Science and Technology Policy in Transition Countries: Experience of South Africa

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to

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An Evolving System of Innovation

- 1. Context
- 2. Evolution of the NSI
- 3. Knowledge infrastructure
- 4. Knowledge Measurement
- 5. Knowledge Workers
- 6. Knowledge transfer
- 7. Open economy
- 8. Framework conditions



South Africa – the Rainbow Nation

- 1,000,000 km²; 5,000 km coastline; no navigable rivers
- Mediterranean, semi-desert, warm temperate and sub-tropical climates
- 2000m inland
- Exceptional biodiversity; 10% arable
- Large PGM deposits; metals; abundant coal; limited hydro; no oil
- 47 million people; 11 major languages (9 indigenous)
- 9 Provinces

Political, Social, & Economic Revolution

- 1. Dutch, French, British colonial rule
- 2. Settler-indigenous wars; 1910 Union of South Africa
- 3. Slavery; Market economy; *Apartheid*
- 4. 1960-1990 Liberation War
- 5. 1994: Multi-party democracy; Tripartite Alliance
- 6. Reconstruction and Development Programme
 - Improved quality of life
 - Employment creation
 - Competitive economy
 - Rising level of social security
 - Human resource development
 - Safety and security

From Apartheid to Tripartite

- 3. 1996: S A Constitution adopted
- 4. 1996: Growth, Employment and Redistribution strategy
- 5. Labour Relations; Basic Conditions of Employment
- 6. Promotion of Extension of Land Tenure
- 7. White Papers on Education (5)
- 8. Skills Development
- 9. Preferential Procurement
- 10. Employment Equity

Socio-economic facts & figures

- 1. Market economy + State sector
- 2. GDP \$500 billions (20% of continental GDP)
- 3. 35% Witwatersrand (Gauteng Province)
- 4. High self sufficiency; negative current acct. (6% GDP)
- 5. Johannesburg Securities Exchange #12 in market cap
- 6. Services 70% of GDP
- 7. Exports equiv to 30% GDP; commodities = manufactures
- 8. GNP/c PPP \$12,000
- 9. High unemployment +/- 25%
- 10. Poorly quantified '2nd Economy'

- 11. Forced removals 1912 1980's drive systemic poverty
- 12. 55% urbanised; growth + 5%
- 13. Free health care and education
- 14. 16-45 age HIV prevalence +/-20%
- 15. Skewed property ownership; HRD
- 16. Mass education system of poor quality
- 17. Social safety net instituted
- 18. High levels of crime
- 19. Gini 0,59 but 0,35 if social transfers included

An African welfare state?



South Africans

Petra Rohr-Rohendaal -

2. Evolution of the NSI

- •1815 1870: Smallpox vaccine; Royal Observatory; South African Museum; South African College (University of Cape Town)
- •1870: Diamonds: (Cape)
- •1886: Gold: (Witwatersrand) NSI re-locates North
- •1911: College of Mines predecessor of Wits U
- •1914: 1st World War materiel supplier
- •1923: ESKOM; 1928: ISCOR; 1956: SASOL
- •1939: 2nd World War materiel supplier; telemetry
- •1945: CSIR
- •1960: Liberation struggle Arms and Oil Embargo

Performing the balancing Act





3. Knowledge infrastructure



- Five research universities
- Seven science research performing councils
- Museum scientific sections
- Cyclotron laboratory
- Nuclear energy corporation
- Optical, radio and magnetic observatories
- Institutes for marine & aquatic biodiversity
- National botanical institute
- Industry research institutes
- Industry associations
- Learned societies and professional bodies
- Extensive consulting and technical services
- Standards and quality control
- Regulators and intellectual property registers

Diversity

UNIVERSITY	HERD (ZAR m)	Publications	PhD students
Medical University of South Africa	8	50	64
North West University	84	267	558
Rand Afrikaans University	82	277	578
Rhodes University	60	165	193
University of Cape Town	312	564	783
University of Fort Hare	12	79	23
University of KwaZulu Natal	238	704	960
University of Port Elizabeth	38	123	183
University of Pretoria	254	954	1,529
University of South Africa	83	435	859
University of Stellenbosch	205	624	757
University of the Free State	86	334	529
University of the North	19	63	75
University of the Western Cape	63	106	245
University of the Witwatersrand	330	557	620
University of Transkei	6	14	1
University of Venda for Science and Technology	11	24	27
University of Zululand	11	61	128
TOTALS	1,900	5,401	8,112

THE BIG FIVE



4. Knowledge measurement



Resilience through the transition

GERD = R 12,07 billions



The top quintile perform 86% of business R&D



GERD: GDP comparative



PERCENTAGE OF GDP

GERD:GDP EU comparative (2004)



Source: CeSTII EU-25 Benchmarking study (pending)

Public R&D in relation to GDP, 2003



Regional R&D expenditure: GDP NUTS 1



Researchers (FTE)/1000 labour force, 2003



Measuring Innovation

- Based on OECD/Eurostat Oslo Manual
- Stratified random sample from Statistics SA business register
- CIS undertaken in all EU and many other countries every 4 years, now bi-ennial
- Covers business sector (mining, manufacturing, services)

Sources of Innovation (type)

	High/medium	Low	Not applicable
Internal sources	82.9	6.6	10.5
Customers	68.8	16.6	14.6
Suppliers	68.5	20.2	11.3
Conferences, trade fairs	38.4	32.2	29.4
Professional & industry associations	35.5	29.2	35.3
Scientific or trade journals	34.7	35.8	29.5
Consultants, private labs	28.2	27.2	44.6
Higher education institutions	15.7	23.9	60.4

Sources of Innovation (country)



Sources of Innovation (type/region)



5. Knowledge workers

- Limited flows of quality school leavers
- Increased pull of management sciences
- Attractiveness of careers in government or business
- Difficulties in measuring full R&D Value Chain
- Losses through emigration
- Little inward flow (foreign university staff <5%)
- Unused potential of foreign postgraduate students (15-20%)

Researchers (FTE) by sector



People count

RESEARCHER FTE	1992	2004
Business	3395	4411
Government	2428	2342
Higher Education	3631	3374
TOTALS	9454	10127

Age profile of Researchers



Expansion of Higher Education

Year	1991	2003	% Change
Students	430 014	717793	67%
Masters 8	24 802	52333	111%
doctoral			
students			
Instruction 8	11 831	14 534	23%
Research			
staff			

Sustained by contract staff?



6. Knowledge transfer

- Internationalization of R&D
- Scientific publications
- Patenting
- Plant breeders rights
- TBOP
- Copyrights and registered designs
- Networks



"Foreign R&D is particularly important for most OECD countries (the United States being an exception), since the bulk of innovation and technological change in small countries is based on R&D that is performed abroad. But domestic R&D, i.e., business, government and university research, is also an important driver of MFP growth.

It is also key in tapping into foreign knowledge; countries that invest in their own R&D appear to benefit most from foreign R&D" (Pilat, 2002).

What does this mean for the small NSI's of Africa?

Publications/million population, 2003



ISI Publications (normalized)

Country	Articles/GDP
Israel	67.8
Sweden	59.7
Switzerland	57.3
Finland	47.2
Denmark	44.3
New Zealand	43.2
Netherlands	39.9
Estonia	36.6
United Kingdom	36.4
Canada	35.8
Ireland	24.5
South Africa	22.2
United States	21.8
Taiwan	17.9
South.Korea	8.6
India	6

Size counts

Publications

1991		2001	
Discipline	SRCA	Discipline	SRCA
Geol/Petrol/Mining Engn	8.976	Geol/Petrol/Mining Engn	8.732
Multidisciplinary	4.211	Animal Sciences	4.338
Animal Sciences	3.897	Entomology/Pest Control	4.014
General & Internal Medicine	3.637	Philosophy	3.174
Aquatic Sciences	3.225	Veterinary Med/Animal Health	2.919
Entomology/Pest Control	3.193	Environ Studies, Geog & Dev	2.787
Archaeology	3.034	Multidisciplinary	2.755
Veterinary Med/Animal Health	2.719	Environment/Ecology	2.654
Plant Sciences	2.622	Plant Sciences	2.643
Inorganic & Nucl Chemistry	2.429	Political Sci & Public Admin	2.603
Classical Studies	2.362	General & Internal Medicine	2.266
Environment/Ecology	2.306	Aquatic Sciences	2.251
History	2.077	Biology	2.139
Philosophy	2.036	Education	2.088

Source: Albuquerque, E. (2003) 'Immature systems of innovation: Introductory notes about a comparison between South Africa, India, Mexico and Brazil' CEDEPLAR/FACE/IFMG

Falling world share, but key strengths

Citation ranking, ESI 1995-2005

Scientific discipline	UCT	ΡΤΑ	Free State	Wits	Natal	Sbsch
Biology & biochemistry	4					
Chemistry				4		
Clinical medicine	1	2	4	1	2	2
Engineering		3		4		
Environment /ecology	2	3			4	
Geosciences	3			2		
Materials science				4		
Plant & animal	2	2	3	4	2	3
Social science	2			2	4	

Manufacturing BERD by type of industry

			Medium-Low-Tech
	High-Tech	Medium-High-Tech	and Low-Tech
Hungary	64.9	26.0	9.1
Ireland	64.3	10.0	16.7
Finland	62.6	23.4	14.0
UK	56.7	33.6	9.6
Sweden	52.2	40.4	7.4
Slovenia	51.7	32.8	15.5
Belgium	49.8	31.6	18.6
Nertherlands	46.4	36.4	17.2
Denmark	46.1	39.3	14.6
France	44.6	42.0	13.4
US	44.3	44.9	10.8
Cyprus	43.8	27.3	28.9
Japan	41.6	45.9	12.5
EU-25(1)	41.4	47.7	10.9
South Africa	41.0	29.5	29.5
Italy	40.9	47.5	11.5
Spain	36.0	41.8	22.3
Poland	34.2	45.9	20.0
Latvia	29.3	45.5	25.2
Malta	28.5	42.8	28.6
Germany	26.6	65.6	7.7
Czech Republic	14.9	70.5	14.6

Producing?

Method for producing calcium nitrate granules Dirk Renier Hendrik Rabie, Vanderbijipark (South Africa); Wilfred Roy Morris, Sasolburg (South Africa); and Johannes Petrus Gysbert Eygelaar, Vanderbijipark (South Africa) Assigned to Omnia Fertilizer Limited, (South Africa)

DetNet SOUTH AFRICA



CSIR



Enhanced identification system Raymond Catherall Atkins, Pretoria (South Africa); Mario Alphonso Marais, Pretoria (South Africa); and Hendrik Van Zyl Smit, Pretoria (South Africa) Assigned to Zih Corp., Hamilton (Bermuda) Filed on Aug. 07, 2003, as Appl. No. 10/635,683.

USPTO Patents (SA)

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
No.	89	99	137	112	112	115	110	111	120	113	112

Patents per PPP\$ GNI (2003)

Country	Intensity
Hungary	0.52
Spain	0.40
S Africa	0.27
Argentina	0.17
Russia	0.16
Brazil	0.14
Mexico	0.10
India	0.08
China	0.07
Poland	0.04

Median value 2.2 (30 countries)

US Patents filed vs. income



Source: OECD 2003, 2004; RICYT, 2004

World ranking

Category	Rank
Fischer-Tropsch catalysis	5
Metallurgy	11
Separation technology	16
Communications	16
Drugs and bio affecting compounds	27

Plant Breeders Rights

Country	World Share (%)
United States	14,1
Canada	10,7
Poland	8,1
Japan	6,9
South Africa	3,8

Source: WIPO, 2001

Agric R&D: Agric GDP > 2%

Industry + universities + science councils





BERD Sources of funds, 2002



Business enterprise Government Abroad Other national sources

Source: Benchmarking study (pending)

- Global players: Anglo American, SASOL, SAPPI, Massmart, MTN ...
- R&D concentrated in large organisations: top 20 = 60%
- 17 of top 20 are state => incubator role
- 60% GERD in Gauteng; 15% W Cape; 9% KZN
- At GERD/GGP of 1,42%, Gauteng is <u>the</u> innovation hub
- Mining & chemicals; telemetry, defence, aerospace; systems development; agriculture
- Increasing foreign flows to R&D; automotive, ICT, health

Understand emerging opportunities



Move along the R&D value chain

Service sector BERD (%)



Source: Benchmarking study (pending)

SME Share of BERD (%)



Source: Benchmarking study (pending)

8. Framework conditions



Trajectories in the First Economy

- Defence & aero: >100 years; creative innovation. Global player.
 HIGH R&D
- Automotive: >70 years; licensing; no domestic variants; Global player.
 LOW R&D
- Mining: >100 years; creative innovation; challenged Global player. Depleting
 HIGH R&D
- Petrochemicals: >50 years; creative innovation; Global player. Unlimited HIGH R&D
- Animal and plant health: >100 years; creative innovation; Global player.
 HIGH R&D

HIGH R&D

LOW R&D

- Nuclear energy? Effort since 1980s
- Services sector: global player

Government influence on the NSI

- Government dept research institutes HIGH
- Science councils, institutes, museums MODERATE

FREE MARKET

EFFECTIVE?

- HE; subsidy system HEMIS & DoE AUTONOMOUS
- Business under WTO rules –
- Tools: Grants; R&D tax incentives
- Regulatory
 HIGH COMPLIANCE
 - Registration of scientists, engineers, GMO and clinical trials
 - Ethics Committees

How and why does institutional R&I behaviour change?

Accelerated and shared growth initiative

- 2014: Halve poverty & unemployment; 6% growth
- Address investment climate issues esp. for SMEs
 - starting a business (rank 57)
 - Dealing with workers (rank 87)
 - Protecting investors (rank 9)
 - Enforcing contracts (rank 67)
- Infrastructure investment (> R370bn)
- Sectors w. potential for high growth, employment creation and enterprise development
- Education and skills development/acquisition
 - Focus schools for science and mathematics in previously excluded communities
- Expanded Public Works Programme

Emergent S&T Policy

1. White Paper on S&T.

"The NSI comprises institutions and firms and the interactions among them that generate and disseminate new products and processes."

- 2. National Advisory Council on Innovation
- 3. National Research & Technology Audit
- 4. National Research & Technology Foresight
- 5. Innovation Fund
- 6. Performance Measurement System
- 7. R&D grants and enhanced tax deduction

- 5. Biotechnology Strategy (incubators)
- 6. National R&D Strategy
 - Coordination of budgets
 - Central role of DST
 - Technology Missions & Platforms
- 7. Publicly-funded IP
- 8. Knowledge generation
 - Graduate attraction, recruitment and retention
 - Recapitalization of public R&D institutions
 - University Centres of Excellence
 - Research Chairs Programme

An expression of confidence

THANK YOU

When the second se