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Government and Innovation Policy
An Analysis of the South African Experience since 1994

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An Analysis of the South African Experience since 1994

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ABSTRACT

South Africa used to follow a policy of import substitution, necessitated by subscription to apartheid. However, following the democratic elections of 1994, the country abandoned this policy and put in place a whole host of measures to increase its industrial competitiveness. Policy makers gave specific attention to achieving this goal through technological development. The country has shown considerable sophistication in framing the necessary policies and institutions to hasten this process of domestic technology development coupled with a better absorption of imported technologies. However, South Africa has not shown as much sophistication in implementing and evaluating these otherwise laudable policies. For instance, a significant number of research grants have been made available to its innovation system comprising the higher education sector, the science, engineering and technology institutions(SETIs) and the business enterprise sector. But this has not resulted in desirable results, as the R&D intensity and the number of patented innovations continues to be low. An analysis of the real weaknesses of the innovation system shows that the country suffers from a severe shortage of scientists and engineers who can engage in R&D. The reason for this is a near stagnant enrolment in science and engineering subjects and possibly migration abroad. Without addressing this basic lacuna in its innovation system, the country has put in place three sizeable research grants. Given the limited number of researchers, these research grants run the risk of "crowding" themselves out. Thus the South African case once again confirms our hypothesis that countries may not be successful in stimulating R&D in their enterprise sectors by merely fine-tuning financial instruments such as research grants and tax incentives. For financial instruments to be very effective, there has to be a critical mass of research scientists and engineers.

Keywords: innovation policy, national systems of innovation, research intensity, patenting behaviour, fiscal instruments, human resources policy, venture capital, South Africa

JEL Classification: O31;O38

INTRODUCTION

South Africa and India represent two economies from Type 1 countries[1] that have been subscribing to a policy of import substitution and technological development through self-reliance. While South Africa was forced to subscribe to this strategy owing to its apartheid policy, India did so by choice. However, since the 1990s, both the economies have effectively dismantled this policy and have opened up their economies in varying degrees to external involvement: South African policy changed from 1994 onwards, following its democratic elections and India from 1991 onwards with the initiation of market-oriented policies culminating in the new economic policy of 1991. Given the fact that sufficient time has elapsed, it will now be instructive to analyse the innovation policies of these two Type 1 countries, both of which are characterised by a dualistic system: high technology sectors co-existing with rather low technology sectors, and considerable poverty and income inequalities.

This paper is part of a larger UNU/INTECH research project entitled, "Market-friendly Innovation Policies in Developing Countries". The main objective of this study is to identify the policy instruments and institutions which developing countries can put in place to encourage more R&D investments by their respective private sector enterprises. The study is based on the experiences of five developing countries of the Type 1 variety namely, Malaysia, Singapore, India, South Africa and Brazil. Further it also include the case of Israel which has a very unique innovation policy. In the present paper, I focus on the South African case. The major research questions and the survey of the state-of-the-art of the literature are presented in Mani (1999).

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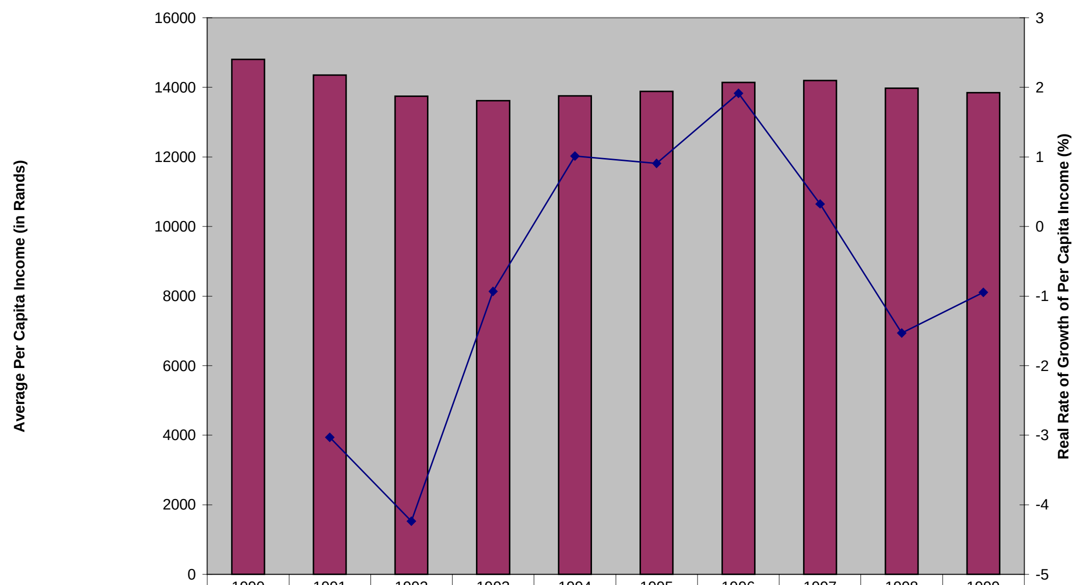
[1] Type 1 countries are those developing countries which have the potential to create technologies on their own. This technological potential is measured by the number of patents granted to inventors from these countries in the US. There are 11 such developing countries. For the details of this, see Mani (2000b).

1. THE CASE OF SOUTH AFRICA

The South African economy is an outlier on the African continent. It is the most developed country on the continent, and with a per capita income of US$3000, it is more similar to Malaysia than to its immediate neighbours. However, the economy has not grown at all during the 1990s, but has experienced only violent fluctuations (Figure 1). But in the arena of science and technology, South Africa can report a number of achievements. Its is the only African country to have been awarded a sizeable number of patents in the US. On average, inventors from South Africa secured 57 patents in the US during the period 1985–1999, thus making it one of the top innovative countries in the developing world. Since 1994, the new government has been completely revamping the S&T administrative apparatus in the country and has been putting in place a whole host of essentially research grants to encourage innovation by three important components of its national system of innovation, namely the business enterprise, the government research institutes and the higher education sector. In the following sections, I will set out to analyse the various instruments the country has put in place to achieve this. As usual, l place the discussion in the context of certain distinctive features of the South African manufacturing sector.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Per Capita Income	14806	14357	13749	13621	13759	13884	14150	14196	13979	13847
Rate of Growth (%)		-3.03	-4.23	-0.93	1.01	0.91	1.92	0.33	-1.53	-0.94

Figure 1: Real Rate of Growth of South Africa's Per capita Income: 1990–1999
Source: South Africa. Department of Trade and Industry (2000)

1. 2 THE ENTERPRISE SECTOR IN SOUTH AFRICA

The manufacturing sector in the country accounts for about 20 per cent of the total economy. There are two distinct dimensions of the economy that merit our attention. The first is the performance of the sector, and the second is the structure of the manufacturing sector in terms the number and size distribution of firms, as well as in terms of the industry-wise distribution of firms. On both these dimensions, South Africa is very comparable to the Indian case.

1.2.1 Performance of the Manufacturing Sector: In terms of physical performance, the sector did very badly during the 1990s. For instance, the manufacturing value added (Figure 2) decelerated during much of the 1990s, and especially during the last two years. However, according to Schneider (2000), the deceleration in manufacturing output started as far back as the 1970s.[2] The precise reasons why this happened during the 1990s needs to be researched, as quite a number of the factors that had caused the earlier deceleration in growth rate were reversed. The gross fixed investments in the sector have also shown sharp year-to-year fluctuations.

[2] He attributes this to at least eight factors, namely (I) insufficient attention given to the achievement of technological autonomy ; (ii) insufficient efforts taken to make South African businesses internationally competitive; (iii) restrictions on black labour that limited mobility, training, education, and the size of the domestic market; (iv) the high cost of skilled labour due to the "civilized labour policy" (by which skilled, technical and professional work was reserved by statute for whites); (v) domestic unrest generated by apartheid; (vi) international sanctions and disinvestment generated by apartheid; (7) costly state programmes designed to make South Africa self-sufficient, including "separate development', local content regulations, and uneconomic new state corporations; (viii) overly capital-intensive industries resulting from labour market restrictions, subsidies for capital investment, artificially low interest rates, and over valued exchange rate during the 1960s and 1970s.

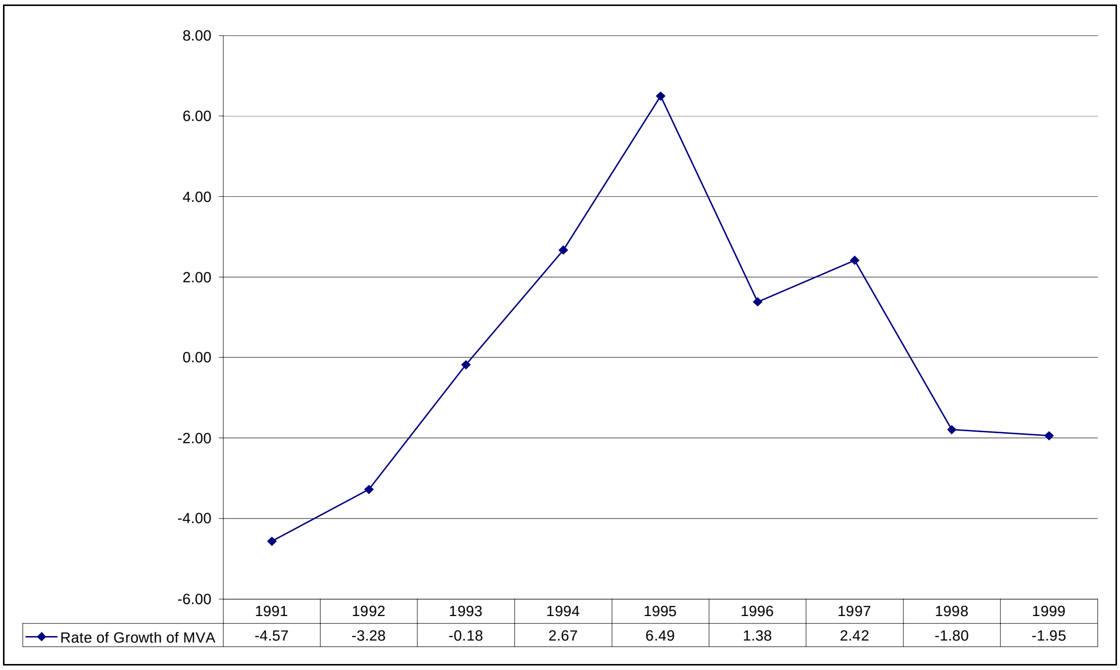


Figure 2: Rate of Growth of South African Manufacturing Value Added: 1991–1999
Source: South Africa. Department of Trade and Industry (2000)

1.2.2 Structure of the Enterprise Sector: Two dimensions of structure are considered: firstly, in terms of the degree of concentration, and secondly, in terms of the industry-wise distribution of firms. In terms of the degree of concentration, the sector is dominated by large firms. Kaplinsky and Manning (1998) found that: (i) In 1992, the six largest conglomerates were estimated to control approximately 87 per cent of issued capital on the Johannesburg Stock Exchange; (ii) Large South African firms were responsible for between 70.9 per cent and 75.3 per cent of total manufacturing employment; and (iii) Over 80 per cent of industrial output in South Africa emanates from large enterprises. This high degree of concentration, coupled with protection from external competition, meant that the demand for innovations is very low. In terms of distribution of industries, the manufacturing sector is fairly spread out, with the food processing industry accounting for the largest share (Table 1). In this way, the enterprise sector in South Africa is very distinct from that of Singapore and Malaysia in the sense that no one particular industry dominates the sector.

Table 1
Structure of South Africa's Manufacturing Sector during the late 1990s
(Based on an average share in Manufacturing Value Added during 1997-1999 in per cent)

Industry	Share in Value Added
Processed food	12.07
Other chemical products	7.99
Metal products, excl. machinery	6.92
Motor vehicles, parts and accessories	6.74
Basic iron and steel products	5.86
Non-electrical machinery	5.28
Beverages	4.97
Paper and paper products	4.91
Electrical machinery	4.88
Industrial chemicals	4.70
Petroleum and petroleum products	4.62
Printing and publishing	4.14
Clothing, excl. footwear	3.71
Non-metallic mineral products nec	3.40
Plastic products	3.19
Textiles	3.07
Wood and wood products	2.31
Non-ferrous metal products	2.19
Furniture	1.81
Other manufacturing	1.69
Radio, television and communication apparatus	1.27
Rubber products	1.19
Glass and glass products	0.89
Other transport equipment	0.75
Footwear	0.64
Professional equipment etc.	0.41
Leather and leather products	0.38
Total Manufacturing	100.00

Source: South Africa. Department of Trade and Industry (2000)

In summary, firstly, the manufacturing sector has been performing very badly, even during the 1990s even when some of the potential hurdles that were inimical to the growth performance of the sector were reversed. Secondly, the high degree of concentration meant that the demand for innovations for the enterprises was very low. Thirdly, much of the industrial sector is dominated by low technology industry such as food processing. It is against this background that I analyse the role of policies and institutions that the new government has put in place, especially since the mid 1990s.

1.3 END RESULT OF THE POLICIES

Given the fact that the innovation policy of the new government is very recent (post 1996), it may be too early to measure the end result of the policies. However, what is attempted here is to trace the trends in two standard indicators that I have been using, namely (i) investments in R&D; and (ii) exports of high technology products.

1.3.1 Investments in R&D

It must be mentioned at the very outset that the quality of data on R&D investments in the country is far from satisfactory. The main source of data on R&D investments in the country used to be the biennial surveys of "Resources for R&D" conducted by the erstwhile Department of National Education: the latest available in the series is for 1993–1994. Because of the changes in survey methodology it is opined that (Foundation for Research Development, 1996) comparisons of inter-temporal R&D investments are difficult. Specifically, the feeling is that the biennial surveys have actually underestimated investments in R&D by the business enterprise and the higher education sectors. The latest available survey is for the period 1997–1998[3] and all that is available of this survey is a series of 12 slides presented in the website of Department of Arts, Culture, Science and Technology (DACST).[4] This survey contains only the following items: (i) gross expenditure on R&D; (ii) research personnel; (c) financing and performance of gross expenditure on R&D in four sectors (industry, government, higher education and not-for-profit); (iv) R&D expenditure by field of research, socio-economic objectives, strategic focus, type of cost. The data on each of these are at the aggregate level and are available for just one year, namely 1997–1998. The survey methodology is not spelt out and the response rate is not indicated either.[5] Given the quality of the data contained in this survey, caution has to be exercised in interpreting it. Some of the inconsistencies in the data will emerge in my analysis of the data on R&D investments.

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[3] I understand that this survey was contracted out to a private consultant.

[4] See http://www.dacst.gov.za/science_technology/st_profile/index.htm. Subsequently, I have managed to secure a document entitled, "Survey of Resources Allocated to Research and Development, 1997-98" published by DACST in August 2000. However, this 16-page booklet contains no more additional data than that presented in the website, except for a glossary of terms, and the glossary contains terms that do not occur in the text of this booklet.

[5] In a private conversation, the consultant who conducted the survey was of the opinion that the survey covered only about 20 per cent of the number of firms in the business enterprise sector.

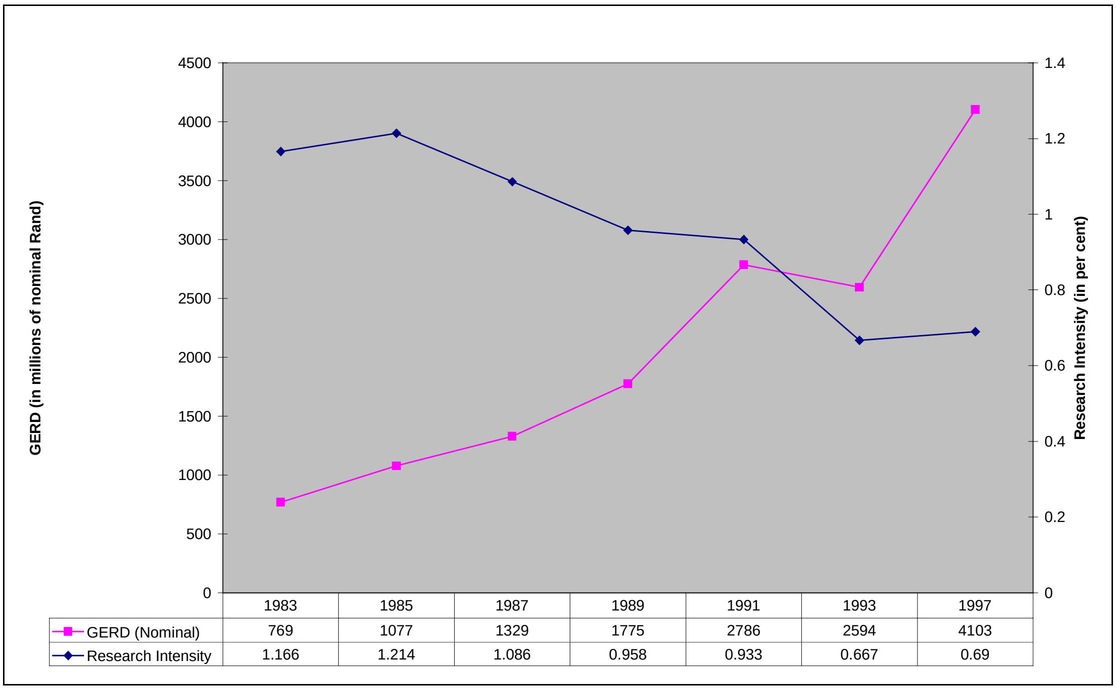

Figure 2: Gross Investments in R&D: 1983–1997
Source: Foundation for Research Development (1996) and South Africa. Department of Arts, Culture, Science and Technology, DACST (2000)

Gross investment in nominal R&D (despite the possible massive underestimation in data) shows a dramatic increase in nominal terms, although the R&D intensity of the country has been showing a secular decline over time. According to DACST (2000), the fall in the R&D intensity (in 1997) is specifically due to the so-called "dramatic withdrawal of government from funding related to defence R&D. Recent defence data indicate that defence receives 25% (in real terms) from what it used to receive in the beginning of the 1990s and no measures have been adopted to compensate for that withdrawal of R&D funding". If indeed this is the case, how does one rationalise the reported increase in nominal GERD in 1997 (even with underestimation)?. The fall in the research intensity has more to do with the relative rates of growth of GERD and GDP, especially when the GERD registered a strong growth in 1997.

About one half of R&D investments in the country are expended by the private industrial sector (Table 2): the share could even be higher if the revisions are made for the possible under-estimation of this sector. Government accounts for the next highest category. The higher education sector has seen a major erosion in its share over the years and currently accounts for only 10 per cent of the total R&D expenditure of the country.

Table 2
Sector-wise Distribution of R&D Investments in South Africa, 1983–1997
(Value in Millions of Nominal Rands)

	Private Industrial	Higher Education	Government	Non Profit	Abroad	Total
1983	394(51)	121(16)	247(32)	7(1)		769
1985	445(41)	240(22)	382(35)	11(1)		1077
1987	549(41)	262 (20)	509(38)	10(1)		1329
1989	744(42)	407(23)	613(35)	10(1)		1775
1991	1304(47)	554(20)	903(32)	25(1)		2786
1993	1411(53)	388(15)	818(31)	27(1)		2594
1997	2052(50)	410(10)	1354(33)	Nil	287(7)	4103

Note: Figures in parentheses indicate percentage share of the total
Source: Foundation for Research Development (1996); and DACST (2000)

Traditionally, the private sector financed its own R&D investments in their entirety (Table 3). However, during the 1990s, the share of government increased significantly, reaching ten percent in 1991 (an aberration?) and then subsequently declining to 5 per cent. Similar data for the latest survey are not available.

Table 3
Financing of Private Industrial R&D in South Africa 1988–191993
(Percentage Share)

	Own Funds	Government	Other External Funds*
1983	99.22	0.49	0.29
1985	99.16	0.77	0.07
1987	99.31	0.67	0.01
1989	97.87	2.02	0.12
1991	89.34	10.31	0.35
1993	95.11	4.55	0.34
1997	NA	NA	NA

Note: * This indicates funds from the higher education and non-profit organisations
Source: Foundation for Research Development (1996)

It is thus interesting to note that the importance of government in funding private industrial R&D is very much on the increase in South Africa since the 1990s. The separation of private industrial R&D between local and foreign companies is not available[6] .

1.3.2. Exports of High Technology Products

High technology exports (excluding armaments) from the country have been growing at a rate of 20 per cent per annum, but the level of exports is very low when compared to the US,

[6] It is interesting to note that DACST (2000) defines a foreign company as one where 50 per cent or more of the equity is held by non-South African residents. However, I could not find any data table or figure in which a break down the R&D expenditure by ownership is provided.

Singapore and Malaysia. However, the high technology intensity of South Africa's manufactured exports is slowly increasing.

Table 4
Performance of South Africa with respect to High Technology Exports, 1992–1997
(Value in thousands of US$)

	High Tech Exports	Share of High Tech Exports	Ratio to the US.	Ratio to Singapore	Ratio to Malaysia
1992	418341.009	4.83	0.004	0.019	4.09
1993	443801.791	4.73	0.004	0.016	3.29
1994	479766.897	4.91	0.004	0.012	2.50
1995	696737.044	5.77	0.005	0.013	2.74
1996	725660.03	5.70	0.005	0.013	2.76
1997	977890.117	7.59	0.006	0.016	3.31

Source: Mani (2000a)

An examination of the patenting behaviour of inventors from South Africa shows (Figure 3) that of the 284 patents that were granted to inventors from South Africa during the period 1995–1999, more than 75 per cent were awarded to individuals and the rest to domestic and foreign firms. Domestic firms include two governmental agencies, namely the Atomic Energy Corporation with ten patents and the Council for Scientific and Industrial Research (CSIR) with nine patents. The only foreign company that has secured patents is British Technology Group(BTG);.[7] however, these are very likely to have been purchased from other South African individuals or companies. In terms of technology classes (Table 5), there is a mix of both high and medium technologies. Some of the patents are in fact in non-manufacturing areas such as medicine (surgery). Thus my analysis shows that the research intensity of the country as a whole has actually declined with fluctuations. The number of patents granted to South African inventors has also declined sharply, and most of the patents are actually taken by individuals and government organisations. This is very significant, as much of the R&D is actually performed by the enterprise sector despite the fact that the growth rate of this sector has actually been decelerating in terms of domestic value added. It is against this background that one analyses the innovation policy of the country.

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[7] BTG is a global technology investment and development company operating in the life and physical sciences industry sectors. BTG purchases technologies from clients worldwide and commercialises them. It thus helps to create a "market for technology".

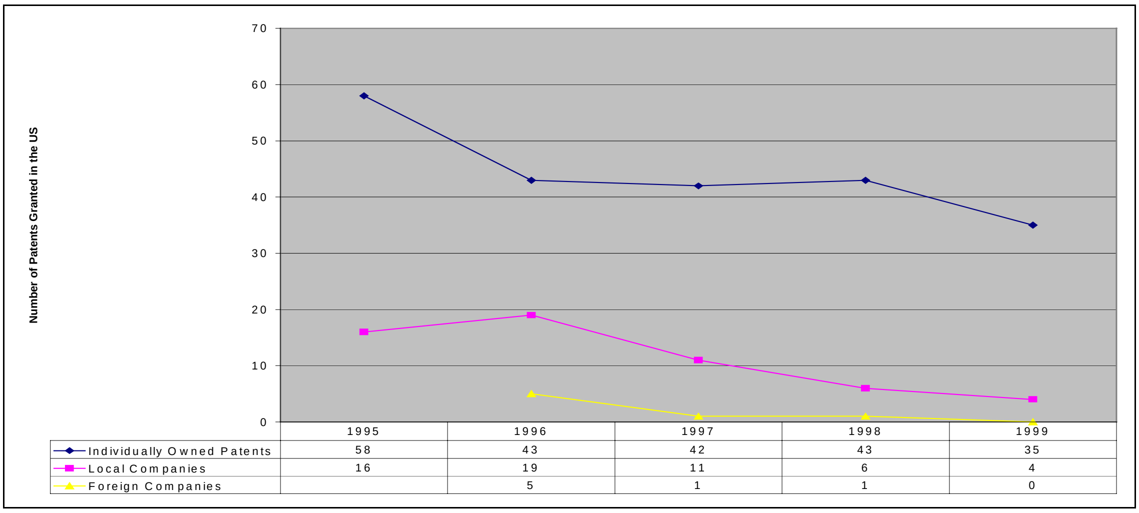

Figure 3: Number of Patents Granted to South African-based Individuals, Local and Foreign Companies: 1995–1999
Source: USPTO (2000)

Table 5
The Top 15 Most Emphasised Patents by Inventors from South Africa

Technology Class	Technology	Cumulative Number of Patents Granted, 1995-1999
Class 210	Liquid Purification or Separation	21
Class 514	Drug, Bio-Affecting and Body Treating Compositions	19
Class 405	Hydraulic and Earth Engineering	17
Class 340	Communications: Electrical	16
Class 015	Brushing, Scrubbing and General Cleaning	14
Class 604	Surgery	12
Class 606	Surgery	12
Class 052	Static Structures (e,g., Buildings)	11
Class 429	Chemistry: Electrical Current Producing Apparatus, Product and Process	11
Class 473	Games using Tangible Projectile	9
Class 209	Classifying, Separating and Assorting Solids	8
Class 335	Electricity: Magnetically Operated Switches, Magnets, and Electromagnets	8
Class 423	Chemistry of Inorganic Compounds	8
	Total for the above 15 **Cumulative total of all technology classes 1995-1999**	166 **560**

Source: USPTO (2000)

1.4 POLICY INSTRUMENTS AND INSTITUTIONS

In terms of evolution of the policy on innovation, there are essentially two phases: phase 1 covers the period up to 1994, and phase 2 covers the post-1994 phase. In this study, we are concerned only with the latter phase: Marais (2000) summarises the S&T policy and systems in the country during the first phase. The major impetus for restructuring the innovation system was initiated by an IDRC report entitled "Towards Science and Technology Policy for a Democratic South Africa" released in 1993 and commissioned by the African National Congress (ANC). The report found that:

- There was a leadership vacuum in S&T at Ministerial level;
- Resource allocations has essentially been frozen;
- The relationship between the needs of the disadvantaged majority and the resources and capacity of the S&T institutions needed to be articulated
- There was a need for transformation in the governance of S&T institutions;
- The S&T community should become actively involved in shaping the future S&T policy.

This report led to a Green Paper on Science and Technology[8] in January 1996. The paper contained the main points for discussion and was subjected to a wide consultation process within and outside the government and especially among the various stakeholders.[9] These consultations led to the drafting of a White Paper on Science and Technology entitled "Preparing for the 21st Century", which was approved by the government on 4 September 1996.

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[8] In addition, it also lead to the National Research and Technology Foresight Project. The aim of this exercise was to help identify those sector-specific technologies and trends that will contribute to significant improvements in the quality of life of South Africans in the next ten to 20 years. In particular, it sought to: (i) identify those technologies and latent market opportunities that are most likely to generate benefits for South Africa; (ii) develop consensus on future priorities among the different stakeholders in selected sectors (industrial, socio-economic or service); (iii) co-ordinate the research effort between different players within selected sectors; (iv) reach agreement on those actions that are needed in different sectors to take full advantage existing and future technologies. The exercise covered 12 "foresight sectors", namely, Agriculture and Agro-processing, Biodiversity, Business and Financial Services, Energy; Health, Information and Communication Technologies,; Environment; Manufacturing and Materials; Mining and Metallurgy; Safety of Citizen and Society; Tourism; and Youth. All the 12 reports are now available (http://www.dacst.gov.za/science_technology/foresight/index.htm) and the thinking within the government is to factor these into the various research grant schemes.

[9] These are central policy departments, government line departments, agencies, science, engineering and technology institutions (SETIs), state corporations, business, higher education sector and non-governmental organisations.

In essence, this document constitutes the official science and technology policy of the country. This policy commits government to attaining excellence in the use of science and technology in maintaining a cutting-edge global competitiveness and addressing the urgent needs of disadvantaged citizens (defined as those who are less able to assert themselves in the market). The framework for the new policy is that of a National System of Innovation (NSI). The NSI is described as a "means through which the country will seek to create, acquire, diffuse and put into practice new knowledge that will help the country and its people to achieve their individual and collective goals". However, the term "NSI" is described in rather a textbook fashion, and the "White Paper" does not delve into any of its indicators in empirical terms. The goals that the White Paper set were those of:

- promoting competitiveness and employment creation;
- enhancing the quality of life;
- developing human resources;
- working towards environmental sustainability; and
- promoting an information society.

The White Paper consists of ten chapters divided into two parts. Part 1 maps out the context and summary while Part 2 focuses on specific policy initiatives. Table 6 summarises the main policy instruments that were contemplated in the White Paper.

Table 6
Main Policy Instruments for Supporting Innovation in South Africa
(As Envisaged in the White Paper on Science and Technology 1996)

Policy Instrument/Institution	Scope
1. Institutional Mechanisms	
• A national ministry and department within it responsible for Science and Technology	The Ministry and the Department have a number of specific functions. But their major purpose is to stimulate and co-ordinate the national system of innovation.
• National Advisory Council on Innovation (NACI)	The council consisting of up to 22 individuals (drawn from many different stakeholders within the NSI), is charged with carrying out inquiries, studies and consultations with respect to the functioning of the NSI. NACI is to work very closely with a similar industry-headed body, namely the National Science and Technology Forum.
• National Research Foundation	Responsible for support to research and research capacity building
2**. Research and Technology Foresight Exercise**	This involves detailed consultations concerning potential technological trends and trajectories of significance to the socio-economic development of the country.
3. **Research and Technology Audit**	The principal output of this exercise will consist of: • An assessment of existing government interventions in science, engineering and technology • An innovation survey of the South African science, engineering and technology system • A research and technology inventory of the South African economy**.**
4. Science Budget	An annual Science Budget document, constructed using data drawn from departmental budgets will be prepared and this will include all governmental S&T expenditures like: • Science councils and national facilities • Departmental and intramural expenditures and transfer payments on S&T • Other departmental transfers for S&T, including in particular the support offered by the Department of Education to institutions in the higher education sector
5. Regulatory Policy	DACST is to work with the Department of Trade and Industry to align South African patenting regulations with international norms
6. Financing of Innovation	• Innovation Fund. An inter-departmental committee will be established to align the objectives the Innovation Fund with the Support Programme for Industrial Innovation (SPII) and other funds. • A co-ordinated system of grant financing of research in institutions of higher education • Tax incentives for R&D expenses (as covered by section 11 of the Income Tax Act of 1962) in the form of both revenue and capital expenditures is tax deductible and is to be continued. In addition contributions to institutions are also tax deductible and the requirement that these expenses are to be certified by the CSIR is done away with.
7. Management and Financing of Government SET Institutions	The government support of R&D in SETIs is to be considered under three headings: • Budgetary support • Contract support • Grant support Every SET performer potentially operates on the basis of two forms of funding, namely "core funding" and "competitive funding". • Core funding for government SET institutions is provided in the annual budget of the government, either as a Parliamentary Vote or a transfer payment. Such funding will be ring-fenced to ensure

	that it is not diverted to other uses. • Competitive funding is to be provided through two routes, namely via contracting and through the Innovation Fund Since 1987, the science councils (SCs) have been required to generate an increasing share of their operating budgets by means of contract income obtained directly from the market. However, some small changes in the nature of this contract income are suggested: • Making a portion of SC funding (determined by the review process) conditional upon partnerships with the private sector • Strict monitoring of auditable systems for financial management within SCs to ensure that cross-subsidisation for revenue-earning projects does not occur and that the grant and budgetary funds are spent with economy, efficiency and effectiveness • By 1997, all SCS will be required establish the overhead costs of their activities, and will be required to charge full direct costs plus overheads on all SET contracts.
8. Human resource development and capacity building	Towards this strategy, links are sought with the "Growth and Development Strategy". It consists of four strategies: • A human resource development investment strategy which would be an integrated and affordable five-year HRD plan; • A training strategy which details sectoral investment programmes for the National Training Strategy • Restructuring education through improving the quality of education within the prevailing fiscal constraints with the priority on skills for employment, growth and democracy and a plan for effective backlog provision • Social partnerships in human resource development with specific reference to partnerships with the private sector on education, health and training. The White Paper also suggests compulsory Mathematics/Science up to the exit level (currently Standard 7). These subjects would consequently be contained in the General Education Certificate proposed by the Department of Education. DACST will assist the Department of Education in developing a technology education programme for schools. The Government SETIs can engage in postgraduate education but within the context of formal agreements with universities or other tertiary level educational institutions.
9. Promoting linkages between sectors and between stakeholders	The White Paper underscores the need for and importance of promoting linkages within various components of the South African National System of Innovation But does not spell out any linkage mechanism in concrete terms.
10. Science and Technology Infrastructure	• Use of modern IT services for effective communication • Establishment, operation and maintenance of technical services (e.g. metrology, standardisation, calibration) • Statistical services, indicators and databases, the creation of which is the primary responsibility of the government.

Source: Compiled from DACST (1996)

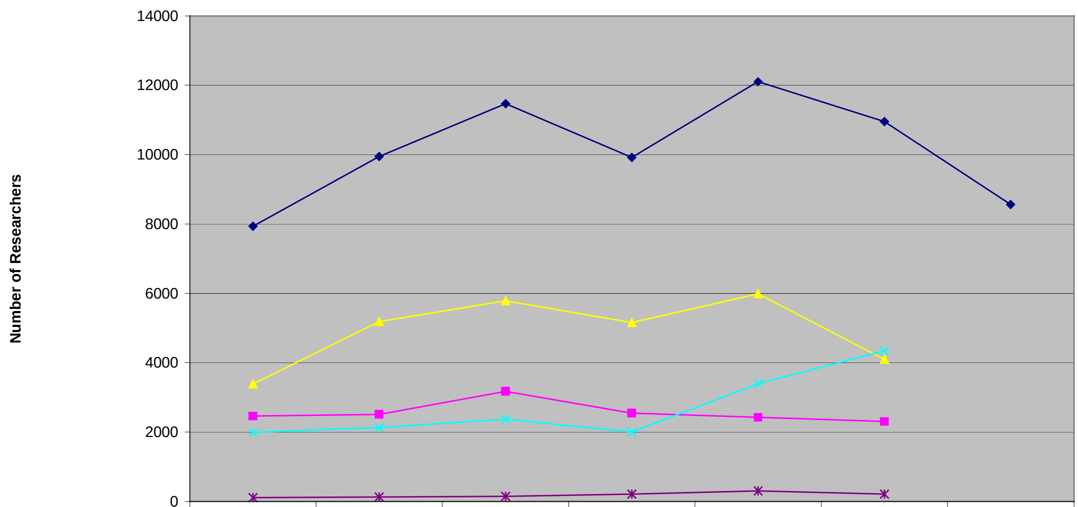
No attempt is made here to subject this comprehensive document to a detailed review. However, there is an excellent review of it by Kaplan (1999). According to him, the White Paper has not operationalised the term "National System of Innovation" in any precise manner and, moreover, the goals and objectives outlined in the Paper were very broad and general and consequently these objectives could not be easily translated into an operational plan of action. Suffice it to say that on a number of crucial issues (such as human resource development, promoting linkages between various components of the NSI and science and technology infrastructure), the Paper suffers from a sort of profound vagueness. To illustrate, though the Paper states that collection and maintenance of statistical indicators of the NSI is the primary responsibility of the government, the country does not even have good quality data on such commonly employed indicators such as R&D expenditure (see my comments with respect to the quality of R&D data in Section 1.3.1 above). Regarding human resource development, in all fairness, one may also will have to take into account two other policy documents, namely (i) *The Skills Development Strategy for Economic and Employment Growth in South Africa of 1997* and (ii) The Education White Paper 3, dealing with *"A Programme for the Transformation of Higher Education,* also published in 1997. The White Paper has thus effectively set the background for promoting innovation in the country. Following the usual practice, I now organise the discussion of the various arrangements for facilitating innovation under four headings:

- Policies affecting the supply of technically trained personnel in particular;
- Policies leading to the restructuring of the technological infrastructure, specifically the CSIR
- Policies leading to the issuing of various types fiscal incentives, especially research grants
- Promotion of venture capital funds.

I discuss each of these seriatim:

1.4.1 Policies affecting the supply of technically trained personnel

South Africa has a severe shortage of technically skilled personnel to engage in R&D. This is best captured by the statistic on the density of research scientists and engineers in R&D (RSE). The RSE of the country, which was 33 per 10 000 labour force in 1990 (Foundation for Research Development, 1996) sharply declined to 16.3 by 1997–1998 (DACST, 2000). This decline is mainly due to the almost21 per cent decline in the number of researchers (on a full-time equivalent basis) (Figure 4). The decline is greatest



	1983	1985	1987	1989	1991	1993	1997
Total	7939	9946	11469	9919	12102	10957	8566
Government	2457	2510	3173	2547	2420	2303	
Higher Education	3384	5183	5780	5160	5984	4096	
Business	1990	2130	2372	2001	3395	4341	
Non-Profit	108	123	144	211	303	216	

Figure 4: Trends in the Number of Full-time equivalent Researchers in South Africa
Source: Foundation for Research Development (1996) and DACST (2000)

in the government and the higher education sectors, while there has actually been an increase in the enterprise sector. In fact, even within a short period of four years, between 1992 and 1996, the science and engineering workforce as a percentage of the workforce in the formal sector reduced from 3.6 to 2.3 per cent. This reduction can be explained by the reduction in the enrolment for university-level courses in the natural sciences and engineering (Table 7). In fact, the enrolment in science and engineering courses has been virtually stagnant during the last three years.

Another reason for the shortage of skilled personnel is the emigration of technically trained personnel, more popularly known as the "brain drain". This issue has been analysed in some depth in a recent report by Crush et al (2000). Perhaps this explains the reduction in the number of researchers in the higher education and government sectors. Estimates of emigration over the period 1989–1997 amount to over 200 000. Given the strict controls on immigration by the Ministry of Home Affairs, the net migration has been increasing over time. The White Paper is silent on the issue of making available more scientists and engineers for doing R&D. Most of the strategies that are implied in other governmental policies (for instance, the skills development strategy) are aimed at making available or improving the skills levels of workers for production activities rather than for research. This shortage of sufficiently qualified human resources is thus an important element of discord in the national system of innovation. This brings to the fore the important point that despite using such terms as "NSI", an actual application of the real idea of an NSI is wanting in South Africa.

Table 7
University Enrolment for Degrees* in South Africa, 1985–1997

	Total Enrolment for Degrees*	Total Enrolment in Natural Sciences and Engineering**	Percentage Share
1985	179127	34326	19
1986	194723	35166	18
1987	207690	35820	17
1988	224923	37171	17
1989	238643	38660	16
1990	247602	39298	16
1991	267196	41007	15
1992	278265	42088	15
1993	284403	42484	15
1994	295231	44240	15
1995	320197	47532	15
1996	318762	47505	15
1997	307767	47813	16

Notes: * This include the following levels: (a) First degree; (b) Honours; (c) Masters; and (d) Doctoral ; ** This includes the following disciplines: a) Mathematical Sciences; (b) Physical Sciences; (c) Life Sciences; (d) Agricultural Sciences; (e) Engineering; and (f) Architecture

Source: For the data up to 1993: Foundation for Research Development (1996); and For the data from 1994–1997: Unpublished data from National Research Foundation

1.4.2 Restructuring of the Technological Infrastructure:

The technological infrastructure in the country is basically provided by the state, as is the practice in most countries. In South Africa, this takes the form of eight science councils and other science, engineering and technology institutes (SETIs). The SETIs were subjected to a detailed evaluation (in 1998) to assess their functions and to map out their role in the National System of Innovation. These evaluations were conducted at two levels: firstly, at the specific SETI level and secondly by means of a "System Wide Review" of all the SETIs.[10] These evaluations were a prelude to the restructuring of the SETIs to make them align much more closely with the goals of the NSI. Of these, from the point of view of research for the enterprise sector (which incidentally is the focus of the present study), only two of the SETIs are considered here, namely the CSIR and the South African Bureau of Standards (SABS). These are also the two SETIs that have undergone considerable restructuring in the form of decreasing reliance on state grants as a source of income.

[10] These reports are available in the DACST website: http://www.dacst.gov.za/science_technology/seti/index.htm. Kaplan (1999) has been very critical of these reviews as the review teams "were composed of international and local experts, many of whom were active researchers in the fields in question. This was problematic because researchers are necessarily almost always partisans for their own particular fields of inquiry and the reports generally lacked an appreciation of the trade-offs that were necessary in a situation of highly constrained resources".

Table 8
Distribution of Income for the SETIs: 1996–1997

SETI	Own Income* (%)	State Grant (%)
1. South African Bureau of Standards (SABS)	77.7	22.3
2. Council for Scientific and Industrial Research (CSIR)	52.0	48.0
3.Medical Research Council(MRC)	23.9	76.1
4. Council for Minerals and Energy (MINTEK)	22.7	77.3
5. Human Sciences Research Council (HSRC)	18.0	82.0
6. Agricultural Research Council (ARC)	17.2	82.8
7. Council for Geosciences (CGS)	16.7	83.3

Notes: * Excludes minimal income from interest on cash reserves and rental. *Data on the eighth science council, the National Research Foundation, are not included as it is a grant-funding agency rather than a research institution.
Source: DACST (1998)

The CSIR is an important component of the technological infrastructure. With a total strength of about 3000 personnel and an annual budget averaging R700 million, it is easily one of the largest among the eight science councils in the country It is organised into nine technology divisions, and its core competencies are in manufacturing, materials and information technology (Figure 5). It was completely restructured in 1987. Until then, it had relied heavily on parliamentary grant income for its existence, but today a large proportion of its income is derived from contracts with the private sector (Figure 6).

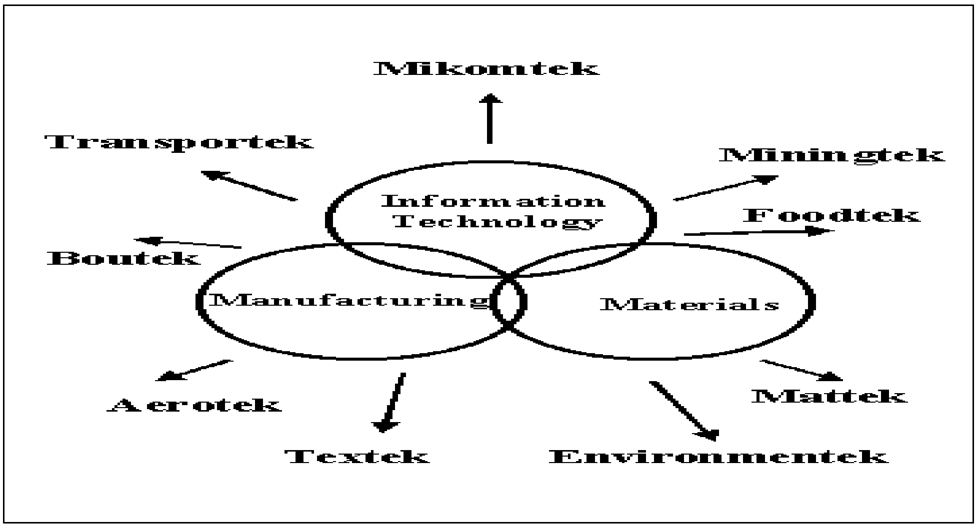
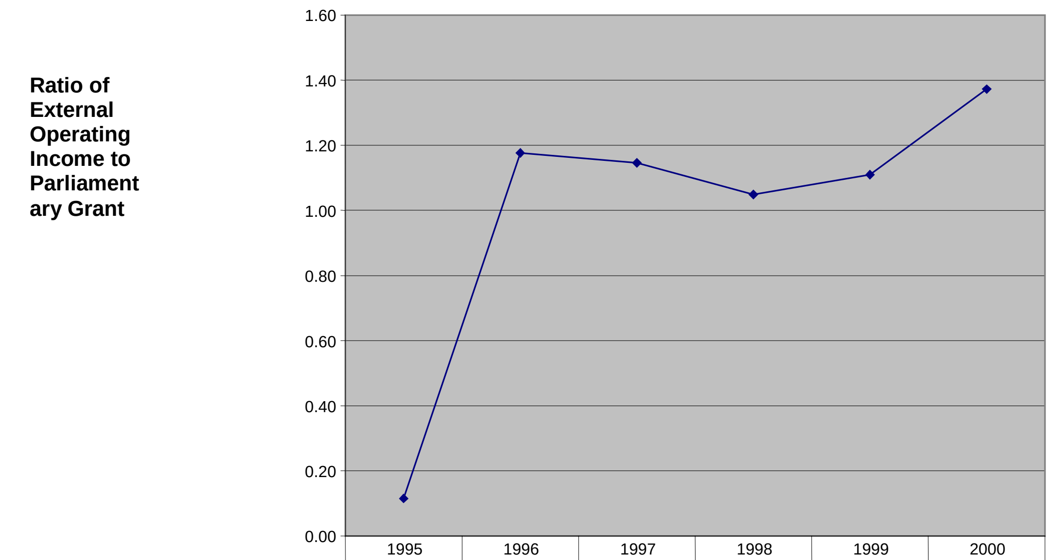


Figure 5: Technology Divisions and Core Competencies of the South African CSIR
Source: DACST (1997)

DACST undertook two detailed reviews of the functioning of the CSIR. The first one was by a panel that conducted a specific review of the CSIR alone, and the second was a "System Wide Review" of all the SETIs, including the CSIR. The panel that undertook the first review conducted detailed interviews with the major clients of the CSIR and reached the conclusion that it is a "technologically proficient and market-driven organisation" and it made a number of recommendations to further strengthen the organisation's links with industry. The major recommendations of the panel in this regard are as follows:

- "Ensure more migration of persons between industry and the CSIR. More persons should be recruited from industry and more CSIR persons located in industry. Short-term arrangements should also be possible. The CSIR needs to have persons with intimate insider knowledge of its major customers.
- Each major programme with industry would benefit from the presence of persons with genuine industrial experience.
- There is a need to establish long-term co-operation committees with key clients and with industrial associations in order to liaise on longer-term technological needs and demands".



	1995	1996	1997	1998	1999	2000
Ratio of Grant to External Operating Income	0.12	1.18	1.15	1.05	1.11	1.37

Figure 6: Rising Share of External Contact Income
Source: CSIR (Various Issues)

The share of the private sector in the external contract income has come down from about 56 per cent in 1995 to about 50 per cent in 2000, while the share of the public sector has increased from 18 per cent to 21 per cent during the same period. This may be due to the introduction of new research grants such as the Innovation Fund. The CSIR, with a cumulative total of nine patents (1995–1999) accounts for only about 3 per cent of the total number of patents granted to inventors from South Africa. This may mean that by forcing the organisation to seek more contract income, largely from the private sector, the organisation may be devoting much of its attention to solving routine problems of industry rather than working on real R&D projects that result in the development of new products and processes and thereby lead to more patents.

The recommendations of the second evaluation panel was more or less in line with those of the former. Some of the major recommendations are reproduced below:

- A reconfiguration of CSIR's SET portfolio was recommended to phase out less mission-relevant activities and thus to release funds for developing significant new competencies in advanced manufacturing, especially in areas like computer simulation and virtual reality, and in some areas of information technology;
- The divisions should focus their activities **more** (emphasis mine) on innovative longer-term research projects directed towards enabling technologies on the basis of which industry can develop internationally competitive products and services;
- In order to provide the South African system of innovation with a large number of well-trained, excellent junior researchers, the CSIR should offer more opportunities for post-doctoral fellows to pass through its laboratories, and subsequently move on to the private sector as well as to other publicly financed institutions.

These recommendations are noteworthy and one cannot fault them as such. However, the second one appears to be contradict to some extent the requirement that the CSIR rely more heavily on contract income, which would make it more committed to undertaking quick-yielding short-term research projects. Furthermore, the contribution of the CSIR to the development of technically trained personnel in the country does not appear to have been met. There has actually been a reduction (see Figure 4) in the number of researchers. Again, this reduction cannot be attributed to the CSIR alone and may be more a reflection of the fundamental weaknesses in the country's higher education sector. But this is an important issue that needs to be thoroughly researched.

There has been a recent initiative between the CSIR and one of the provincial governments to establish an "Innovation Hub". The idea is to create a South African "Silicon Valley" South Africa for knowledge-based high technology start-ups. The hub will act both as a business incubator and as a training centre for entrepreneurial skills development. Approximately R150 million is to be spent on infrastructure development. This idea is to be slowly extended to other areas in the country as well. Given the fact that the project is in its very early stages, no further comments on it are possible.

The importance of standardisation in the process of technology development was discussed in some detail in Mani (1999). To recapitulate the main points, standards confer at least two major benefits. In the first is a list of what may be termed direct benefits and the second a list of indirect benefits. The immediate impact of standardisation is to reduce transaction costs by providing clearly specified interface requirements for products. It can thus lower barriers to market entry and speed up competition and thus the demand for new technologies. In other words, though it is a supply side measure, it has the potential to stimulate demand for technological improvements as well. Furthermore, it fulfils a quality certification function, which is especially important for industrial components. In terms of indirect benefits, the preparation of new standards and the ongoing review of existing ones provides an important forum for the exchange of technical information, both within each industry and among its users and suppliers. The South African Bureau of Standards (SABS) has the responsibility within the country for the development and publication of standards for products and services. In addition, it also runs both quality and product management certification schemes. The precise position of the SABS in the county's NSI is best summed up by the panel that reviewed it in 1998: "As a standards and conformance organisation, the SABS does not have any significant research or innovation capacity or capability but does play a vital role, within the National System of Innovation, in providing the facilities which are essential to the introduction of the products of innovation to the market-place. The effective introduction and use of new products is not possible without well-developed, timely and modern standards, ready availability of testing facilities and a system of conformity assessment to ensure compliance with standards and community expectations with respect to quality, protection of health and safety, and the maintenance of a sustainable environment".

Both the panels found a number of shortcomings in the management of the SABS. The Board was also found to be neglecting a number of important markets in which it could play an important role, such as the supply of quality management systems in other SETIs, certification of parastatal organisations and in the provision of standard services to small and medium enterprises. In the light of this, the panels suggested the bifurcation of the SABS into two separate entities. The first would be a government-funded standards writing institution and the second would be an organisation responsible for accreditation, certification and the provision of laboratory services, all operated on a commercial basis. These recommendations have since been implemented, with the commercial activities organised in two business units, namely Certification and Test House. Some dimension of the performance of the SABS is outlined in Table 9. One area in which the organisation has been doing well is in the generation of its own income: the ratio of commercial income to government grants increased from 2.2 in 1999 to 2.47 in 2000 (Table 9). Moreover, the number of standards issued has also registered a 40 per cent growth.

Table 9
Performance of the SABS: 1999-2000
(Value in Thousands of Rands)

Indicator	1999	2000
1. Commercial Income	165643	174685 (5.5)
2. Government Grant	75020	70638(-5.8)
3. Cumulative Number of Standards Issued	4724	5289 (12)
4. Number of Standards Issued Annually	404	565 (40)
5. SABS ISO schemes registered	1739	1871(8)
6. Product Certification	2505	2587 (3)

Note: Figures in parentheses indicate percentage increase
Source: SABS (2000)

In short, as far as technological infrastructure is concerned, there has been a reorganisation of the activities of both the CSIR and the SABS. Both have been made more market-oriented. While this is very natural for the SABS, the increased dependence on the market by the CSIR is likely to force it to compromise on long-term research. This is an important issue that needs to be looked into.

1.4.3 Provision of Fiscal Incentives for Innovation

There are essentially ten different government-supported financial schemes that encourage innovation-related activities within the enterprise sector, each of which addresses the financing gap at a specific stage in the innovation chain[11] (Table 10). None of the schemes are

[11] I am grateful to Dr Rocky Skeef of the National Research Foundation for helping to identify these schemes. I do not consider the parliamentary grant separately as it is already routed through most of the other schemes. A detailed catalogue of all the funding by governmental and parastatal agencies for the science, engineering and technology (SET) can be found in the website of the National Science and Technology Forum (NSTF): http://www.nstf.org.za/.

comprehensive enough to cover all the components of the innovation chain. The schemes can be divided into three categories:

(i) **Research grants**: (a) Innovation Fund, (b)Technology and Human Resources for Industry Programme (THRIP); (c) Support Programme for Industrial Innovation (SPII); and (d) Partnership in Industrial Innovation (PII).

(ii) **Development finance** especially for enterprise development: (a) Venture Capital; (b) Development Finance; (c) Seed Capital; (d) Feasibility Study Scheme.

(iii) **Tax Incentives for R&D**

Table 10
Government Supported Financial Schemes at Various Stages of the Innovation Chain

Innovation Stage → / Government Schemes ↓	Idea	Basic Research	Applied Research	Feasibility	Tech-nology Devel-opment	Products and Process Develop-met	Ability to Manufacture	Market Entry	Market Develop-ment
Innovation Fund	■		■	■	■	■	■		
THRIP			■		■	■			
SPII (Matching Scheme)					■	■	■		
PII					■	■	■		
Feasibility Study Scheme				■					
Seed Capital					■	■	■		
Venture Capital[12]							■	■	■
Development Finance									■
Tax Incentives	■	■	■						

Source: Adapted from communication with Rocky Skeef, National Research Foundation, Pretoria.

I now discuss the more important of these schemes in greater detail.

(i) Innovation Fund: This grant scheme is an important outcome of the White Paper and is administered by the Innovation Trust, which functions under DACST.[13] According to DACST,

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[12] At present, there is very little government support for venture capital in the country. For details see the last section of the paper(Section 1.4.4).

[13] Most of the trustees are officials of DACST

it is a programme of support that addresses problems "serious enough to impede socio-economic development or affect the county's ability to compete in products and services". The funds are disbursed through competitive bidding and are intended for large-scale collaborative projects that should involve a significant component of R&D and generate new knowledge leading to novel products, processes or services. The projects have to be completed within a period of three years, and there have been three rounds of selections since 1998-1999.[14] A total of 57 projects totalling R325 million have been funded in five broad areas, namely, crime prevention, information society, information and communications technologies, biotechnology, and manufacturing in general (referred to as value addition) (see Table 11). Most of the projects are in manufacturing *per se*, and most of the projects have been in either the SETIs or the universities. The private sector accounted for about a third of the amount granted in the first round, but its share was virtually zero in the second round and 28 per cent in the third round. Similarly, the CSIR alone accounted for about third of the grants in the first round, but this again has come down significantly over the three rounds. In short, the Innovation Fund is, by and large, targeted at governmental agencies, though one is not arguing that this has been a deliberate strategy of DACST. However, given the large size of the grants under the Innovation Fund and the small size of the number of researchers, it is very likely to crowd out other grant schemes, especially the THRIP scheme.

Table 11
Profile of Innovation Fund Grants during the First three Rounds
(Value in thousands of Rands)

Field/Area	Number of Projects	Amount Granted	Average per project
1. Value Addition	22	132583 (41)	6027
2. Biotechnology	12	76904 (24)	6409
3. Information Society	11	64037(20)	5827
4. Information and Communication Technologies	5	26198(8)	5240
5. Crime Prevention	7	25390 (8)	3627
Total/Average	57	325112	5704

Source: DACST

[14] The first round covered the three years beginning with the 1998 fiscal year, the second the three years beginning 1999 and the third the three years beginning 2000. A call for proposals for

Since all the projects are for a period of three years, even the projects that were sanctioned under the first round would only just be nearing completion, and therefore it is rather too early to evaluate the efficacy of this programme. However, some comments can be made on the management of the programme. Firstly, there is enough information available on the existence of this Fund and the selection criteria are explicitly laid out and appear to be transparent. In order to measure whether the competition for Innovation Fund grants had increased over time, I define two rates. The first is called the rate of success and is computed by taking the share of projects which are successful during each round as a percentage of the total (adjusted[15]) applications received during each round. An increase in this ratio would mean that the competition for the funds has decreased over the course of the rounds. The second ratio is the rate of frivolous projects and is computed by taking the percentage share of outright rejects in the total number of applications received during each round. The ratios have been worked out (Figure 7) and indicate that while the competition for Innovation Fund grants has decreased significantly (as indicated by the positively sloping success rate curve) the quality of proposals received has also has deceased(as indicated by the positively sloping rate of frivolous projects curve). This appears to be a worrisome fact. Since the number of researchers are limited and the projects are large, in terms of the quantum of grants, there is always a tendency for more mediocre proposals to get funded. It is also a matter for concern that the cost of administering the Innovation Fund is not readily available.[16]

[15] The total number of applications received during each round has been adjusted for outright rejects: the outright rejects are termed frivolous or non-serious applications.

[16] I have not come across a published annual report of the "Innovation Fund". The DACT website used to have summary sheets of Projects Funded in the first two rounds giving details of the successful projects and even a detailed assessment of the all the proposals received during the first round.. However after a recent (since January 2001) reorganisation of the website, these data are no longer available. See http://www.dacst.gov.za/science_technology/index.htm

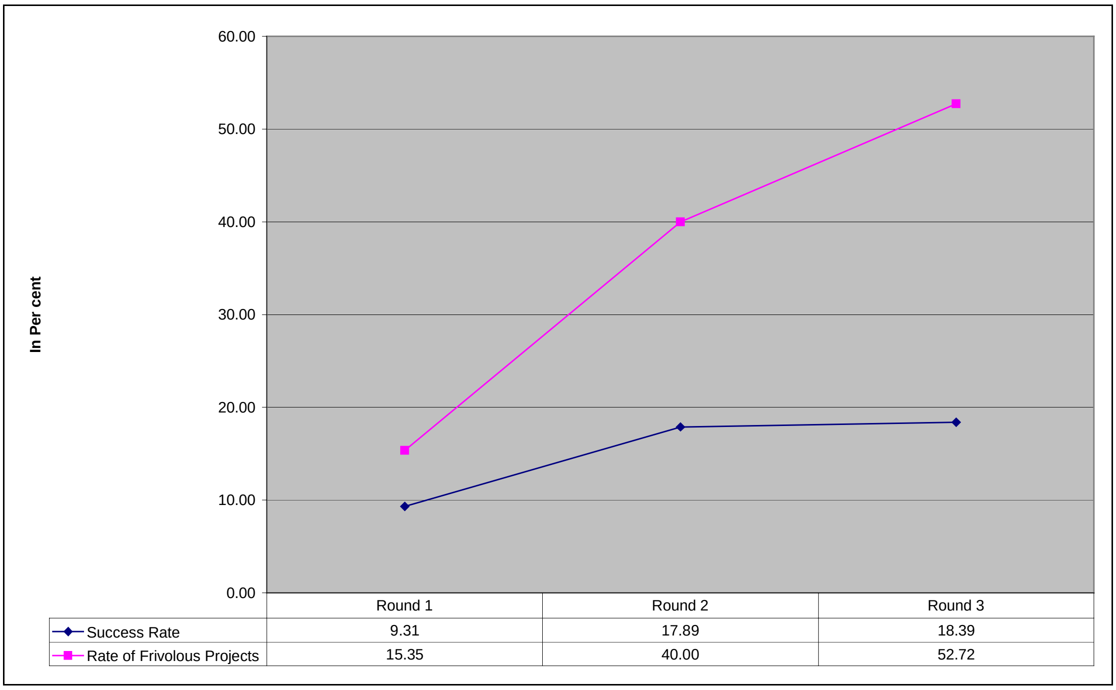


Figure 7: The Rates of Success and Frivolous Projects through the three Rounds of the Innovation Fund
Source: DACST

(ii) Technology and Human Resources for Industry Programme (THRIP): This is another research grant scheme funded by the Department of Trade and Industry (DTI) and managed by the National Research Foundation (NRF). The scheme was introduced in 1992–1993,[17] but real allocations under the project commenced only in 1994–-1995, and the real take off took place only from 1996–1997 onwards (Table 12). In other words, the scheme had a rather long gestation period. Representatives of all agents in the NSI, namely industry, the SETIs and the higher education sector, guide the working of this scheme. The programme has one main objective and two ancillary ones:

- To contribute to the increase in the number and quality of people with appropriate skills in the development and management of technology for industry;
- And as a corollary of the above, to promote increased interaction among researchers and technology managers in industry, higher education and SETIs, with the aim of developing skills for the commercial exploitation of science and technology. This should involve, in particular, promoting the mobility of trained people among these sectors.
- To stimulate industry and government to increase their investments in technology creation and diffusion.

[17] It was established in 1991 but its first budgetary allocation was in 1992–1993.

Judged by the above, it is a really a unique (within the South African context) project in that it seeks to link the various components of the NSI such as the government, the higher education sector, the SETIs and the business enterprises. Moreover, it explicitly addresses the shortage of skilled manpower for research. Finally, the choice of technological focus for the activities to be supported by THRIP is left to the industrial participants and their partners. The mechanisms comprising THRIP as well as the selection criteria and other details are set out in DTI (1998). The funding under the scheme is approved for the duration of the project, up to a maximum of five years, subject to meeting all the conditions of the grant and achieving satisfactory progress. Funding of the projects is based on a matching support basis, and there are essentially two funding formulae. The first is referred to as "R1 for R2", in terms of which THRIP will generally consider contributing a maximum of one rand for every two rands invested by industry in a project that otherwise satisfies the criteria for support. The second is called "R1 for R1", in terms of which every rand contributed by industry is matched equally by THRIP.[18] There has been a significant increase in the success (narrowly defined) in fund allocation over time.

Table 12
Progress under the THRIP Funding
(Value in Millions of Rands)

	Available for Funding	Actual Funding	Success in Funding (%)
1993	1.5	0	0.0
1994	8.17	0	0.0
1995	14.84	2.98	20.1
1996	11.86	5.99	50.5
1997	27.33	22.72	83.1
1998	46.7	46.34	99.2
1999	75.28	71.2	94.6
2000	99	97.4	98.4

Note: The success in funding is defined as that percentage of available funding that has actually been allocated to projects.
Source: National Research Foundation

Since the scheme has been in operation for over five years, it is instructive to analyse the tangible output that has resulted from this scheme. Five indicators of output are employed, namely three measures of human resource development and two measures of physical output of the research funded under the scheme: (i) number of students

[18] To qualify for this, the project must satisfy (in addition to the normal THRIP criteria), the following: (i) It involves at least five students, of whom at least half are African or female; (ii) The industrial partner involved is a Small, Medium or Micro Enterprise (SMME); and (iii) More than one industrial partner contributes and the second highest industry contribution is at least 10 per cent of the highest industry contribution.

supported at university and technikon levels, (ii) number of researchers involved; (iii) number of researchers who were exchanged between universities and business enterprises, known as Technology Innovation Promotion through the Transfer of People (TIPTOP) candidates; (iv) number of both local and foreign patents secured; and (v) number of products or artefacts developed (see Table 13).

Table 13
Actual Output of THRIP: 1995–-1999

Indicator	1995	1996	1997	1998	1999
1. Number of students supported	246	1053	1589	1711	2131
2. Number of researchers involved	NA	NA	597	911(309)	927(296)
3. TIPTOP Candidates	NA	NA	12	46	46
4. Number of Patents (Local and Foreign)	8	19	39	49	36
5. Products and artefacts developed	NA	NA	116	242	290

Note: Figures in brackets indicate the number of team leaders
Source: National Research Foundation

There are, of course some obvious limitations in the data. Firstly, the data were all collected by the funding agency itself, namely the NRF. Secondly, the definition, and indeed measurement, of some of the indicators can be problematic. For instance, the number of students supported does not tell us whether the students actually graduated or not. Again, the number of products and artefacts developed does not indicate how many of these have actually been transferred to industry and are in commercial production at the moment. It holds good for the number of patents, as there is no information on how many of these are under actual exploitation. But then these data, though ideal, are really hard to come by. So going by the data presented in Table 13, THRIP is a really successful programme, as most of the indicators register considerable increases over the years. However, the ultimate acid test of the success of THRIP is its ability to increase the number of research scientists and engineers engaged in R&D. Its performance should be judged against increases in RSE over time.

(iii) Support Programme for Industrial Innovation (SPII): This is once again a DTI scheme, which is actually implemented by the Industrial Development Corporation (IDC).[19] The scheme, which was introduced in 1993, is designed to promote technology development in the enterprise sector and consists of three separate schemes (Figure 8).

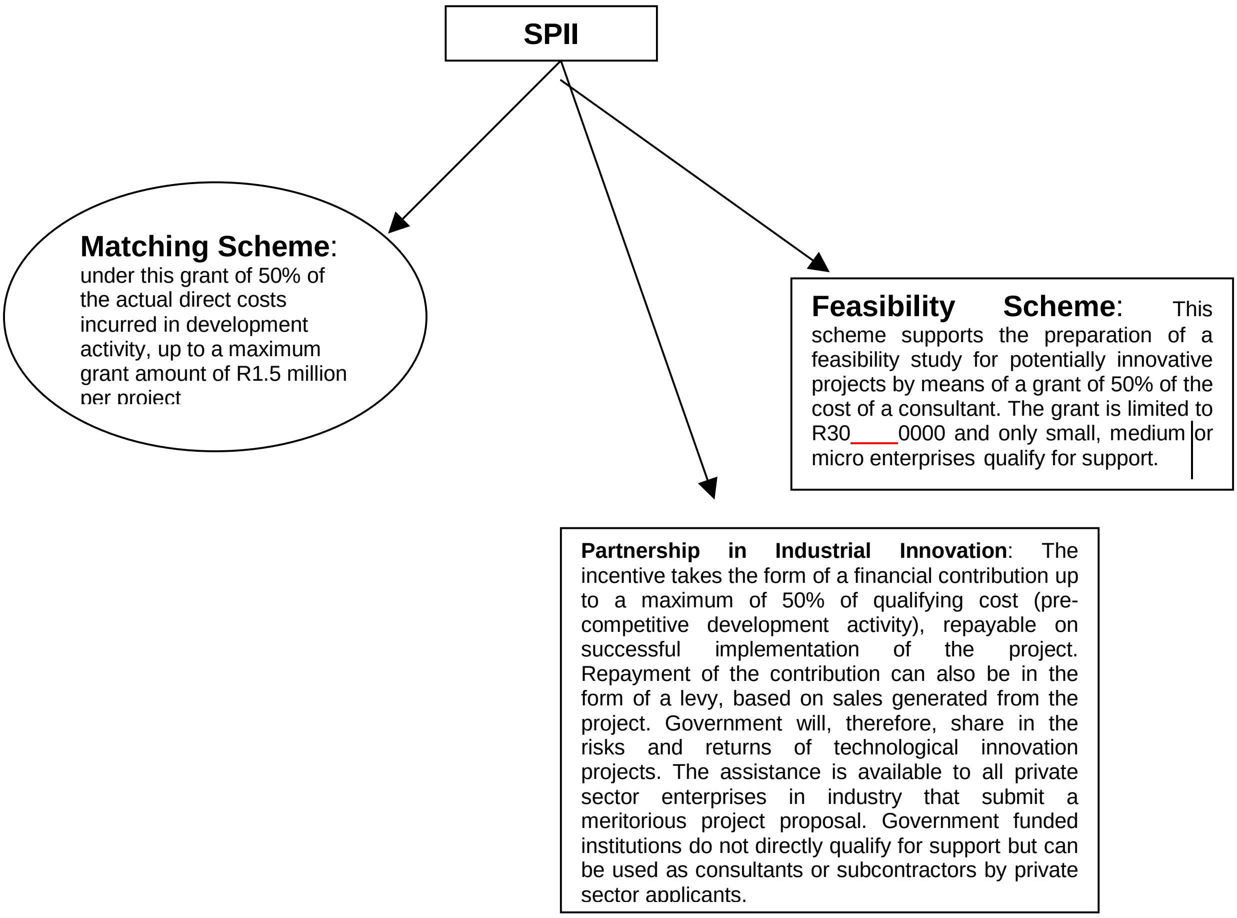
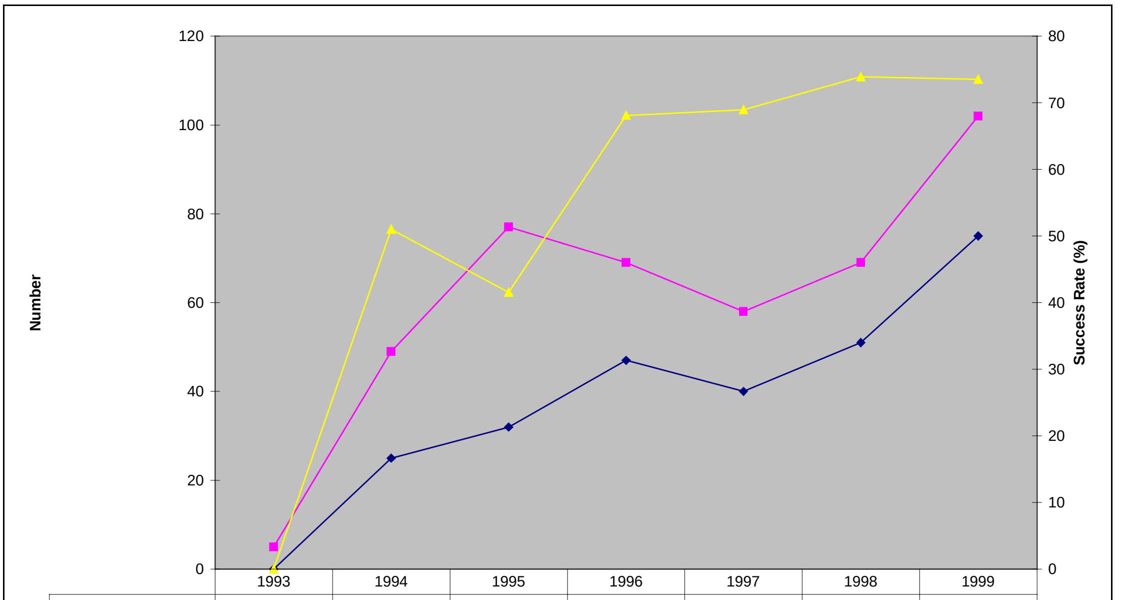


Figure 8: Structure of the SPII Scheme
Source: Industrial Development Corporation

There has been a phenomenal growth in the number of applications, but the rate of rejection has also come down, implying thereby reduced competition for the funds (Figure 9). In fact, the probability that an will application will be successful in obtaining funding certainly increased in the late 1990s as opposed to the earlier period up to the mid 1990s. It is not clear whether this is due to: (a) relaxed criteria; or (b) a significant increase in the quality of the research proposals over time. A second dimension of the scheme is that only two-thirds of the total disbursements of R202.66 million (cumulatively 1993–2000) has been actually utilised by the applicants. A third concern, in terms of industry-wise distribution of the funds approved, very nearly 60 per

[19] The SPII is actually a successor to an earlier (1989) DTI grant scheme known as the Innovation Support for Electronics (ISE) scheme, which was intended to promote the local design and manufacture of innovative electronic products.

cent have gone towards the electronics industry (including software). The chemical and pharmaceutical industry is the next highest recipient with about 11 per cent, followed by the mechanical industry with about 8 per cent. It is now instructive to find out whether the scheme has been successful or not. Once again, the evaluation is conducted on the basis of a survey of the companies involved by the IDC. The companies are required to provide post-completion data for three years (after the completion of the project) to the IDC on a compulsory basis.



	1993	1994	1995	1996	1997	1998	1999
Applications	5	49	77	69	58	69	102
Approvals	0	25	32	47	40	51	75
Success Rate (%)	0	51	42	68	69	74	74

Figure 9: The Success Rate of Applications under the SPII Programme: 1993–1999
Source: Industrial Development Corporation

Three indicators have been collected, namely sales of the product developed and sold (both domestic and export sales), the number of new jobs created as a result of the manufacture of this new product and the average research intensity of the company involved (Table 14). Two caveats have to be borne in mind when interpreting this data. Firstly, the coverage of firms has been only approximately 50 per cent. Secondly, because of the time lag between project funding and the realisation of sales, it is difficult to draw a direct causal link between the projects funded and the resultant level of economic activity.

Table 14
Performance of the SPII Recipients
(Based on Matching Scheme Only)

Indicator	1997–1998	1998–1999	1999–2000
(i) Sales (in millions of Rand)	249.7	614.6	552.7
• Domestic	159.5	432.2	289
• Export	90.20	183.3	265.7
(ii) Employment created (in numbers)	860	3675	1395
(iii) Average Research Intensity of the Companies (in per cent)	4.3	11.6	12.7
Response Rate (in per cent)	NA	63	45

Source: Industrial Development Corporation

The data do not present a clear trend. However, it is interesting to note that, despite the lower response rate in 1999–2000,[20] the average research intensity of the companies has shown an increasing trend. It must be stated that the research intensity is unusually high, as, according to the latest R&D survey the research intensity. for the nation as a whole is only 0.69 (see Figure 2). However, the higher research intensity may also be a reflection of the fact that much of the SPII grants have gone towards the research-intensive electronics, chemical and machinery sectors.

The feasibility scheme was introduced only in June 1998. As mentioned before, the scheme aims to assist small, medium and micro enterprises to prepare a thorough feasibility study for a potentially innovative project. Theoretically speaking, the feasibility scheme is likely to encourage small businesses to initiate R&D projects that can then be funded under the matching scheme The scheme is currently under review to improve its functioning. During its first year (1998–1999) two studies were completed and both resulted in successful matching scheme applications. In its second year of operation (1999–2000), the scheme attracted eleven applications, of which nine, accounting for R 0.24 million, were approved. Seven of these were completed during the year and six of these resulted in matching scheme applications. However, with the introduction of a "competitiveness fund" by the DTI, the feasibility scheme is likely to be "crowded out".

[20] The IDC attributes this lower response rate to the fact that the "financial year-ends differ among the companies polled". See IDC (2000). But this does not seem to be a plausible explanation as the financial year-ends of companies are always different.

The third scheme, "Partnership in Industrial Innovation" is directly administered by the DTI. The scheme is intended to support large development projects, and there will be no limit on the amount of the grant other than budgetary constraints. However, there is absolutely no data whatsoever available on the functioning of this grant scheme.

Thus the three grant schemes (Innovation Fund, THRIP and SPII) all compete with one another in supporting industrial innovations in the country. Given the fact that the number of researchers that are qualified to engage in R&D is rather limited, the grant schemes run the risk of "adverse selection". Some of the schemes, especially THRIP, are designed to address this shortage in technically trained manpower.

Tax Incentives for R&D: The White Paper makes explicit reference to the existence of a tax incentive for R&D:

"Present legislation covering the treatment of R&D expenses for tax purposes is covered in Section 11 of the Income Tax Act of 1962, which outlines two ways in which expenditure can be offset against taxable income. If costs of a revenue nature are concerned, expenditure incurred for the purpose of scientific research undertaken for the development of the business or by way of contributions to research performing institutions, is considered to be legitimate business expenditure and is deductible from taxable income. Whereas contributions to institutions are deductible only if the CSIR certifies that it approves the research proposal and that it is satisfied that such contributions will be used in the research undertaken. Costs of a capital nature can be deducted from taxable income as a tax allowance consisting of 25% of the expenditure over a four-year period subsequent to the initial purchase. Similar conditions apply as for costs of a revenue nature, namely that the taxpayer must have incurred the costs for the purpose of scientific research undertaken for the development of the business, and that the CSIR has certified that the research was performed during the year of the assessment and was financed by such expenditure. Although widespread use is made of the above allowances, the use of the CSIR as a certifying body presents a problem to some firms because of a clear conflict of interest. At the time the Act was passed, the CSIR was wholly government funded, and was not perceived as a potential competitor to private sector enterprises. This situation has changed very significantly since then and this White Paper therefore proposes that the use of the CSIR as a certifying body be re-examined".

This shows that South Africa operates a simple tax deduction for R&D purposes and no tax credit schemes. Although the White Paper refers to the widespread use of these incentives, there are hardly any data on the number of enterprises that have claimed these incentives. In a recent paper, Kaplan (2000) has undertaken an empirical exercise in measuring the attractiveness of the country's tax regime with respect to R&D by computing what is called a B-Index.[21] The B-Index for South Africa, in comparison with certain other countries, is presented in Table 15.

Table 15
The Attractiveness of South Africa's Tax Regime with respect to R&D in a Comparative Perspective
(Based on 1995-1996 Values for a Large Company)

Country	B-index	Tax Credits	Expense Deduction	Statutory Corporate Income Tax Rate (%)
Spain	0.658	Yes	CUR, ME	35.00
Canada	0.714	Yes	CUR, ME	31.00
USA	0.893	Yes	CUR	40.75
Australia	0.889	Yes	CUR, ME	36.00
Netherlands	0.906	Yes	CUR	37.00
France	0.923	Yes	CUR	33.30
Korea	0.893	Yes	CUR	36.50
Mexico	1.015	Yes	CUR	34.0
South Africa	1.008	No	CUR	37.50
Japan	1.014	Yes	CUR	50.60
Sweden	1.015	No	CUR	28.00
Italy	1.051	No	CUR	53.20
Germany	1.051	No	CUR	56.60

Notes: CUR = immediate deduction of current expenditures; ME = immediate deduction of capital expenditures

Source: Warda (1996), the estimates for South Africa are from Kaplan (2000)

Higher the value of the B-Index lower is the attractiveness of a country's tax regime with respect to R&D. On the basis of the value of the B-index, Kaplan reached the conclusion that the county's tax regime is not very favourable to R&D and, given the existence of some evidence about the efficacy of tax incentives in promoting R&D in developed countries in particular, he makes a strong case for extending and strengthening tax incentives for R&D in the country.

However, I am not sure whether one can make a case for improving tax incentives for R&D by analysing the level of the B-Index across space, as the B-Index is only an indicator of how favourable a country's tax regime is (with respect to R&D). It does not measure the effectiveness of tax incentives. A better measure of effectiveness is the

[21] The B-Index represents the ratio of after-tax cost (ATC) of a (say) 1 Rand expenditure on R&D divided by 1 less the rate of tax on corporate income(t). The generic formula for the B-Index : $B = ATC/(1-t)$. For further details see Warda (1996).

elasticity of R&D expenditure with respect to a unit reduction in the cost of doing R&D. However, since South Africa does not have a tax credit scheme, it is impossible to compute any measure of elasticity. Moreover, the only country for which comprehensive elasticity measures exist is the US, and even in this case, results show a mixed picture in the sense that there is no unambiguous evidence that tax incentives promote R&D.[22] Furthermore, the more general point can be made that if the B-Index does indeed measure the "attractiveness" of tax incentives, then one should expect an inverse correlation between the level of the B-Index and the level of research intensity (GERD to GDP ratio). In other words, the higher the B-Index (and the lower the attractiveness of the tax regime), the lower will be the research intensity. In order to check, this I ran a zero-order correlation co-efficient between Kaplan's estimate of the B-Index (as outlined in Table 15) and the GERD to GDP ratio of all the countries in his sample. The answer was (+) 0.558, which is just the opposite of what was expected. In fact, even a casual analysis of the table confirms the above result: Spain has the most attractive tax regime, but it has also one of the lowest research intensities among the countries in the sample of countries considered. It is pertinent to note that the Katz commission[23] was very much opposed to the idea of providing tax incentives to the private sector as it "erodes the tax base and is difficult to administer". Even in the developed market economies, over 60 per cent of the direct support for technology development in enterprises is in the form of research grants, while there has been considerable erosion in the share of tax incentives (Mani, 2001). Grants can be better administered to achieve specific targets.

1.4.4 Promotion of a venture capital industry[24]

In South Africa, venture capital is a subset of private equity capital: private equity in the country is broadly classified into three sub-classes, namely, venture capital, development capital and

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[22] See Mani (1999) for a survey of the US studies on elasticity of R&D expenditure.

[23] Commission of Inquiry into certain Aspects of the Tax Structure of South Africa. The reports of this commission are available in the website of the National Treasury at: http://www.finance.gov.za/

[24] In working out the ideas contained in this section I have relied on two reports on the South African venture capital industry and an interview with Mr. Jo Schwenke, President of the South African Venture Capital and Private Equity Association (SAVCA). The first report was prepared for the South African Venture Capital Association by KPMG (1999) and the second is a report prepared for the government by Stillman, Sunderland, Heyl and Swart (1999),

buy-out funding. Private equity[25] provides equity capital to enterprises that are not listed on a public stock exchange. The total capital under management by the private-equity industry amounts to R27.5 billion, though independent private equity funds amounts only to 43 per cent of it (namely R11.93 billion in 14 enterprises). The remaining funds are essentially captive funds under government, aid agencies and banks. On the contrary, the total private-equity investments amount to R21.6 billion and at 1.5 per cent of the country's GDP, this market is much bigger than the private equity markets of Netherlands (0.9%), Australia (0.4%) and Sweden (0.7%). Historically speaking, the industry has been dominated by captive funds. However, of late, and since 1999, an increasing amount of commitments are being raised by independent private equity funds from third-party sources abroad. However the share of government is very low at 5 per cent or so (Figure 10).

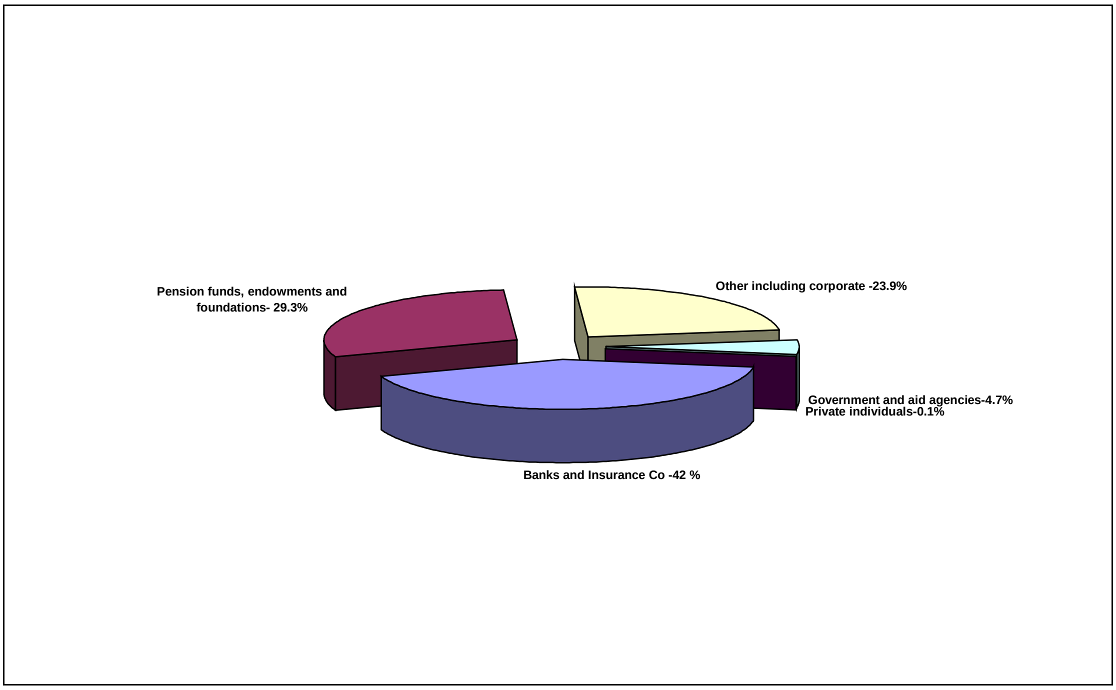
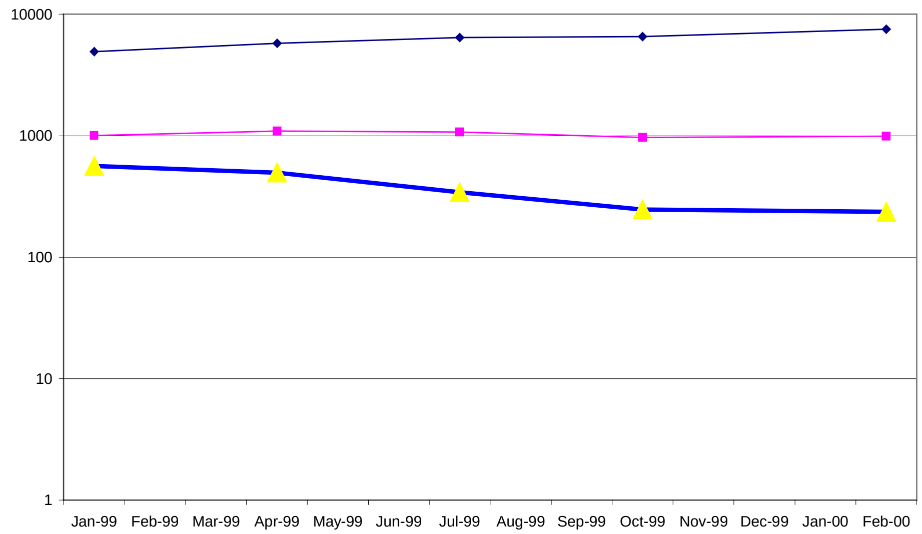


Figure 10: Share of Government in Third Party Funding in South Africa's Private Equity Industry
Source: KPMG (1999)

In fact, government's involvement in promoting venture capital in the country is as recent as 1999, when it commissioned a feasibility study on the scope of the venture capital industry in the country (Stillman et al., 1999). Before I survey the various initiatives of the government, it

[25] Private equity can be used to develop new products and technologies, to expand working capital, to make new acquisitions or to strengthen a company's balance sheet. The existing managers can also use it to resolve management issues, for instance the buy-out or buy-in of a business.

is important to understand the profile of the venture capital industry in the country which until now has been entirely private sector-driven. Three dimensions are considered: its performance, and industry-wise and stage-wise distribution of the investments. Performance, as measured by the movements in the venture capital index[26] *vis-à-vis* the private equity index and the Johannesburg Stock Exchange All Share Index, shows that the industry has not been doing all that well: of course the data refer to just one year (Figure 11). The value of the indices (plotted on the vertical axis) has been converted into logarithmic values to facilitate comparison.



	29/01/99	30/04/99	31/07/99	30/10/99	29/02/00
ALSI	4915	5755	6445	6556	7552
Private Equity Funds	1004	1093	1071	968	993
Venture Capital Index	563	496	343	247	236

Figure 11: Movements in the Value of the Venture Capital Index in the Johannesburg Stock Exchange
Source: Johannesburg Stock Exchange, http://www.jse.co.za/

In terms of cumulative investments much of the investments have been directed towards non-technology-oriented sectors such as banking, insurance, financial services, retail, media, entertainment and leisure (Table 16).

26 It is referred as IX89 and consists of the share prices of 39 venture capital companies.

Table 16
Industry-Wise Distribution of the Private Equity Investment Industry in South Africa

Industry	Cumulative Investments (%)
Technology related:	
• Manufacturing	26
• Information Technology	19
Non-Technology related:	
• Media, Entertainment and Leisure	15
• Banking, financial services and Insurance	11
• Services	8
• Retail	7
• Other	14

Source: KPMG (2000)

Investment at the seed, capital, start-up and early stage accounts for only 6.1 per cent (Table 17). In other words, what is conventionally referred to as venture capital forms only a very small percentage of the private equity investment market.

Table 17
Distribution of Stage Wise Investments in the South African Private Equity Investment Market

Investment Stage	Cumulative Investments (%)
Conventional Venture Capital Related:	
• Start up and early stage	5.7
• Seed Capital	0.4
Other Stages	
• Expansion or development	60.9
• Management Buy-outs	20.7
• Replacement Capital	12.3

Source: KPMG (2000)

However, almost all venture capital related investments are in the form of equity investments, and in addition, "value added support" is provided. This shows that the venture capital industry in the country is very small and is in its infancy. Traditionally speaking, outside the US, especially in OECD countries, venture capital institutions have received a fair amount of support from government. Mani (1999) has provided a survey of these. In fact, in most developing countries, the venture capital industry was established by their respective governments.[27] In the case of South Africa, I could not identify any specific policy with respect to the establishment and growth of the industry[28]. Even the otherwise comprehensive White Paper is silent on this aspect. However, according to the DTI, some efforts are being made to establish a series of venture capital funds in the country, one of which will be in partnership with the CSIR for financing spin-offs from the CSIR's research. However, the venture capital industry in the country is currently entirely private sector-driven and in the process of being organised.[29] Given the fact that the country has a well-developed stock market, an exiting mechanism for the venture capitalist (which, incidentally, is the main hurdle to the establishment of the industry) does not present any problems. However, the country does have a serious shortage of skilled personnel to work in the industry, and there does not appear to be any concerted action on the part of the government to overcome these problems.

[27] For an account of the role of government in establishing venture capital institutions in India and Singapore, see Mani (1997) and Mani (2000b) respectively.

[28] This was confirmed by Mr. Schwenke. In most countries, however, venture capital investments attract preferential tax treatment.

[29] Recently, the industry established its own association, the SAVCA.

SUMMING UP

South African policy makers have shown considerable sophistication in innovation policy formulation. Policies, especially the technology policy of the country (referred to as the White Paper). have been framed after considerable consultation with stakeholders. The policies, as well as the institutions that support science and technology in general, have been subjected to detailed reviews. The country is also one of the few from the developing world to explicitly use the national systems of innovation approach. However, my analysis shows that this subscription to seemingly sophisticated terms and concepts is more in form than content. The innovation policy has been backed by a detailed technology foresight study through which a set of about 12 broad priority areas has been identified.

A series of three research grants has been established, administered by three different agencies, and these grants have been targeted at the foresight priority areas. Of these three, the Innovation Fund was found to be the largest, whereas THRIP was the most unique in that it sought to address one of the most fundamental weaknesses of the NSI, namely the shortage of technically trained personnel who can engage in R&D. Given the time that has elapsed since the introduction of the schemes, it is still too early to evaluate them in the strict sense of the term. What has been attempted in this paper has been a preliminary analysis, according to which, none of the instruments have effectively addressed, or are poised to address, the severe shortage of skilled manpower, not only for simple manufacturing but also for research. As a result, the research intensity of the country is very low (especially considering its elaborate technology infrastructure), and most of the patents granted to inventors from South Africa are individually owned. Moreover, the rate of growth in patenting has been virtually stagnant over the last ten years or so. Finally, given the fact that the manufacturing sector is highly concentrated (despite explicit efforts by the government to promote small and medium enterprises), the demand for innovations appear to be very low in the South African context. What is called for at this stage is thus a human resource development policy, from primary level through to tertiary level, in order to increase enrolments for science engineering education. South Africa also needs industrial policy measures that can reduce the degree of concentration and thereby promote increased competition between firms. In this respect, the South African case is very similar to the Malaysian one. Both South Africa and Malaysia would benefit from learning from the Singaporean model of promoting innovation through the human resource development route.

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