Quantitative assessment of South Africa's inventive outputs: International patent analysis

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June 2006

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Executive Summary

This document has been prepared on the request of NACI in order to identify the inventive activity of South Africans as it is manifested in the form of patents. Patents are used internationally as indicators of national and corporate inventive activity. We quote Griliches[1] who points out that "Patent statistics remain a unique source for the analysis of the process of technical change. Nothing else even comes close in the quantity of available data, accessibility, and potential industrial, organizational, and technological detail."

Inventive activity is analysed in terms of patents awarded to South African inventors by the USA patent office, by the European Patent Office and by USPTO, EPO and Japanese patent office together (triadic patents). The choice of the particular patent offices is in accordance to international best practise. We emphasise that patents in those patent offices are examined for originality, usefulness and novelty (an activity which does not take place in the South African Patent Office).

South African inventors are identifies to apply and receive approximately 110 patents per year from the USPTO. Fewer patents are granted to South Africans by the EPO and according to triadic system (USPTO; EPO and JPO). Analysis of the South African patents according to technological classes (period 2000 to 2004) identifies that class 210 "Liquid Purification or Separation" is the most prolific class with 26 patents. Class 424 "Drug, Bio-Affecting and Body Treating Compositions" is second in the list with 22 patents. In comparison to other countries South Africa is ranked fourth in the world in class 518 "Chemistry: Fischer-Tropsch Processes; or Purification or Recovery of Products Thereof" and 12th in class 075 "Specialised Metallurgical Processes". We suggest that the identified classes indicate the country's strengths and government can support their further development and exploitation in the national interest. Overall South Africa is ranked 29th in the world.

Co-invention analysis identifies that during the period 2000-2004 there were 117 co-invented patents out of the 556 patents granted to South African inventors (21%). USA

1 Griliches, Z. (1990) "Patent Statistics as Economic Indicators: A Survey." *Journal of Economic Literature*, 28 :1661-1707 p1702

is the main technological collaborator of South Africa with 37% of the collaborative efforts (43 patents). Germany and the UK follow with 22 and 18 patents respectively.

Corporate patent analysis shows that SASOL Technology Ltd has the most patents during the most recent 5-year period. Furthermore it is identified that a number of organisations that used to be prolific patent holders in the past have stopped doing do in the most recent period.

Comparison of the number of applications in the Patent Cooperation Treaty system with the number of granted patents by the USPTO or EPO reveals that on average only half of the PCT applications become eventually patents.

The report outlines the "pro-patent policy hypothesis" and the "fertile technology hypothesis" which explain the international growth of patents during the last 15 years and identifies that South Africa has not benefited by those international changes.

Regression analysis indicates that "business enterprises R&D expenditure" determines to a large extend the number of triadic patents granted to different countries (with obvious policy consequences). South Africa is identified to produce well below the expected number of patents and it is argued that structural impediments (high patenting costs; lack of large corporations in the economy etc) may explain that discrepancy.

Finally the report identifies that further research on the reasons behind the difference in the number of PCT applications and number of patents granted and the declining inventive activity of particular corporations may lead to valuable policy insights and guidelines.

Introduction

Monitoring and evaluating the various facets of the scientific enterprise is a necessary and integral part of science policy. Rising costs of research and development and competing disciplinary claims for financial resources require intelligent allocation of resources, which presupposes knowledge of the activities and performance of the innovation system.

One of the most efficient and objective methods of assessing research and innovation performance is through scientometric indicators. An indicator is defined[2] as "statistics of direct normative interest which facilitates concise, comprehensive and balanced judgments about the condition of major aspects of a society. It is in all cases a direct measure of welfare and is subject to the interpretation that, if it changes in the "right" direction, while other things remain equal, things have gotten better or people better off." Scientometric analysis, the quantitative study of the innovation system, is based mainly on bibliometric and patent indicators. In bibliometrics the number of publications in a field is considered as an indicator of research activity. Similarly in patent analysis the number of patents awarded to an institution or a country is used as an indicator of technological activity. Patent indicators - within the science and technology (S&T) context - are used to measure inventive performance, diffusion of knowledge and internationalization of innovative activities - across countries, firms, industries, technology areas, etc.

The philosophy underlying the use of bibliometric indicators as performance measures has been summarized in De Solla Price's statement that "for those who are working at the research front, publication is not just an indicator but, in a very strong sense, the end product of their creative effort."[3]

Of course, there are many trained scientists who are not required to publish. They may perform managerial or administrative functions, they may teach available knowledge or they may apply existing knowledge in making new products and in providing services. The common characteristic of all these scientists is that they are far away from the research front. They provide the infrastructure for the producers of knowledge and they exploit the end results of research and development. In any case, however, they cannot be considered as "knowledge" producers.

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2 DHEW (1970) "*Towards a Social Report*" Department of Health, Education and Welfare University of Michigan Press, Ann Arbor

3 De Solla Price D (1975) "The Productivity of Research Scientists" In *Yearbook of Science and the Future, Encyclopaedia Britannica Inc.*, University of Chicago, Chicago.

The same way, in which scientific articles are accepted as a legitimate reflection of scientific research, patents are accepted as a reflection of technological achievements. Griliches[4] has pointed out that "Patent statistics remain a unique source for the analysis of the process of technical change. Nothing else even comes close in the quantity of available data, accessibility, and potential industrial, organizational, and technological detail."

Patents fulfil two roles. They provide inventors with legal protection for novel products and processes and simultaneously, they ensure that the knowledge of these products and processes becomes available to society. In this way both private and public interests are served. Carr[5] describes the concept of patent as follows:

"A patent is an exclusionary right granted by a government entity. The concept behind the United States patent system is that the government grants statutory protection to an inventor in the form of exclusionary rights for a period of years in return for a disclosure of the creativity of the grantee. The exclusionary rights granted by the patent are the rights to exclude others from making, using or selling the patented invention throughout the United States and its territories for a period of 17 years. In exchange for these rights, the patent discloses and teaches technical knowledge relating to the invention. During the life of the patent, scientists and other inventors benefit from the disclosure of prior art information by avoiding repeating efforts to discover that which is already known. After the patent expires, the invention belongs to the public and anyone can make, use or sell the invention without permission of the patentee"

Patent analysis possesses a number of strengths that facilitates their universal use as scientometric tools. They are highly reliable because they are well defined and unambiguous. They facilitate detailed categorisation and hence make possible the study of scientific and technological fields and sub-fields and finally they make

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4 Griliches, Z. (1990) "Patent Statistics as Economic Indicators: A Survey." *Journal of Economic Literature*, 28 :1661-1707 p1702

5 Carr K.F. (1995) "*Patents Handbook: a Guide for Inventors and Researchers to Searching Patent Documents and Preparing and Making an Application*" McFarland and Co., Jefferson, NC and London

possible international comparisons. OECD provides guidelines for the use of patents in their relevant manual.[6]

In the United States of America the National Science Foundation[7] is using bibliometrics, patent and trade in high technology analysis to monitor the health of American science and technology on a continuous basis; in Europe the European Commission[8] is using similar approaches in order to monitor the health of the European innovation system and the Organisation for Economic Cooperation and Development[9] (OECD) is using the indicators for monitoring and comparative purposes.

The purpose of this document is to identify the performance of the South African innovation system as it is manifested in the analysis of patents.

Methodology and data sources

Patent analysis- within the science and technology (S&T) context - is used to measure inventive performance, diffusion of knowledge and internationalization of innovative activities - across countries, firms, industries and technology areas. Porter, et al[10] argue that patent indicators are the most appropriate for defining the innovative capacity of countries and that international patenting is strongly correlated with alternative measures of innovative output such as the number of scientific journal articles and also with outcome measures such as a country's market share in high-technology industries.

The patents most often utilized internationally for this type of analysis are those awarded by the USPTO. Although most countries in the world have their own patent

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6 OECD (1994) *"The Measurement of Scientific and Technological Activities, Using Patent Data as Science and Technology Indicators - Patent Manual"*, OECD, Paris

7 NSB (2004) *"Science and Engineering Indicators-2004"*, National Science Board, Arlington, VA: National Science Foundation.

8 EC (1997) *"Second European Report on S&T Indicators 1997"* European Commission, Directorate General XII. Science, Research and Development, Brussels.

9 OECD (2003), *Main Science and Technology Indicators*, Organisation for Economic Cooperation and Development, Paris

10 Porter, M. E., Scott S., and the Council on Competitiveness (1999), *"The New Challenge to America's Prosperity: Findings from the Innovation Index"*, COC: Washington

authorities, the use of the USPTO provides a number of advantages. First in the majority of the patent offices, patents are not examined for originality, usefulness and novelty. Consequently counting and comparing patents awarded by different patent offices in different countries may be misleading because of differences in the criteria used and the easiness of awarding patents, bias towards local patents etc. The obvious solution in order to avoid the above-mentioned shortcomings is to use a common denominator such as an external patent system with an objective approach in its awarding patents approach (i.e. the USPTO). The USPTO examines claims according to a number of criteria. These are[11]:

- Subject matter: an invention must fall into one of the categories the patent law divides patentable subject matter into.
- Utility: An invention must fulfil the substantive requirement of "utility". An invention must perform a designed function or achieve some minimum human purpose.
- Novelty: an invention has to be novel.
- Non-obviousness: the knowledge in the technological field at the time of invention must not make the invention obvious to one of ordinary skill in that area.
- Definiteness: one skilled in the art must understand the limits of the invention based on the claim language.

Second, the US represents the most important single market for technological sales and hence is a key drawing card for technology-based products. Owners of important commercial inventions will make sure that they are protected in the USA market. Third, the costs involved and the complexity of filing foreign patents in the USA tend to screen out trivial patents.

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11 Fordis, B.J. and Sung, M.L. (1995) How to avoid patent rejection, *Bio/Technology* 13, 42-43

Although patents facilitate the development of a number of useful indicators they have a number of drawbacks. Patented inventions are not necessarily all the inventions produced in a country or organization. Many inventions are not patented because there are other barriers to entry (e.g. lack of brand names among the competitors), because inventors may undertake other measures of protection (e.g. the encapsulation of products in epoxy resin to deter imitation) or because inventors consider that the invention will be profitable even if imitators may appear in the foreseeable future.

The USPTO classifies the patents to different classes and subclasses. The class breakouts represent major divisions of technology in the US Patent Classification System (USPCS). The USPCS contains currently approximately 460 total classes and 150,000 total subclasses. The classification of the patents to subclasses is done according to information disclosed in the patent. If more than one technology is identified as pertinent to the patent, one subclass is designated as the primary classification and the remainders are designated as cross-reference classifications. Counting patents by primary classification ensures that each patent is counted only once. The residence of the first named inventor listed on the patent grant determines patent origin.

Furthermore the USPTO classifies patents to utility patents (i.e. patents for invention), reissue patents, plant patents, design patents and statutory invention registrations and defensive publications. In our investigation we utilize only utility patents.

For comparative purposes we also report patent statistics from the European Patent Office.

An additional approach that we use in our analysis is that of the triadic patent families' analysis. The approach has been developed recently by OECD[12]. Patents taken in various countries to protect inventions can be linked together to build triadic patent families: a set of patents taken at the European Patent Office (EPO), the

12 Dernis H. and Kahn M., (2004) "*Triadic Patent Families Methodology*", STI Working Paper 2004/2, OECD, Paris

Japanese Patent Office (JPO), and the US Patent and Trademark Office (USPTO) that share one or more priorities. Patent families are derived from priority application (first filing to a patent office for a patent to protect an invention). A single priority may lead to several patents or a single patent may include several priorities.

The triadic patent families approach has a number of advantages. When patent counts are based on a single office, many patents with little or no value are included while few are extremely valuable (skewed distribution of patents' value). Furthermore, it is difficult to compare domestic filings with foreign patent applications since the average value of foreign patents might be higher than that of the domestic ones, due to the self selection process. The self selection process occurs when the inventor (applicant) - usually filing for protection at the domestic patent office - extends the protection to foreign countries. Only a proportion of the total domestic patents are subsequently filed abroad: extending protection to foreign countries increases the costs of patenting for the inventor (additional patent office fees, translation costs, attorney fees, etc.). The inventor (applicant) will only accept these additional costs on the condition that expected revenues outweigh patenting costs. As a consequence, triadic patent families tend to capture the most economically important inventions and - to certain extent - the inventions included in the data set are comparable to each other. Furthermore, due to the rules and regulations within patent offices, comparing patent counts based on different patent offices (*e.g.* USPTO vs. EPO) is limited: differences in processing and publishing patent filings, scope of patent protection, etc. Thus, identifying triadic patent families improves the comparability of indicators by eliminating the impact of country's specific rules and regulations.

Dernis *et al* argue that in comparison with traditional indicators based on patent filings to a single patent office, the triadic patent families cover a homogeneous set of inventions as the most important inventions are deemed to be protected by a patent at the EPO, JPO and the USPTO.

Furthermore, the resultant indicators are less influenced by patent offices' rules and regulations, and patenting strategies. Consequently, counting triadic patent families provides indicators of an improved quality and international comparability for measuring innovation performance of countries.

Finally we report South African applications in the Patent Cooperation Treaty (PCT) system. The PCT is an international treaty, administered by the World Intellectual Property Organization (WIPO), between more than 125 Paris Convention countries. The PCT makes it possible to seek patent protection for an invention simultaneously in each of a large number of countries by filing a single "international" patent application instead of filing several separate national or regional patent applications. The granting of patents remains under the control of the national or regional patent Offices in what is called the "national phase."

Briefly, an outline of the PCT procedure includes the following steps:

Filing: you file an international application, complying with the PCT formality requirements, in one language, and you pay one set of fees.

International Search: one of the world's major patent Offices identifies the published documents which may have an influence on whether your invention is patentable and establishes an opinion on your invention's potential patentability.

International Publication: as soon as possible after the expiration of 18 months from the earliest filing date, the content of your international application is disclosed to the world.

International Preliminary Examination: one of the world's major patent Offices may, at your request, carry out an additional patentability analysis, usually on an amended version of your application.

Entry into the National/Regional Phase: after the end of the PCT procedure, you start to pursue the grant of your patents directly in the countries in which you want to obtain them.

The advantages of the PCT system are as follows:

(i) you have up to 18 months more than if you had not used the PCT to reflect on the desirability of seeking protection in foreign countries, to appoint local patent agents in each foreign country, to prepare the necessary translations and to pay the national fees;

(ii) you can rest assured that, if your international application is in the form prescribed by the PCT, it cannot be rejected on formal grounds by any PCT Contracting State patent Office during the national phase of the processing of the application;

(iii) on the basis of the international search report and the written opinion, you can evaluate with reasonable probability the chances of your invention being patented;

(iv) you have the possibility during the optional international preliminary examination to amend the international application and thus put it in order before processing by the various patent Offices;

(v) the search and examination work of patent Offices can be considerably reduced or eliminated thanks to the international search report, the written opinion and, where applicable, the international preliminary report on patentability that accompany the international application;

(vi) since each international application is published together with an international search report, third parties are in a better position to formulate a well-founded opinion about the potential patentability of the claimed invention; and

(vii) for you as an applicant, international publication puts the world on notice of your application, which can be an effective means of advertising and looking for potential licensees.

South Africa's Performance

Figure 1 shows the number of patents awarded to South African inventors in the USPTO during the period 1963 to 2004. The figure makes profound that the number of South African patents in the USPTO was increasing up to early 1990's and after that it was stabilized around a figure of 110 patents per year.

Figure 2 shows the South African share in the USPTO for the period 1963-2004. The shares to the total number of patents granted and to the number of foreign patents granted are shown. The graph of the number of SA to number of foreign patents granted indicates a long term decline. The number of patents granted to inventors of other countries (than South Africa) has increased much faster than the number of patents awarded to South African inventors and hence the relevant ratio has declined from above 0.5% in 1965 to 0.1% during 2004. The ratio of number of South African patents to total number of granted patents, substantially lower due to the large number of USA patents, shows a smaller variation because of a relative decline in the number of USA patents over time. We elaborate on the above issues in the discussion section.

Figure 1: South African number of patents – USPTO 1963-2004

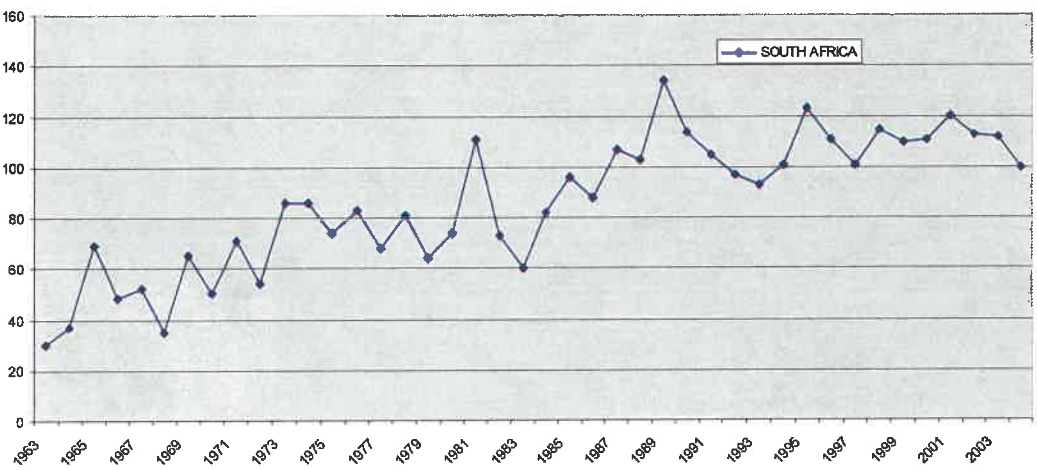

Figure 2: South African share of patents – USPTO 1963-2004

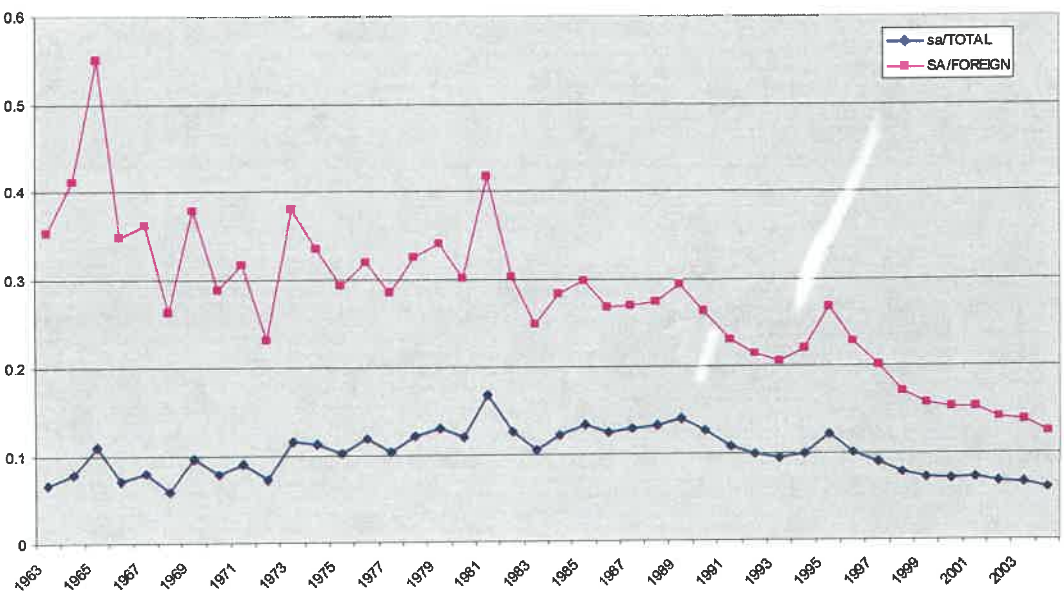

Table 1 shows the number of patents granted to South African inventors and inventors from a selected set of other countries during 1991, 1994, 2000 and 2004. The countries have been selected because they started the 1990s with fewer patents than South Africa and during 2004 they were producing substantially larger numbers. For example, Indian inventors were awarded 22 patents during 1991. In 2004 Indian inventors were awarded 363 patents - a more than 16 fold increase. Similarly inventors from Hong Kong and Singapore (relative small countries in terms of population) have been able to increase substantially the number of their patents within a decade.

Table 1: Number of patents in South African and selected countries

Granting year	1991	1994	2000	2004
South Africa	105	101	120	100
China, HK	50	57	179	311
Singapore	15	51	218	449
India	22	27	131	363
Ireland	53	48	121	186
Brazil	62	60	98	106
Norway	111	126	248	243
New Zealand	41	37	107	142
China, P Rep	50	48	119	404
Foreign Origin	45,334	45,610	72,426	80,022

Table 2 shows the top 30 countries in terms of number of patents granted during 2004. The table shows the number of patents granted to inventors from different countries as well as their relative share of patents in the USPTO. USA tops the table with 84271 patents which constitute 51.5% of the total number of patents granted. Japan follows with 35350 patents or 21.6% of the total. South Africa and Mexico are at the bottom of the list (29th and 30th positions) with 0.1% of the patents each. It should be mentioned that South Africa was in the 21st position during 1991.

Table 2: Percent and number of patents granted in year 2004 by country of origin (USPTO): Top 30 countries

	Country	Number	Per Cent
1	USA	84,271	51.5%
2	Japan	35,350	21.6%
3	Germany	10,779	6.6%
4	Taiwan	5,938	3.6%
5	South Korea	4,428	2.7%
6	United Kingdom	3,450	2.1%
7	France	3,380	2.1%
8	Canada	3,374	2.1%

9	Italy	1,584	1.0%
10	Sweden	1,290	0.8%
11	Switzerland	1,277	0.8%
12	Netherlands	1,273	0.8%
13	Israel	1,028	0.6%
14	Australia	953	0.6%
15	Finland	918	0.6%
16	Belgium	612	0.4%
17	Austria	540	0.3%
18	Singapore	449	0.3%
19	Denmark	414	0.3%
20	China, P Rep	404	0.2%
21	India	363	0.2%
22	China, HK	311	0.2%
23	Spain	264	0.2%
24	Norway	243	0.1%
25	Ireland	186	0.1%
26	Russia	169	0.1%
27	New Zealand	142	0.1%
28	Brazil	106	0.1%
29	**South Africa**	100	0.1%
30	Mexico	86	0.1%
	TOTAL	**163,682**	**100%**

Table 3 shows the number pf patents awarded to a number of corporations for comparative purposes. IBM at the top of the list was granted 3248 patents during 2004. The table makes profound that a number of corporations are substantially bigger in terms of patents than most of the countries. Canon for example is granted more patents than Belgium, Austria and Denmark together. During 2004 only 10.6% of the granted patents by USPTO were granted to individuals.

Table 3: Number of patents from prolific organisations (2004)

Organisation	Number
IBM	3248
Canon	1805
HITACHI	1514
TOSHIBA	1311
Matsushita Elec Ind Co	1934
NEC	813
Sony	1311
Fujitsu	1296
Samsung	1604
Honda Motors	736
University of California	422

NASA	102
Microsoft	629
University of Texas	99
California Inst Technology	135

Table 4 shows the patent classes in which South Africa has been granted more than 10 patents during the 2000-2004 period. The class 210 "Liquid Purification or Separation" is on top of the list with 26 patents. Class 424 "Drug, Bio-Affecting and Body Treating Compositions" is second in the list with 22 patents. The eight classes in the table (out of the more than 400 classes) include 23% of the total number of patents granted to South African inventors. Appendix 1 provides comprehensively the distribution of South African patents to different classes for the period 2000 to 2004.

Table 4: Patents granted to SA inventors by technology class

Class	Class Title	2000	2001	2002	2003	2004	Total
210	Liquid Purification or Separation	7	9	5	4	1	26
424	Drug, Bio-Affecting and Body Treating Compositions (incl. Class 514)	5	4	5	7	1	22
340	Communications: Electrical	5	7	2	3	1	18
075	Specialised Metallurgical Processes, Compositions for Use Therein, Consolidated Metal Powder Compositions and Loose Metal Particulate Mixtures	1	7	2	2	4	16
423	Chemistry of Inorganic Compounds	2	3	3	2	3	13
532	Organic Compounds (incl Classes 532-570)	2	2	3	3	3	13
518	Chemistry: Fischer-Tropsch Processes; or Purification or Recovery of Products Thereof	1	2	2	1	5	11
198	Conveyors: Power Driven	3	3	2	0	2	10

Tables 5 to 12 present the ranking of countries according to number of patents they have been awarded in specific technology classes. For example, Table 5 shows that in class 518 "Chemistry: Fischer-Tropsch Processes; or Purification or Recovery of Products Thereof" the top country is USA with 145 patents during the period. Japan, United Kingdom, France and South Africa follow with 15, 12, 11 and 11 patents respectively. South Africa shares the fourth position with France.

Table 5: Top patenting countries in USPTO in class 518 (Chemistry: Fischer-Tropsch Processes; or Purification or Recovery of products Thereof) 2000-2004

JAPAN	15
UNITED KINGDOM	12
FRANCE	11
SOUTH AFRICA	11
ITALY	7
RUSSIAN FEDERATION	7
NORWAY	6
CANADA	3
CHINA P.REP.	3
GERMANY	3
NETHERLANDS	3
SOUTH KOREA	2
BELGIUM	1
SWITZERLAND	1
DENMARK	1
TRINIDAD/TOBAGO	1

Table 6: Top patenting countries in USPTO in class 075 (Specialized Metallurgical Processes, Compositions for Use Therein, Consolidated Metal Powder Compositions, and Loose Metal Particulate Mixtures) 2000-2004

JAPAN	279
GERMANY	81
AUSTRIA	53
CANADA	52
SWEDEN	41
FRANCE	37
AUSTRALIA	29
SOUTH KOREA	26
SWITZERLAND	25
UNITED KINGDOM	20
SOUTH AFRICA	16
FINLAND	11
VENEZUELA	9
ITALY	8
NORWAY	8
INDIA	7

Table 7: Top patenting countries in USPTO in class 210 (Liquid Purification or Separation) 2000-2004

JAPAN	511
GERMANY	378
CANADA	236
FRANCE	184
UNITED KINGDOM	111
SWEDEN	87
AUSTRALIA	76
NETHERLANDS	71
TAIWAN	57
FINLAND	52
SOUTH KOREA	52
ITALY	50
SWITZERLAND	33
ISRAEL	30
AUSTRIA	28
SOUTH AFRICA	26
BELGIUM	23

Table 8: Top patenting countries in USPTO in class 340 (Communications: Electrical) 2000-2004

JAPAN	987
GERMANY	453
TAIWAN	207
CANADA	193
UNITED KINGDOM	173
FRANCE	148
SOUTH KOREA	84
ISRAEL	71
SWEDEN	55
AUSTRALIA	45
SWITZERLAND	39
ITALY	34
AUSTRIA	28
NETHERLANDS	23
FINLAND	19
SOUTH AFRICA	18
CHINA,HONG KONG S.A.R.	13
SINGAPORE	10

Table 9: Top patenting countries in USPTO in class 198 (Conveyors: Power-driven) 2000-2004

GERMANY	317
JAPAN	272
ITALY	149
CANADA	101
SWITZERLAND	89
NETHERLANDS	53
FRANCE	52
SWEDEN	43
AUSTRIA	42
UNITED KINGDOM	40
DENMARK	23
TAIWAN	20
FINLAND	16
AUSTRALIA	15
SPAIN	13
SOUTH KOREA	12
SOUTH AFRICA	10
NORWAY	7
BELGIUM	5

Table 10: Top patenting countries in USPTO in class 423 (Chemistry of Inorganic Compounds) 2000-2004

JAPAN	452
GERMANY	246
FRANCE	137
CANADA	80
UNITED KINGDOM	66
SOUTH KOREA	40
NETHERLANDS	26
INDIA	25
ITALY	25
DENMARK	23
SWEDEN	23
AUSTRALIA	22
BELGIUM	19
TAIWAN	19
FINLAND	17
NORWAY	17
CHINA P.REP.	15
RUSSIAN FEDERATION	14
SOUTH AFRICA	13

Table 11: Top patenting countries in USPTO in class 532 (Conveyors: Power-driven) 2000-2004

JAPAN	2347
GERMANY	2246
FRANCE	609
UNITED KINGDOM	600
SWITZERLAND	373
ITALY	282
INDIA	272
SOUTH KOREA	252
NETHERLANDS	218
CANADA	203
TAIWAN	114
ISRAEL	113
BELGIUM	102
SWEDEN	92
AUSTRIA	68
DENMARK	68
AUSTRALIA	66
SPAIN	63
FINLAND	56
HUNGARY	43
RUSSIAN FEDERATION	31
CHINA P.REP.	27
NORWAY	25
SOUTH AFRICA	13

Table 12: Top patenting countries in USPTO in class 424 (Drug, Bio-Affecting and Body Treating Compositions) 2000-2004

JAPAN	2800
GERMANY	2417
FRANCE	1819
UNITED KINGDOM	1775
CANADA	980
ITALY	554
SWITZERLAND	406
SWEDEN	400
ISRAEL	351
DENMARK	317
AUSTRALIA	273
SOUTH KOREA	271
BELGIUM	253
NETHERLANDS	248
INDIA	246
TAIWAN	120
SPAIN	117
CHINA P.REP.	94
FINLAND	93
AUSTRIA	72
NEW ZEALAND	70
NORWAY	64
HUNGARY	54
RUSSIAN FEDERATION	45
IRELAND	40
ARGENTINA	33
SOUTH AFRICA	22

Table 13 summarises South Africa's ranking in the technology classes in which the country produced more than 10 patents over the 5 year period (2000-20004). South Africa is in 4th position in class 518 "Chemistry: Fischer-Tropsch Processes" and the 12th position in class 075 "Specialised Metallurgical Processes..." The technology classes in Table 5 reveal the technological areas in which South Africa has internationally recognised expertise.

Table 13: International ranking of South Africa according to technology class

Class	Ranking
518 Chemistry: Fischer-Tropsch Processes	4
075 Specialised Metallurgical Processes	12
210 Liquid Purification or Separation compositions	17
198 Conveyors: Power Driven	18
423 Chemistry of Inorganic Compounds	20
532 Organic Compounds	25
424 Drug, Bio-Affecting and Body Treating Compositions	28

Table 14 shows the number of patents which have been co-invented between one South African and a foreigner inventor. During the period 2000-2004 there were 117 co-invented patents out of the 556 patents granted to South African inventors (21%). USA is the main technological collaborator of South Africa with 37% of the collaborative efforts (43 patents). Germany and the UK follow with 22 and 18 patents respectively.

Table 15 shows the companies appearing as first assignees in the set of South African patents during 2000-2004 and during 1969-2004. The table shows that SASOL Technology Ltd has the most patents during the most recent 5-year period. It is interesting to note that there are a number of companies with substantial patenting activity during the period 1969-2004 and limited activity during the most recent period. For example AECI appears with 41 patents during 1969-2004 but only with one patent during 2000-20004. It would be important for policy purposes to identify the reasons for the exhibited decline.

Table 14: Number of patents with co-inventors from other countries: SA 2000-2004

Country	Number of patents	Per Cent%
USA	43	37
Germany	22	19
UK	18	15
Australia	8	7
Canada	7	6
Switzerland	5	4
Netherlands	4	3
France	3	3
Sweden	2	2
South Korea	2	2
Poland	1	< 1
Ireland	1	< 1
Israel	1	< 1
Total	117	100

Table 15: Companies appearing as first assignees in the set of South African patents during 2000-2004 and during 1969-2004

First Named Assignee	2000-2004	1969-2004
CSIR	8	36
SASOL Tech Ltd	29	31
Technology Finance Corp	5	1
DENEL	6	14
WRC	6	14
Windsor Tech Ltd	11	11

MINTEK	3	21
Implico BV	5	9
ESKOM	4	8
Ipcor NN	6	6
SASOL Chemical Industries	1	6
Sentrachem Ltd	0	6
Supersensor Ltd	6	6
University of Pretoria	3	6
Claas Selbstfahrende Entemaschinen GMBH	5	5
SA Invention Development Corp	0	8
AECI	1	41
Rotary Profile Anstalt	0	32
Tobacco Research and Development Institute	1	19
Circuit Breaker Industries Ltd	2	17

Table 16 shows the number of patents granted to South African inventors by the European Patent Office during the 1984-2004 period. The table also shows the number of total patents granted by the EPO and the South African shares. When patents have more than one inventor they are allocated fractionally. During the last two years South African inventors have been awarded between 70 and 80 patents. The country's share has been relative stable approximately 0.13% during the most recent years.

Table 16: Number of patents granted to SA inventors by the EPO: 1984-2004

Year	SA@EPO Patents	World Patents	SA Share
1984	16.8	13329	1.26 - 0.3
1985	22.5	15129	1.48 - 0.3
1986	29.5	18490	1.60 - 0.3
1987	16.2	17154	0.94 - 0.3
1988	29.4	19760	1.48 - 0.3
1989	21.4	22581	0.95 - 0.3
1990	33.5	24774	1.35 -0.3
1991	41.8	26664	1.56 - 0.3
1992	27.0	30433	0.89 - 0.3
1993	33.6	36698	0.91 - 0.3
1994	35.7	42025	0.85 - 0.3
1995	32.6	41635	0.78-0.3
1996	54.2	40084	1.35-0.3
1997	55.3	39658	1.39-0.3
1998	42.8	36733	1.16-0.3
1999	42.8	35367	1.21-0.3
2000	40.9	27526	1.48-0.3
2001	40.7	34710	1.17-0.3
2002	69.2	47380	1.46-0.3
2003	72.9	59989	1.21-0.3
2004	79.3	58726	1.35 - 0.3

Table 17 shows the way South African patents are distributed in sections of the International Patent Classification (IPC) system. South Africa presence is highest in Section E: fixed constructions and smallest in Section F: mechanical engineering; lighting; heating; weapons; blasting.

Table 17: South African patents and share in EPO according to IPC

International Patent Classification	South Africa	World	Share
A - Human Necessities	49.6	25363	1.95 - 0.3
B - Performing Operations; Transporting	56.3	35911	1.56 - 0.3
C - Chemistry; Metallurgy	38.1	29663	1.28- 0.3
D - Textiles; Paper	5	3592	1.39- 0.3
E - Fixed Constructions	20.3	5502	3.68- 03
F - Mechanical Engineering; Lighting; Heating; Weapons; Blasting	10.4	16487	0.63-0.3
G - Physics	24.5	25436	0.96-0.3
H - Electricity	17.1	24141	0.71-0.3

We have also examined the collaborative patterns of South African patents in the EPO. During 2002, 2003 and 2004 the percentages of patents with at least a foreign co-inventor were 18%, 11.5% and 16% respectively. The main regions of collaboration are European Union 50% and USA 24%.

Table 18 shows the number of South African triadic patent families according to priority date (first filing of the original application worldwide). The triadic patent families are defined as a set of patents taken at the EPO, USPTO and at the Japanese Patent Office. The figures for the most recent years may be understated because of legal delays at the 3 patent offices for publishing patent information. The table indicates that South Africans do not protect their IP to all three patent offices as often as they do in the individual patent offices.

Table 18: South African Triadic Patents 1990-2001

Year	SA/Triadic Patents	World Patents	SA Share
1990	13.2	32769	0.40 - 0.3
1991	17.3	29973	0.57 - 0.3
1992	32.2	30036	1.07 - 0.3
1993	32.7	30685	1.06 - 0.3
1994	200.3	32202	0.63 - 0.3
1995	25.5	35406	0.72 - 0.3
1996	28.8	38690	0.74 - 0.3

1997	32.3	40909	0.78 - 0.3
1998	35.2	39745	0.88 -0.3
1999	25.3	38474	0.65 - 0.3
2000	19.25	32516	0.59 - 0.3
2001	1.25	20371	0.06 -0.3

Table 19 shows the number of South African PCT International Applications. The table shows that even though more than 300 inventors utilise the service, less than half go ahead to protect their invention through an application in an international patent office. It is interesting from a policy perspective to identify the reasons behind the reluctance of inventors to proceed and protect their intellectual property.

Table 19: Number of PCT applications filed by date of filing by South Africa

Year	Number of applications
1997	**84**
1998	**114**
1999	**317**
2000	**387**
2001	**419**
2202	**384**
2003	**357**
2004	**410**
2005	**360**

Summary and Discussion

This document has been prepared on the request of NACI in order to identify the inventive activity of South Africans. Inventive activity is analysed in terms of patents awarded to South African inventors by the USA patent office, by the European Patent Office and by USPTO, EPO and Japanese patent offices together (triadic patents). We quote Griliches who has pointed out that "Patent statistics remain a unique source for the analysis of the process of technical change. Nothing else even comes close in the quantity of available data, accessibility, and potential industrial, organizational, and technological detail."

Our analysis indicates that South Africa produces a constant stream of patents in the USPTO during the last 15 years and a slightly increasing number of patents in the EPO. The technological class 518 "Chemistry: Fischer-Tropsch Processes; or Purification or Recovery of Products Thereof" appears to be the most inventive for South Africa. South Africa shares the fourth position with France in that class. South Africa occupies the 12th position in class 075 "Specialised Metallurgical Processes..." Those technologies constitute the country's technological strengths and government has the opportunity to build upon them technological platforms to the national interest. We further identify the most prolific SA companies and the countries with which SA collaborates in the production of inventions.

An important finding is that South Africa appears not to have participated in the international explosion of patents during the last 15 to 20 years. During the past 2 decades most of the industrialised countries have experienced an increase in patenting activity.

Two hypotheses have been offered to explain that increase: the pro-patent policy hypothesis[13] and the fertile technology hypothesis[14].

Merges (footnote 13) has suggested that the jump in patenting activity reflects an increase in the propensity to patent inventions, driven by changes in the legal environment for patent holders. The recent international surge in patent applications may be a direct consequence of a major institutional change. Since the 8th General

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13 Merges, R.P. (1992) "*Patent Law and Policy*", Charlottesville, Virginia: Michie Company.

Merges, R.P. (1995) "Economic Impact of Intellectual Property Rights: An Overvieww and Guide." *Journal of Cultural Economics*, 19 (1995):103-17.

14 Greenwood, J. and M. Yorukoglu, (1997) "1974 Carnegie-Rochester Conference Series on Public Policy", 46:49-95

Arora, A. and A. Gambardella (1994) "The Changing Technology of Technological Change: General and Abstract Knowledge and the Division of Innovative Labour." *Research Policy*, 23:523-32.

Kortum, S. and J. Lerner, (1997) "*Stronger Protection or Technological Revolution: What is behind the Recent Surge in Patenting?*" NBER Working Paper 6204, Cambridge, Mass.: National Bureau of Economic Research

Agreements on Tariffs and Trade (GATT) round, industrialized countries have changed their standards for protecting intellectual property via patents. The changes have not only broadened the rights of patentees but have also strengthened the protection of intellectual property rights. These changes have been widely regarded as "pro-patent" and it has been argued that are expressed particularly in the increase in patent filing (see Kortum et al 1997, footnote 14).

A different explanation for the recent jump in patenting stresses the type of technological revolution that has been widening the set of technological opportunities (Greenwood and Yorukoglu 1997, footnote 14). Connected with this is the explosion of new firm formation and innovation in the high-technology sector, particularly in the biotechnology, information technology and software industries. Further, the application of information technology to the discovery process itself may have substantially increased the productivity of research and development (see footnote 14, Arora and Gambardella 1994). Another possibility is that changes in the management of R&D facilities, in particular a shift to more applied activities, have increased the yield of patentable innovations[15]. Still another possibility is that the increased level of patenting activity is the result of an overall increase in inventive input (higher levels of R&D and/or changes in the composition of R&D).This set of ideas can be grouped together as the "fertile technology hypothesis" to explain why patenting has surged.

As no substantial increase can be detected in the number of South African patents it is reasonable to suggest that neither the policy environment neither factors determining technological fertility have changed during the last two decades.

OECD[16] has argued that patents and particularly the triadic ones are the result of business expenditure on R&D. Following their example (see figure 3) we incorporated the South African data in their analysis and we performed a regression of the "business expenditure on R&D" on the number of triadic patents for 35 countries (see appendix 2). The regression line is y=0116 x + 20.679 with R^2=0.9016. The high correlation

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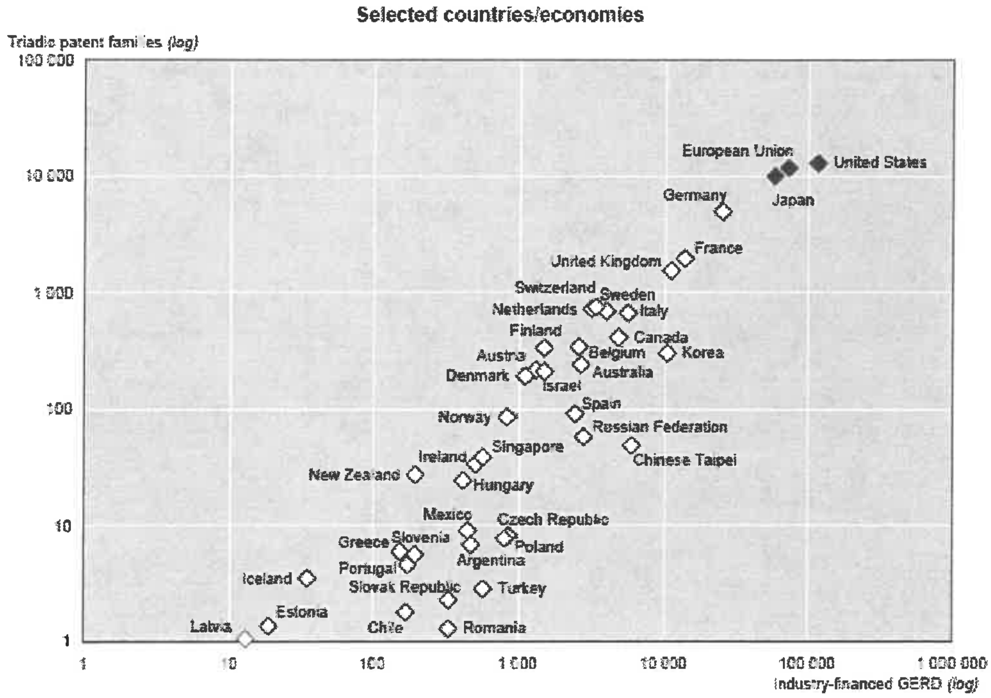
15 Rosenbloom, R.S. and W.J. Spencer (1996) *Engines of Innovation: U.S. Industrial Research at the End of an Era*. Boston: Harvard Business School Press

16 OECD (2004) "*Compendium of Patent Statistics*" Organisation for Economic Cooperation and Development, Paris

Figure 3: Triadic patent families and industry-financed R&D



1. Patents all applied for at the EPO, USPTO and JPO. 1999 and 2000 figures are estimates.
2. Gross domestic expenditure on R&D (GERD) financed by industry, million 1995 USD using purchasing power parities (average over the period 1990-1999).

Source: OECD, Patent and R&D Databases, September 2004.

coefficient indicates that business expenditure in R&D is the determining factor in the production of new inventions in the form of patents. According to regression we would expect to have approximately 170 triadic patents from South Africa. However the actual number is only 30. This discrepancy may be interpreted as meaning that there are structural obstacles in the process of producing patents in South Africa (such as high patenting costs; industrial structure not amenable to patenting; lack of large corporations etc).

Finally, comparison of the various indicators identifies promising areas for further research. For example we identify that a number of inventors utilise the PCT services but only a limited number of them go ahead to apply for patents. Similarly a number of companies that were prolific patent holders in the past have stopped applying for patents. Answers to those questions have the potential to provide policy inside and guidance.

Appendix 1 Distribution of South African patents to different classes for the period 2000 to 2004

The following table displays technology classes and counts of associated patents, as distributed by the year of patent grant

Class	Class Title	2000	2001	2002	2003	2004	Total
210	Liquid Purification or Separation	7	9	5	4	1	26
424	Drug, Bio-Affecting and Body Treating Compositions (includes Class 514)	5	4	5	7	1	22
340	Communications: Electrical	5	7	2	3	1	18
075	Specialized Metallurgical Processes, Compositions for Use Therein, Consolidated Metal Powder Compositions, and Loose Metal Particulate Mixtures	1	7	2	2	4	16
423	Chemistry of Inorganic Compounds	2	3	3	2	3	13
532	Organic Compounds (includes Classes 532-570)	2	2	3	3	3	13
518	Chemistry: Fischer-Tropsch Processes; or Purification or	1	2	2	1	5	11

The following table displays technology classes and counts of associated patents, as distributed by the year of patent grant							
Class	**Class Title**	**2000**	**2001**	**2002**	**2003**	**2004**	**Total**
	Recovery of Products Thereof						
198	Conveyors: Power-Driven	3	3	2	0	2	10
015	Brushing, Scrubbing, and General Cleaning	2	1	2	2	2	9
209	Classifying, Separating, and Assorting Solids	2	1	1	2	3	9
520	Synthetic Resins or Natural Rubbers (includes Classes 520-528)	2	4	3	0	0	9
604	Surgery (Medicators and Receptors)	4	0	2	1	1	8
222	Dispensing (apparatus and process)	2	1	3	1	0	7
273	Amusement Devices: Games	1	2	2	1	1	7
405	Hydraulic and Earth Engineering	2	2	0	3	0	7

The following table displays technology classes and counts of associated patents, as distributed by the year of patent grant

Class	Class Title	2000	2001	2002	2003	2004	Total
426	Food or Edible Material: Processes, Compositions, and Products	1	1	2	1	2	7
473	Games Using Tangible Projectile	0	2	2	1	2	7
502	Catalyst, Solid Sorbent, or Support Therefor: Product or Process of Making	0	2	1	1	3	7
073	Measuring and Testing	1	1	0	1	3	6
102	Ammunition and Explosives	2	2	0	1	1	6
137	Fluid Handling	0	1	2	1	2	6
244	Aeronautics	1	2	1	1	1	6
460	Crop Threshing or Separating	0	1	3	1	1	6
623	Prosthesis (i.e., Artificial Body Members), Parts Thereof, or Aids and Accessories Therefor	0	2	0	2	2	6

The following table displays technology classes and counts of associated patents, as distributed by the year of patent grant							
Class	**Class Title**	**2000**	**2001**	**2002**	**2003**	**2004**	**Total**
315	Electric Lamp and Discharge Devices: Systems	1	1	0	2	1	5
343	Communications: Radio Wave Antennas	0	0	4	1	0	5
428	Stock Material or Miscellaneous Articles	1	1	1	2	0	5
435	Chemistry: Molecular Biology and Microbiology	1	3	1	0	0	5
705	DP: Financial, Business Practice, Management, or Cost/Price Determination (Data Processing)	1	2	1	1	0	5
040	Card, Picture, or Sign Exhibiting	0	1	0	2	1	4
052	Static Structures (e.g., Buildings)	1	1	2	0	0	4
062	Refrigeration	0	1	2	1	0	4
081	Tools	2	1	0	0	1	4

The following table displays technology classes and counts of associated patents, as distributed by the year of patent grant							
Class	**Class Title**	**2000**	**2001**	**2002**	**2003**	**2004**	**Total**
128	Surgery (includes Class 600)	1	0	1	1	1	4
141	Fluent Material Handling, with Receiver or Receiver Coacting Means	0	0	2	0	2	4
156	Adhesive Bonding and Miscellaneous Chemical Manufacture	2	0	2	0	0	4
175	Boring or Penetrating the Earth	0	1	1	2	0	4
204	Chemistry: Electrical and Wave Energy	1	1	1	1	0	4
219	Electric Heating	0	1	2	0	1	4
220	Receptacles	0	2	0	1	1	4
223	Apparel Apparatus	0	1	0	1	2	4
235	Registers (e.g., cash registers, calculators, devices for counting	0	0	3	0	1	4