of the spectrum, we also witness a significant increase in the contribution of authors 60 years and older (from 10% to 18%).
- The 'ageing' of the contribution of authors (the category 60 years and older) has been most pronounced in the Faculties of Education (33%), Arts and Social Sciences (26) and Agrisciences (25%). In all three these faculties the percentage of authors younger than 40 have either stayed the same or increased which means that the real shift has been of staff who fell in the 40 -59 years old category in 2005 now (17 years later) in the 60+ category.
- If we focus on the under 40 category, it is noteworthy that Engineering (55%), Law (49%) and Science (44%) have the largest percentages. Further analysis is required to establish whether the increase, both in post-docs and students, are being reflected in these numbers.

# CHAPTER 4: SU PERFORMANCE IN THE WEB OF SCIENCE

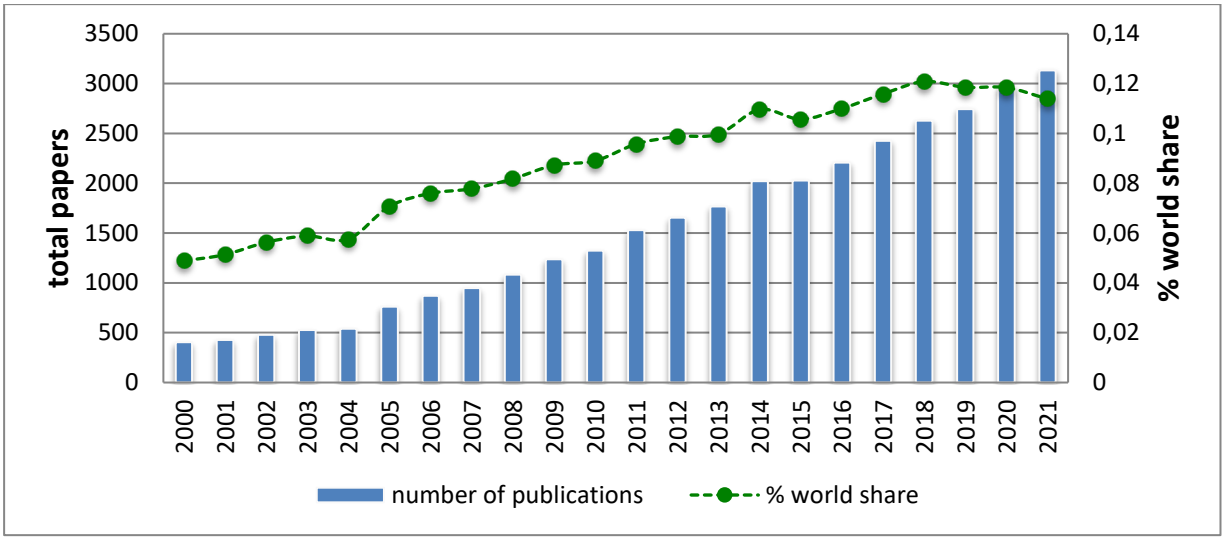
## 4.1 Introduction

Between 2000 and 2021, SU staff and students authored or co-authored a total of 33 689 articles and article reviews in journals that are indexed in the [CA]Web of Science collection. CREST receive, under license from Clarivate Analytics which allow us to develop and conduct a wide variety of bibliometric (including citation) indicators. The advantage of this section is that present findings that address SU's publication performance on the world stage and not only within the South African higher education sector.

## 4.2 SU articles and world share in Web of Science

Figure 34 displays the increase in absolute numbers of article and review articles between 2000 and 2020. The CAGR over this period is healthy 10.5%. The vertical axis shows how SU's share of world papers has increased over this period from 0,048% in 2000 to 0,011%. What is particularly noteworthy is the steep increase over the past ten years. One explanation for this increase is, of course, due to the inclusion of more South African journals in the Web of Science – a development that has been to the benefit of all South African universities. However, although the number of articles has increased from 406 in 2000 to 3331 in 2021, we also see a slowing of the growth in world share (hovering around 0,011% for the past five years.

**Figure 34: SU World share and Publication output (articles and reviews only)**




Although the information about SU's share of world output in the Web of Science is useful (up to a point), it makes more sense to compare SU's relative contribution to South Africa's publication output in the Web of Sciences for the same period with the top performing universities in the country. The table below presents the selected universities' relative country share for 2000 and 2021.

**Table 22: Trends in the differential contributions by SA universities to country publication output (2000 – 2021) – Descending order by share in 2021**

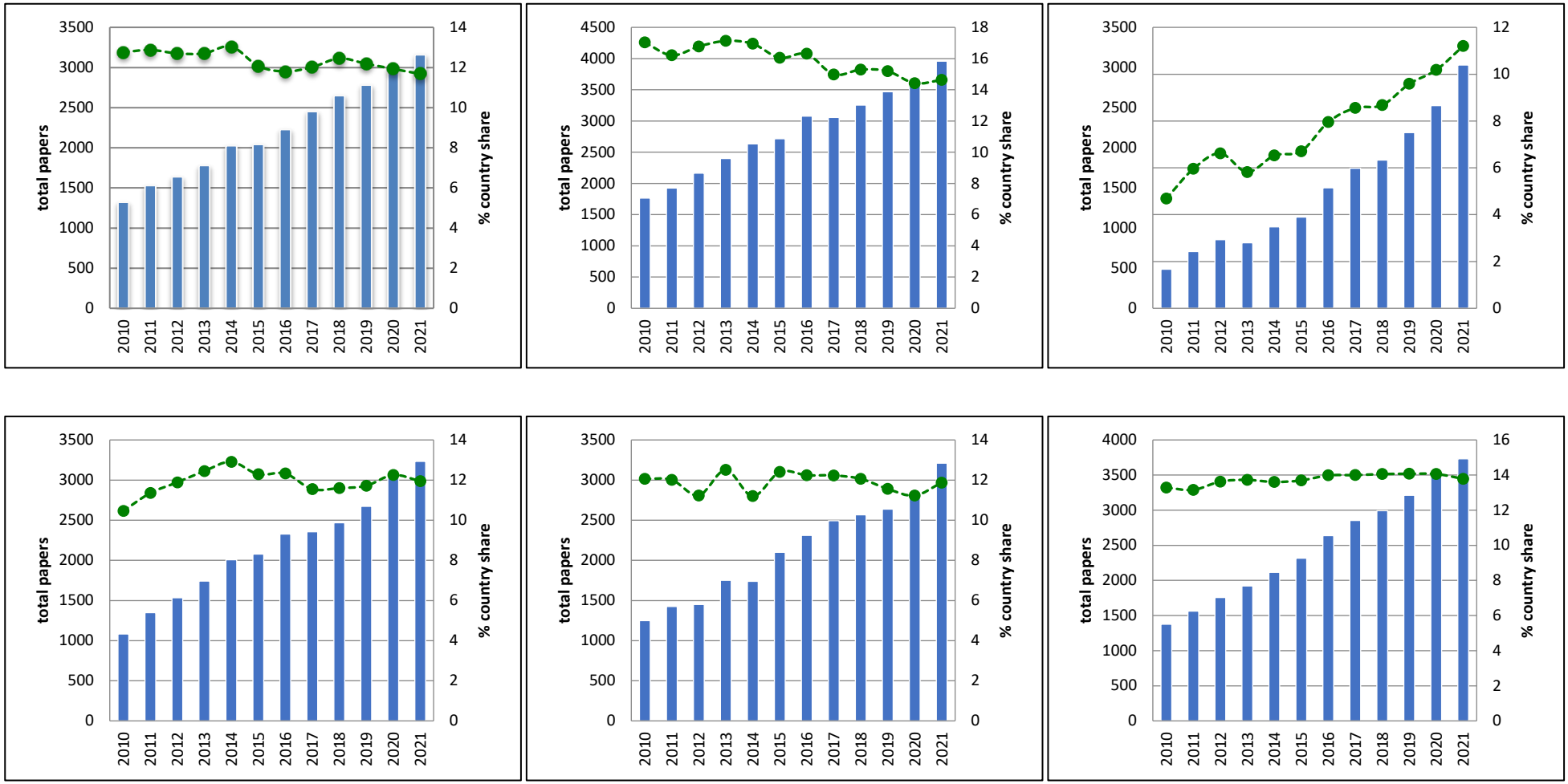
| University | Country share: 2000 | Country share: 2021 | Diff (2021-2000) |
|---|---|---|---|
| UCT | 18,49% | 14,62% | -3,87% |
| WITS | 16,46% | 13,78% | -2,68% |
| UKZN | 11,91% | 11,95% | 0,04% |
| UP | 12,52% | 11,86% | -0,66% |
| SU | 10,26% | 11,68% | 1,42% |
| UJ | 2,76% | 11,20% | 8,44% |
| NWU | 2,51% | 7,29% | 4,78% |
| UFS | 3,79% | 5,76% | 1,97% |
| UNISA | 1,67% | 5,73% | 4,06% |
| UWC | 2,46% | 3,91% | 1,45% |
| RHODES | 3,14% | 2,79% | -0,35% |

Where we have traditionally referred to the 'big five' in the SA higher education sector, it is now more correct to refer to the 'big six' with UJ making major strides in increasing its output relative to UCT, WITS, UKZN, UP and SU. The increase in the relative shares by NWU, UFS, UNISA and UWC are noteworthy, but it is clear that this has been achieved because UCT and WITS (specifically) have lost ground on this indicator of research performance.

**Table 23: Trends in the differential contributions by SA universities to country publication output (2000 – 2021) – Descending order by difference in share between 2000 and 2021**

| University | Country share: 2000 | Country share: 2021 | Diff (2021-2000) |
|---|---|---|---|
| UJ | 2,76% | 11,2% | 8,44% |
| NWU | 2,51% | 7,29% | 4,78% |
| UNISA | 1,67% | 5,73% | 4,06% |
| UFS | 3,79% | 5,76% | 1,97% |
| UWC | 2,46% | 3,91% | 1,45% |
| SU | 10,26% | 11,68% | 1,42% |
| UKZN | 11,91% | 11,95% | 0,04% |
| RHODES | 3,14% | 2,79% | -0,35% |
| UP | 12,52% | 11,86% | -0,66% |
| WITS | 16,46% | 13,78% | -2,68% |
| UCT | 18,49% | 14,62% | -3,87% |

**Figure 35: Article output and country share (2017 – 2021)**




**SU** **UCT** **UJ**

**UKZN** **UP** **WITS**

## 4.3 Disaggregation by scientific field: Relative field strength and trend over time

The Relative Field Strength-indicator, also known as the relative activity index or relative specialisation index, is a useful indicator of the areas of research in which a country or university– compared to the world average in those areas – are more or less active or strong. In Figure 23, the world average is indicated by the bold line at 1. Any value above 1 indicates that the university is more active in that field than the average world activity in that field (compared to other universities. The graph above compares SU's relative field strength for two periods: 2005 to 2012 (Blue line) and 2013 to 2020 (Green line). A comparison of the values on each of the lines shows, with the exception of the agricultural sciences, no significant shifts over time.

The overall spider diagramme shows that SU has – relative to the proportions of these fields in the world – very strong activities in the agricultural sciences and social sciences and humanities. Our publication output in the WoS in the health sciences is commensurate to the world average, whilst we are not as strong or active in the natural sciences. This is also the case for the field of Engineering where SU, as is the case for most South African universities, do not have the same relative strength when compared to the world field output.

**Figure 36: Relative field strength: Comparison between early and most recent time frames**

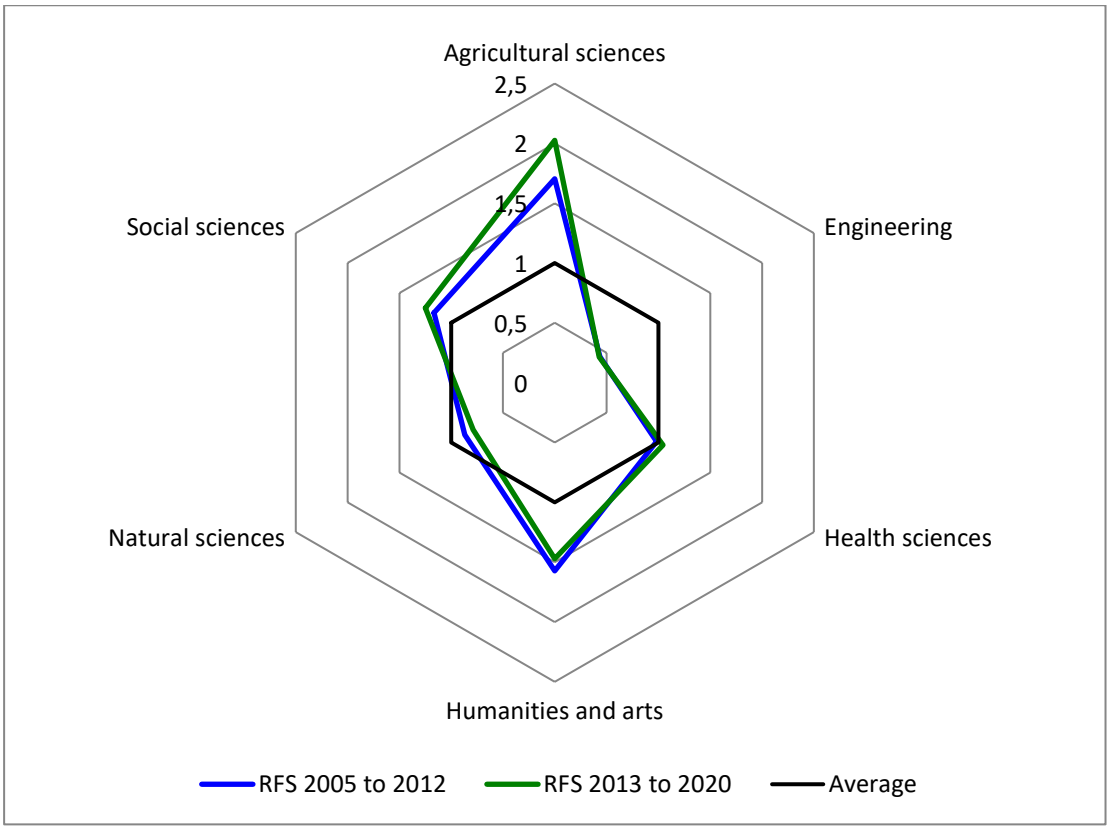
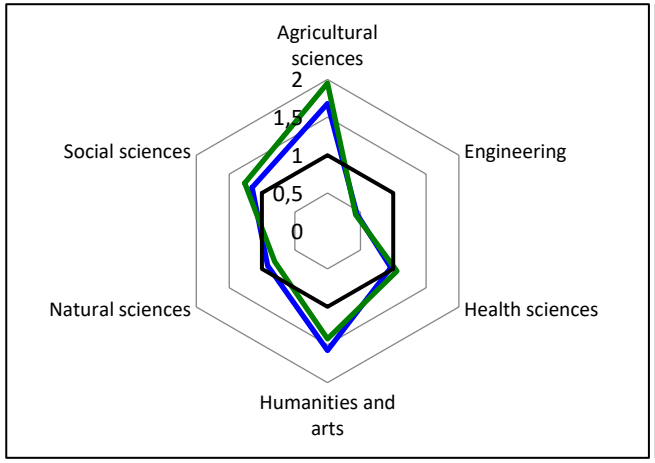
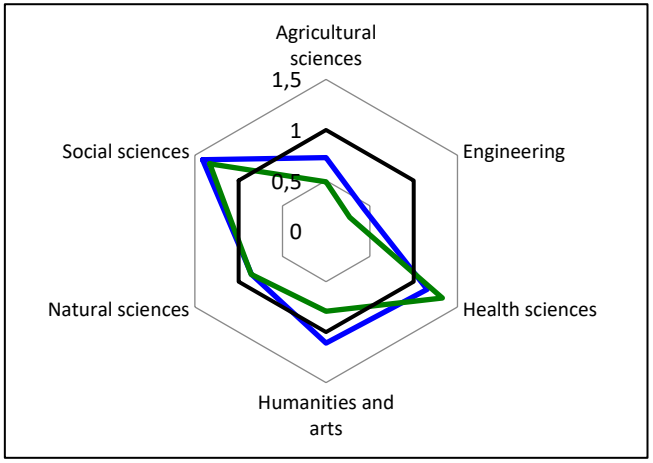


**Figure 37: Relative field strength (RFS scores) in comparison**

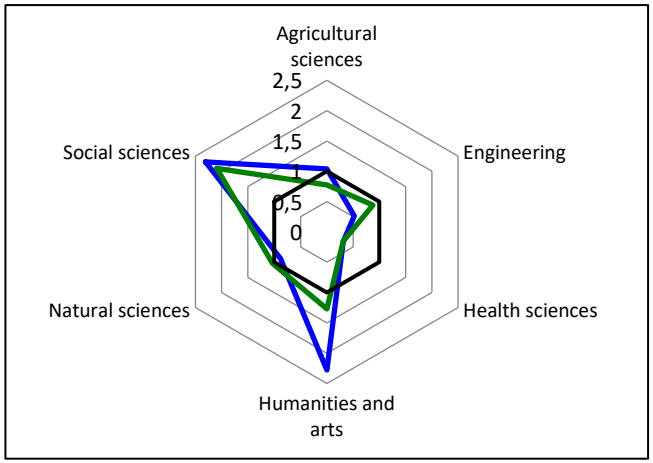
**SU**



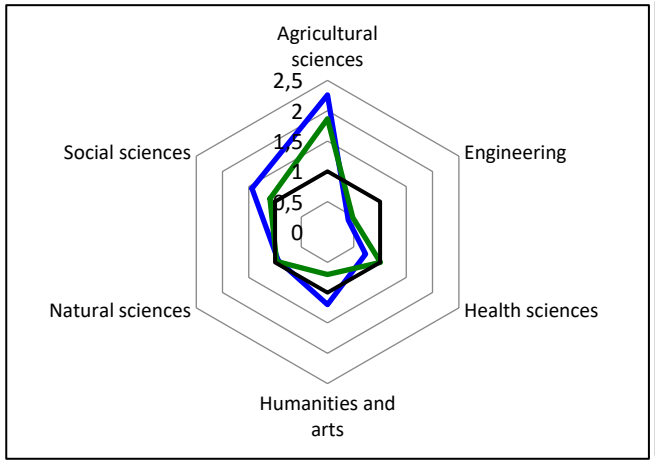

**UCT**



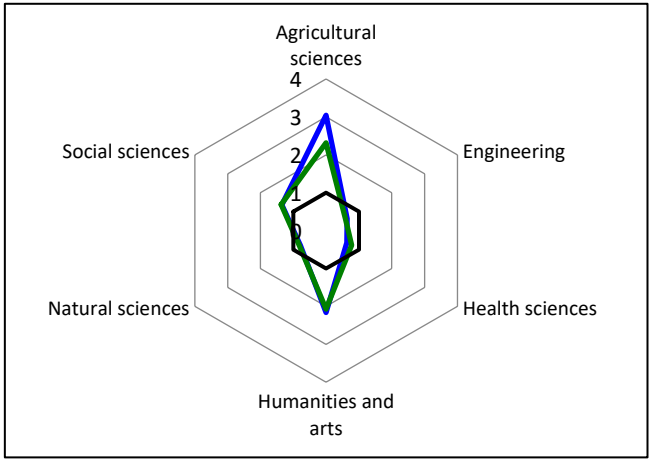

**UJ**




**UKZN**




**UP**




**WITS**

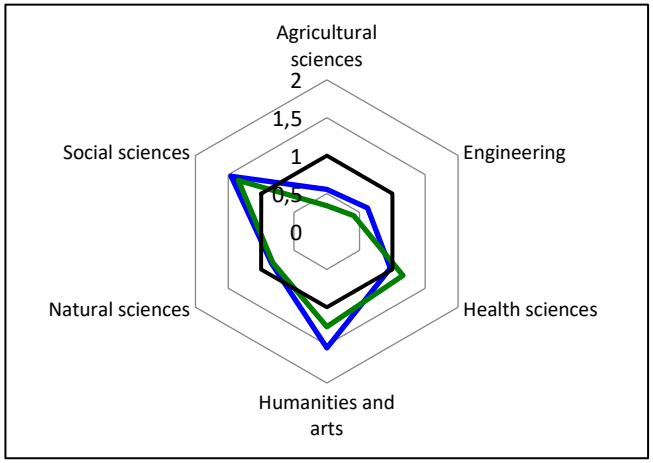
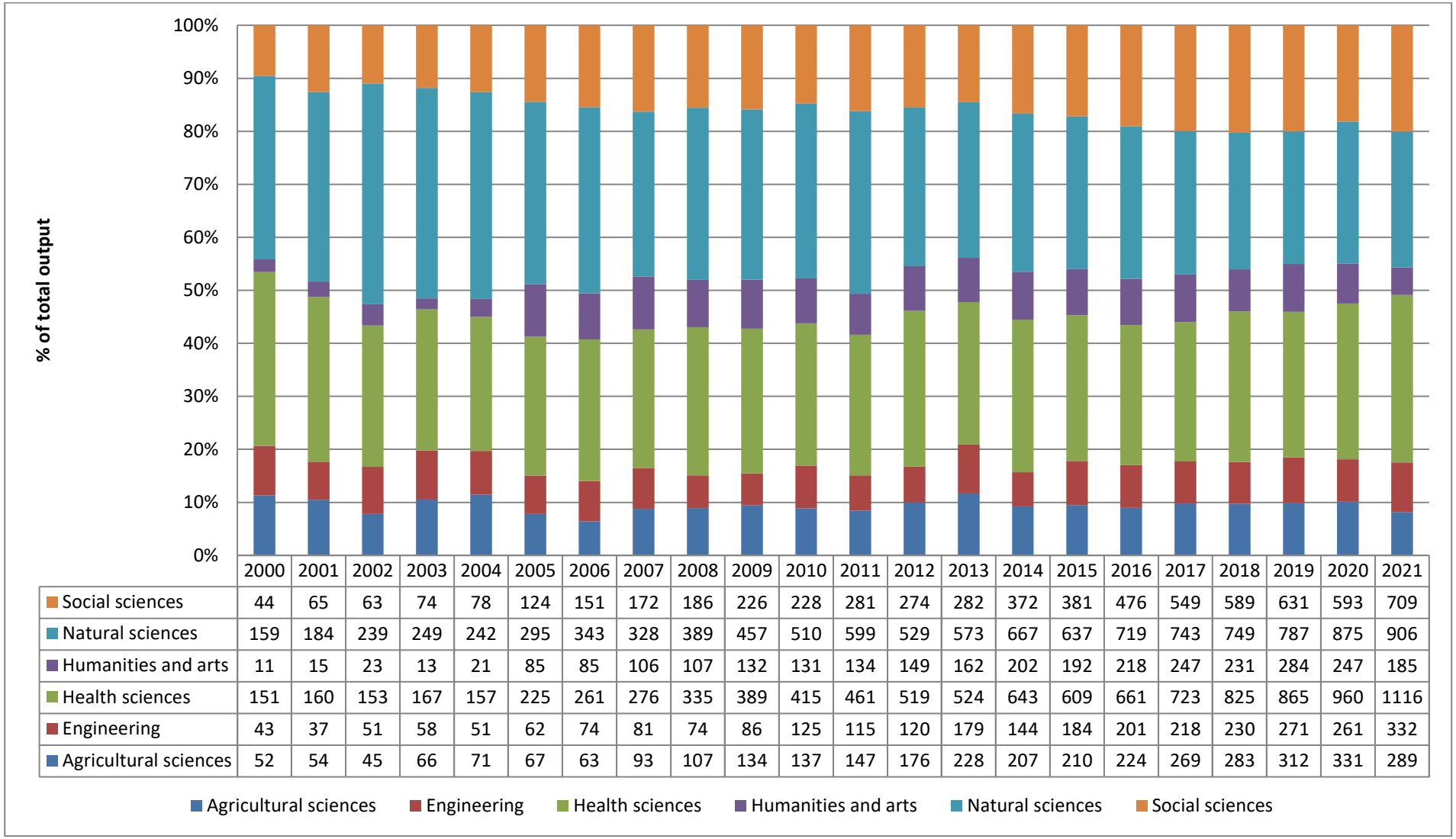
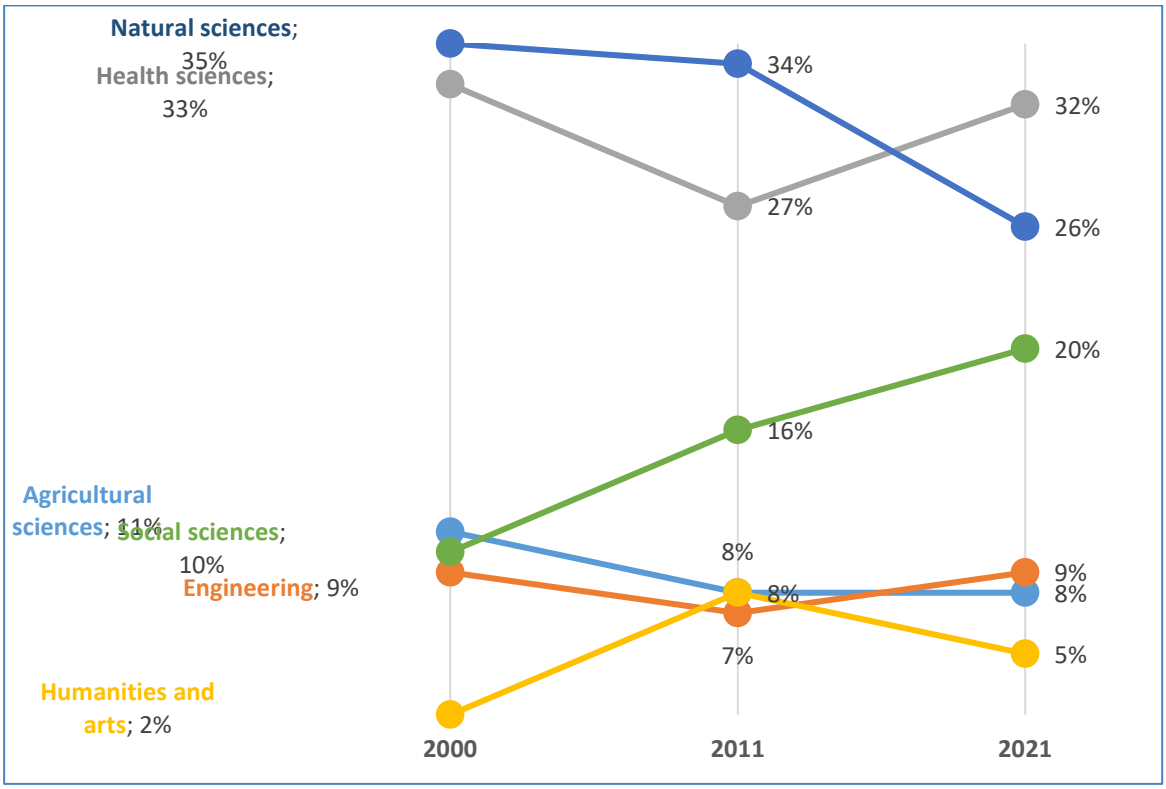


**Figure 38: Distribution of SU articles by main science domain (2000 to 2021)**




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Social sciences | 44 | 65 | 63 | 74 | 78 | 124 | 151 | 172 | 186 | 226 | 228 | 281 | 274 | 282 | 372 | 381 | 476 | 549 | 589 | 631 | 593 | 709 |
| Natural sciences | 159 | 184 | 239 | 249 | 242 | 295 | 343 | 328 | 389 | 457 | 510 | 599 | 529 | 573 | 667 | 637 | 719 | 743 | 749 | 787 | 875 | 906 |
| Humanities and arts | 11 | 15 | 23 | 13 | 21 | 85 | 85 | 106 | 107 | 132 | 131 | 134 | 149 | 162 | 202 | 192 | 218 | 247 | 231 | 284 | 247 | 185 |
| Health sciences | 151 | 160 | 153 | 167 | 157 | 225 | 261 | 276 | 335 | 389 | 415 | 461 | 519 | 524 | 643 | 609 | 661 | 723 | 825 | 865 | 960 | 1116 |
| Engineering | 43 | 37 | 51 | 58 | 51 | 62 | 74 | 81 | 74 | 86 | 125 | 115 | 120 | 179 | 144 | 184 | 201 | 218 | 230 | 271 | 261 | 332 |
| Agricultural sciences | 52 | 54 | 45 | 66 | 71 | 67 | 63 | 93 | 107 | 134 | 137 | 147 | 176 | 228 | 207 | 210 | 224 | 269 | 283 | 312 | 331 | 289 |

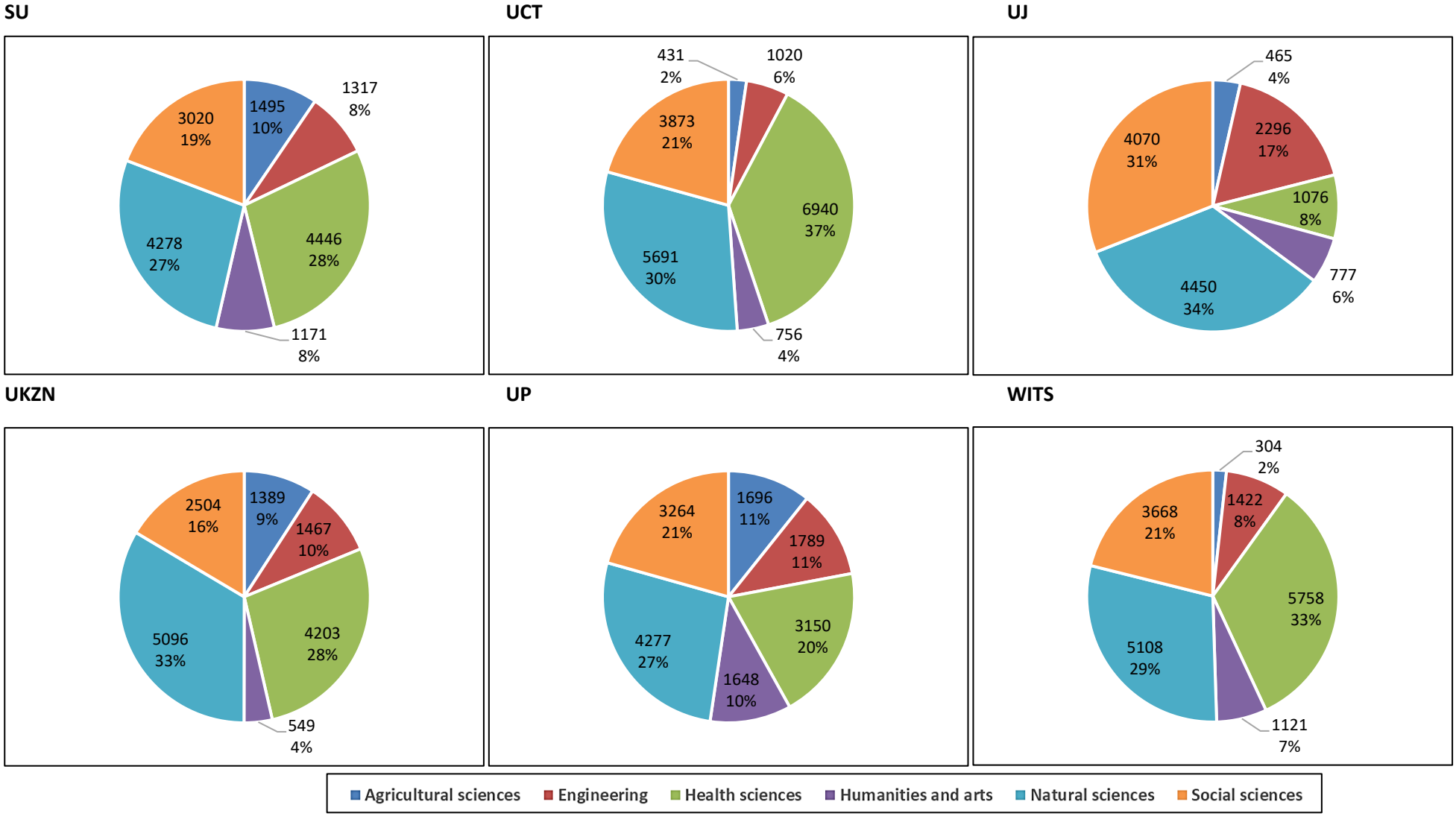
**Figure 39: Summary profile of key trends of shares of SU output in the Web of Science (2000 to 2021)**




Discussion: Universities – especially large ones – are often compared to tankers. It is not easy for them to reverse their direction at short notice. This is especially true of the 'shape of knowledge production' at such institutions. The specific organisational architecture (faculty and departmental design) and programme mix, changes slowly over time. This, of course, is the direct result of the path dependency of the disciplines offered by the university and the reality of relatively slow turnover of permanent staff. Once a senior academic has tenure, he or she can in theory remain in his/her field for 30 to 40 years. In addition, in times of financial cuts and slow growth, universities do not typically have the resources to change their investment and human resources commitments in new fields. There are, of course, exceptions where the better resourced universities, especially with the injection of funding from external sources, are able to establish and grow new centres and institutes (e.g., School on Climate Studies or on Data science).

However, the relative inertia of a university to change the shape of its knowledge production is empirically validated in the figure above where we see that relatively small shifts in the relative shares in research across the six main science fields are recorded.

**Figure 40: Comparison on shape of knowledge production at the level of main science domain amongst top SA universities**

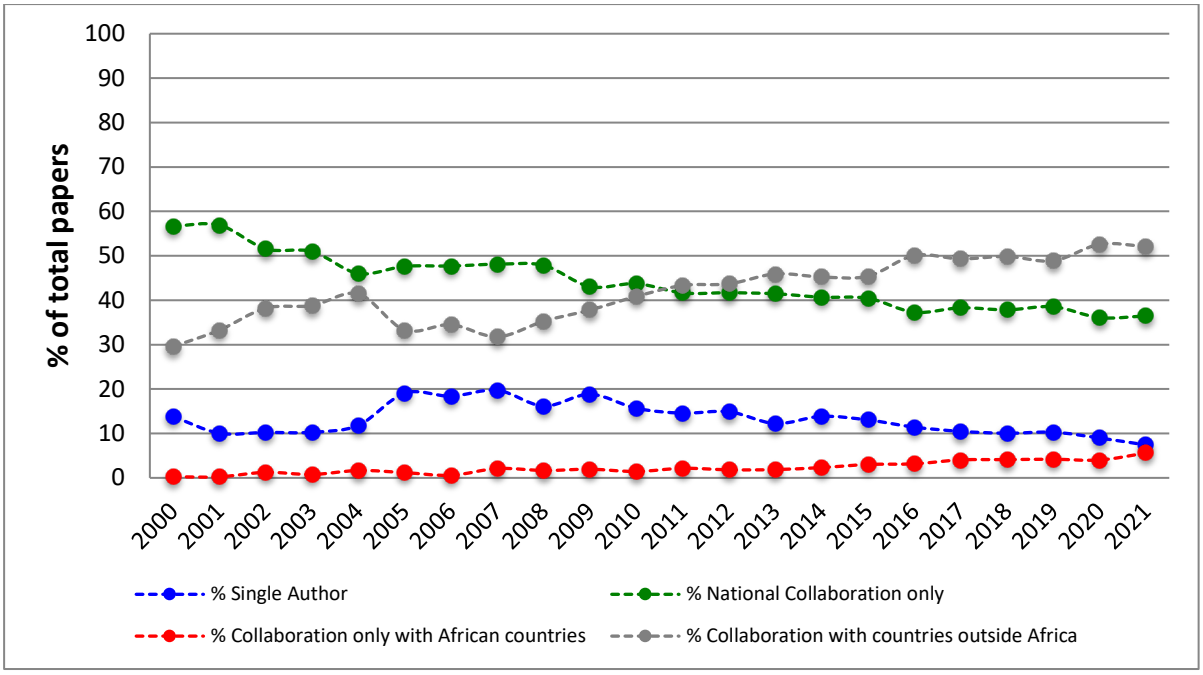


## 4.4 Trends in research collaboration

It is standard bibliometric practice to operationally define collaboration between scientists in terms of the degree of co-authorship of scientific papers. This indicator identifies three categories of research collaboration in terms of co-authorship patterns: **single** authorship (where there is a single author of a paper and hence no co-authorship or collaboration); **national** collaboration (where there are at least two authors from two different universities or research institutions in South Africa); and **international** collaboration (where there is at least two authors: one from a South African institution and another from a research institution in a foreign country).

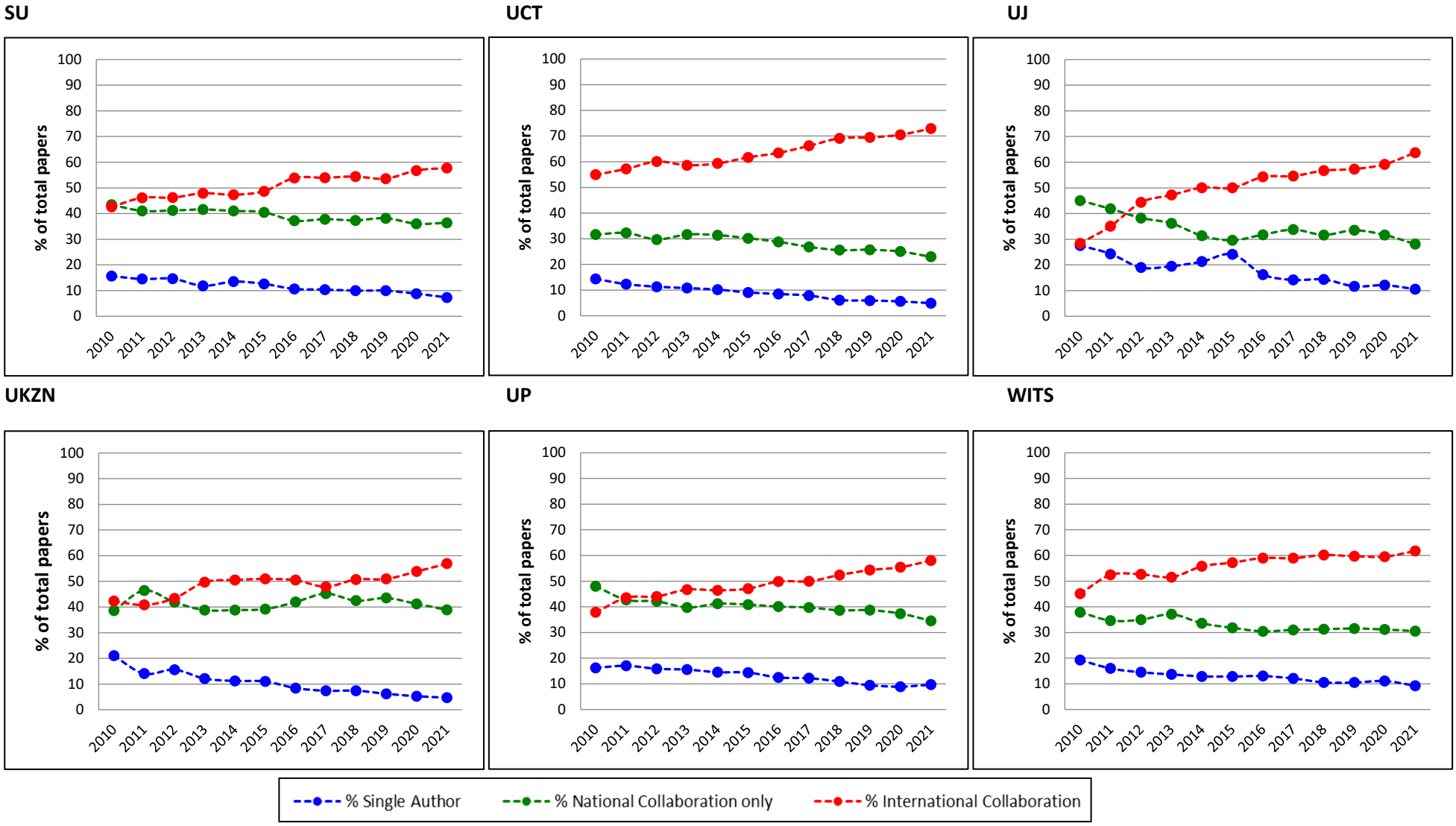
The graph below shows how SU staff have over the past two decades increasingly collaborated with foreign scientists and scholars. International collaboration (co-authored papers) in 2000 constituted 30% of all papers compared to 57% in 2021. This substantial increase in foreign collaboration has meant that national collaboration has declined (from 57% in 2000 to 36% in 2020). The percentage of single-authored papers has nearly halved over this period (from 14% in 2000 to 7% in 2021). Research collaboration with academics and scientists in Africa has increased from near zero in 2000 to 6% of all papers in 2021. Again, it should be emphasized that these trends in research collaboration show the average picture across all scientific fields which hide very substantial differences in collaboration patterns between fields.

**Figure 41: SU trends in research collaboration (2000 – 2021)**




In Figure XX overleaf, we compare the trends in research collaboration between the top six universities in the sector. The overall trend to increased foreign collaboration at all six universities is clear with UCT recording the highest percentage of 70% (and a declining national collaboration at 30%). This is a direct result of the dominance of the medical faculty at UCT where international collaboration is much more prevalent than in other science fields, especially engineering, humanities and social sciences.

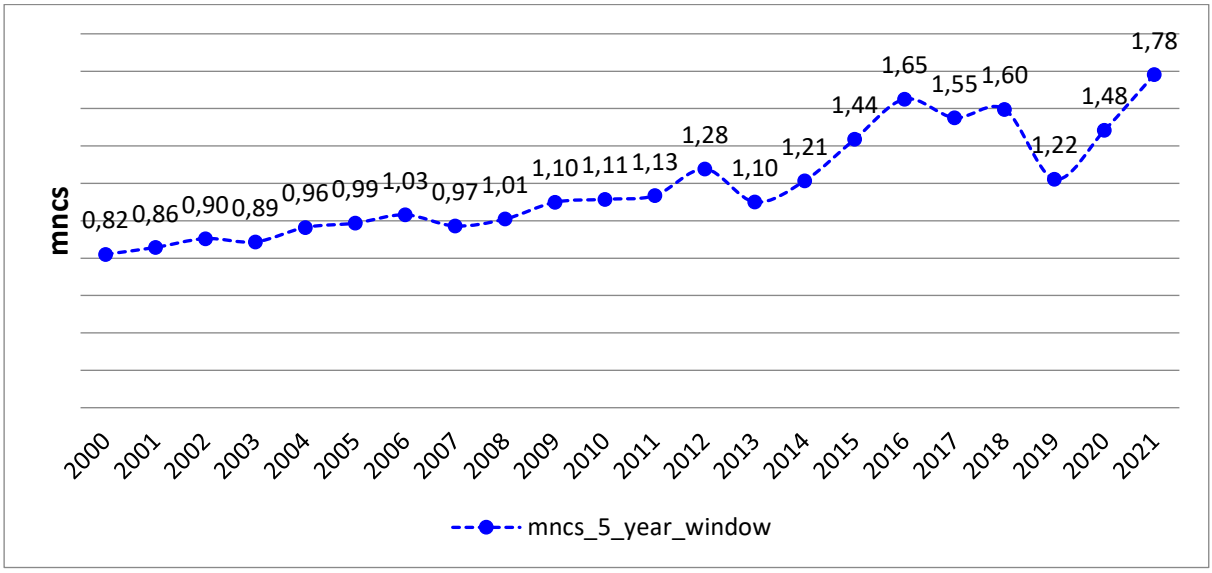
**Figure 42: Trends in research collaboration in comparison**



## 4.5 Citation impact of SU articles and review articles

We measure the visibility or citation impact of our publications by counting the number of times our publications are cited by other scholars in the field. This is seen as a measure – not of the quality of our publications – but indeed of the recognition it gets in the fields that we work. The standard indicator used in this area is the MNCS (Field-normalized citation score) as it normalizes for the differences in citation behaviour (citation density) across scientific fields, document types and publication year. As in the case of the RFS-value, a MNCS-value of 1 also means that the citation impact of a set of publications by an observation unit, is equal to that of the world average for the relevant fields. Figure 43 below shows the trend in the MNCS-values for SU's publications. The results are very positive with an overall trend where the citation impact of the university's publication more than doubling its MNCS score between 2000 and 2021. The value of 1.78 in the most recent year (2021) in effect means that the average SU paper generated nearly 80% more citations than papers in the rest of the world (in the same fields).

**Figure 43: SU mean normalized citation score (MNCS 5-year window)**




A comparison of trends in citation impact across the top six universities is presented overleaf. The data shows that UCT's papers recorded the highest average field-normalized citation score of 1.91, followed by SU (1.79), WITS (1.7), UKZN (1,54), UJ (1.26) and UP (1.14). All but one of these universities (UJ) have medical faculties which is a main contributor to these relatively high citation impact values. Although the differences in values may look small, it must be kept in mind that if one multiplies these average scores with nearly 4 000 papers that are produced by these universities, the aggregate effect is large. These data also explain, to a large extent, why these universities are consistently the highest ranked universities in the country on most international rankings where citation impact carries a significant weight in the calculation of the rank position.

**Figure 44: Comparison of trends in citation impact (MNCS 2010 – 2021) amongst top six SA universities**