

DRAFT REPORT ON INTERNATIONAL RATING SYSTEMS OF COMPETITIVENESS AND HOW TO STRATEGISE TO USE THEM BETTER.

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1. INTRODUCTION

This report relates to a research tour undertaken under the auspicious of the National Advisory Council on Innovation (NACI) in order to get insight into competitiveness ranking as they are applied internationally and nationally, how these are constituted and what lessons the instituting of these systems hold for similar initiatives in South Africa. The tour was an initial step to gather information that would initiate a national discourse on competitiveness and actions needed to institute a national competitiveness initiative. Visits were conducted to the World Economic Forum in Geneva and their counterparts at Harvard University (who compile the Global Competitiveness Report), the European Commission's DG Research (Responsible for the Benchmarking Indicators), The DTI in the United Kingdom, Prof Sanjaya Lall at Oxford University (who is developing a competitiveness system for UNIDO), FORFAS in the Republic of Ireland (who form the Secretariat of the Irish National Competitiveness Council) and the Council on Competitiveness in the United States of America.

The specific objective of this report is to describe international and national rating systems in order to better understand them and identify those indicators from these systems that could possibly serve as a basis for future competitiveness measurement. A further and equally important objective is to use this knowledge to develop a strategy around the international competitiveness rating systems to ensure that they reflect South Africa's competitiveness position fairly and accurately.

2. INTERNATIONAL SYSTEMS

2.1. WORLD ECONOMIC FORUM (WEF) -GLOBAL COMPETITIVENESS REPORT 2001-2002

The Global Competitiveness Report (GCR) is one of two international competitiveness-rating systems that is often quoted in South Africa (the other being the IMD's World Competitiveness Yearbook). Although its validity and its theoretical basis has been questioned by authors such as Kaplan (2001) and Lall (2001) its influence remains considerable and far reaching and thus its basis for measuring competitiveness needs to be examined for constructing a national set of indicators.

The latest report (2001-2002) consists of two indices: the *Growth Competitiveness Index (GCI)*, produced Jeffery Sachs and John McArthur of the Centre for International Development at Harvard University, and the *Current Competitiveness Index (CCI)*, by Michael Porter of the Institute for Strategy and Competitiveness at Harvard Business School, which form the basis for overall competitiveness rankings. Underlying these rankings and indexes are collections of hard data obtained from various national authorities, international agencies and private sources (captured in July/August 2001¹) and an Executive Opinion Survey. Various WEF partner institutes around the world, Business South Africa in our case, conduct the Executive Opinion Survey. The data in the GCR are assembled for 75 countries spanning all stages economic development.

2.1.1. Growth Competitiveness Index (GCI)

“The overall Growth competitiveness index aims to measure the capacity of the national economies to achieve sustained economic growth over the medium term, controlling for the current level of economic development.”² As such, it defines competitiveness as the “Set of institutions and economic policies supportive of high rates of economic growth in the medium term.”³ It considers the potential for growth by accounting for structural, institutional and policy features of national economies over the next 5 years for the 75 countries in its sample and ranks these.

In its ranking the GCI distinguishes between core (innovation driven) and non-core economies based on an economy’s capacity to innovative. Using U.S. patenting data as a proxy for innovative capacity core economies are distinguished from non core economies (15 US utility patents per million of population or more during the 1980s or by 2000 being the threshold.) The essential difference in the GCI’s treatment of core from non-core economies is its identification of the factors responsible for technological advancement. For core economies these factors are related technology creation (innovation) rather than technology diffusion (as in non core economies).

South Africa with 3.0 and 2.5 US utility patents per million of population during the 1980’s and 2000 respectively is classified as a non-core economy.

Apart from the level of technology as a factor in its ranking the GCI also considers the quality of public institutions and macro economic conditions related to growth. It defines three component subindexes according to these factors: a technology subindex, public institutions subindex and macro economic environment subindex.

The Technology Index measures the capacity for innovation and diffusion relative to stages of development while the Public institution index measures the role of politics and bureaucracy in supporting market-based economic activity and the Macroeconomic index measures capital accumulation and efficiency.

For core economies innovation plays a dominant role and the technology subindex is therefore given a higher weighting than the other

South Africa’s overall GCI ranking is 34. Technology index: 46
Public institutions index: 35; Macroeconomic Environment index 27
Note: low technology index compared to neighbours

Country	GCI 2001	Technology Index	Public Institutions	Macro Economic
Ireland	11	19	18	2
Korea	23	9		8
Chile	27	42	21	21
Hungary	28	21	26	
Malaysia	30	22	39	20
Mauritius	32	37	32	30
Thailand	33	39	42	16
South Africa	34	46	35	27
Costa Rica	35	32	37	42
Greece	36	38	40	32
Czech Republic	37	20	53	49
Mexico	42	36	56	36
Brazil	44	49	47	33
Egypt	51	64	33	51
India	57	66	49	45

two when the overall GCI is compiled. The technology index is weighted ½ while the public institutions and macroeconomic indexes ¼ each.⁴ For non core economies the GCI

considers “technological advancement as playing a more limited role relative to the other two factors”⁵. It therefore places a weight of a 1/3 on each component index.

The methodology employed is thus:

1. to categorise economies into core/non-core economies
2. determine a measure of economic growth for the period 1992 2000. The growth is extrapolated to future years using basic test equation.
3. to construct sub indexes from both hard and “soft” data and verify links with growth
4. to combined sub indexes in ratios described to construct the GCI
5. Test relationship between GCI and growth examined using a test equation.

How is the technology index created?

For **core economies**, the technology index is a simple average of an **innovation subindex** (measuring elements of innovation such as patents that are linked to growth) and **an ICT subindex**. Both comprise of hard and soft data (re-based to a 7 point scale). The **Innovation subindex** and **ICT sub index** is made up of ¼ innovation survey data and ¾ innovation hard data and 1/3 ICT survey data and 2/3 ICT hard data respectively. The hard and soft variables are in Table 1 as follows:

Table 1

	Innovation subindex <i>¼ survey data and ¾ hard data</i>	ICT subindex <i>1/3 survey data; 2/3 hard data</i>
Hard Data	<ol style="list-style-type: none"> 1. US utility patents granted per population in 2000 (1/4 weighting) 2. Gross tertiary Enrolment Rate in 1997 (3/4 Weighting) 	<ol style="list-style-type: none"> 1. per capita measures of telephone lines (mainline) 2. per capita measures of telephone lines (mobile) 3. per capita internet hosts 4. per capita internet users 5. computers per capita
Soft Data	<p><i>(broad indicators of technological sophistication and product development)</i></p> <ol style="list-style-type: none"> 1. country’s position in technology relative to world leaders 2. does innovation play a major role in generating revenue for business 3. how much do companies in your countries spend on R&D relative to other countries? 4. extent of business collaboration in R&D with local universities 	<p><i>ICT usage and government policies</i></p> <ol style="list-style-type: none"> 1. extent of internet access in schools 2. competition amongst ISPs sufficient to ensure high quality, infrequent interruptions and low prices 3. is ict and overall priority for government 4. are government programmes successful in promoting the uses of ict 5. are laws relating to ict well developed and enforced

For **non Core economies** the technology index consists of a measures of technology transfer, innovation and ICT combined in the following ratios: 3/8 technology transfer, 1/8 innovation and 1/2 ICT. As with core economies all three comprise of hard and soft data with ratios and variables given in the Table 2 below.

Interestingly in the Technology index South Africa performs better on the soft data side than on the hard data side. South Africa ranks 22 in the non core technology index 16 in the innovation, 16 for ICT and 28 for technology transfer.

Table 2

	Technology transfer subindex <i>½ survey ½ hard data</i>	Innovation subindex <i>¼ survey data and ¾ hard data</i>	ICT subindex <i>1/3 survey data; 2/3 hard data</i>
Hard Data	1. Technology in trade variable. <i>(Measure the extent of manufacturing technology in the export structure of non core economies. Calculated using UN COMTRADE database and StatsCan World trade Analyser used)</i>	<ol style="list-style-type: none"> 1. US utility patents granted per population in 2000 (1/4 weighting) 2. Gross tertiary Enrolment Rate in 1997 (3/4 Weighting) 	<ol style="list-style-type: none"> 1. per capita measures of telephone lines (mainline) 2. per capita measures of telephone lines (mobile) 3. per capita internet hosts 4. per capita internet users 5. computers per capita
Soft Data	1. Is FDI an important source of new technology in your country?	<p><i>(broad indicators of technological sophistication and product development)</i></p> <ol style="list-style-type: none"> 1. country's position in technology relative to world leaders 2. does innovation play a major role in generating revenue for business 3. how much do companies in your countries spend on R&D relative to other countries? 4. extent of business collaboration in R&D with local universities 	<p><i>ICT usage and government policies</i></p> <ol style="list-style-type: none"> 1. extent of internet access in schools 2. competition amongst ISPs sufficient to ensure high quality, infrequent interruptions and low prices 3. is ict and overall priority for government 4. are government programmes successful in promoting the uses of ict 5. are laws relating to ict well developed and enforced

How is the public institutions index created?

The WEF views the public institution as “crucial for their role in ensuring protection of property rights, the objective resolution of contract and other legal disputes, efficiency of government spending in public services, and transparency in all levels of government.”⁶ They are thus deemed to be essential in efficient resource allocation and establishing the stability for growth.

The public institutions index is sole created from responses to the Executive Opinion Survey. In the view of the WEF ⁷“institutional growth is closely linked to economic growth in the no-core countries hence the differing weighting reported earlier on (1/4 for core and 1/3 for non-core). It consists of to components: contracts and law subindex and corruption subindex. The former consists of average scores for countries regarding neutrality in government procurement, judicial independence, clear delineation and respect of property rights, and costs related to organized crime. The latter deals with corruption the important public service areas of imports and exports, connection to public utilities and tax collection. Table 3 below outlines the questions in the Executive Opinion Survey that form the basis on which the public institutions index is created.

South Africa ranks:

- 40 on Contracts and law subindex and
- 32 on Corruption subindex and
- 35 on the public institutions index

Table 3

Public institutions index = ½ contracts and law + ½ corruption	
Contracts and law subindex	Corruption subindex
1. Is the judiciary independent from government and/or parties to disputes?	1. How common are bribes paid in connection to import and export permits?
2. Are financial assets and wealth clearly delineated and well protected by law	2. How common are bribes paid when getting connected to public utilities
3. Is your government neutral among bidders when deciding upon public contracts?	3. How common are bribes paid in connection with annual tax payments
4. Does organized crime impose significant costs on business	

How is the macroeconomic index created?

The macro economic environment index consist of three parts: A macro economic stability subindex consisting of hard data and soft data; A country credit rating measure; and a general government expenditure measure. The three are combined in the ratios ½, ¼ and ¼ respectively to construct the macroeconomic environment index. The macro economic

South Africa ranks:

- 27 on Macro economic index
- 28 on Macro economic stability
- 40 on country credit rating
- 20 on Gov Expenditure

stability soft data measures short-term perceptions of private agents. The related questions as well as hard indicators are given in the Table 4 below.

Table 4

macro economic stability subindex = 5/7 hard data 2/7 soft data	
<p>Hard data: stability of macro economy</p> <ul style="list-style-type: none"> ○ Real exchange rate in 2000 ○ Lending-borrowing interest rate spread in 2000 ○ Inflation in 2000 ○ General government budget balance as percentage of GDP ○ CPI in 200 ○ National savings rate 	<p>Soft data: perceptions on short term outlook of private agents</p> <ul style="list-style-type: none"> ○ Likelihood of recession ○ Credit availability for companies

The above approach with the definition of core and non core economies and underlying changes in the variables of sub indexes marks a change from the approach employed in the previous year (2000/2001). For absolute comparison purposes the current GCI cannot be used with respect to previous years. However, many of the underlying variables from previous years are included, in reorganised form, in the subindexes and can thus be tracked. Notwithstanding the changes there is, as is pointed out in the report, a strong correlation to previous results. It is also important to note that the GCI is not dependent on the level of per capita income and geographical factors not directly incorporated into GCI (variations between regions internally and externally)

2.1.2. Current (sustainable) Competitiveness Index

The Current Competitiveness Index (CCI) “uses microeconomic indicators to measure the set of institutions, market structures and economic policies supportive of high current levels of prosperity.”⁸ It views productivity as the basis for competitiveness and therefore measures productivity potential of companies by determining the sophistication of competing companies (innovative capacity, skills levels, etc) and the quality of microeconomic business environment. Among the latter are a) the quality of factor (input) conditions, b) the context for firm strategy and rivalry, c) the quality of demand conditions and d) the presence of locally related and supporting industries.⁹

The index considers the same 75 countries as the GCI but is exclusively based on the Executive Opinion survey. It constructs two subindexes based on the above; one focussing on company sophistication/practice and the other on quality of the national business environment drawing on a complex array of variables with a demonstrated statistical relationship to GDP per capita. The list of questions covering the variables for the two sub indices is given in Table 5. The challenge for the index is to prove causality between microeconomic determinants and GDP growth?

South Africa ranks:

- 25 on CCI
- 25 on company sophistication subindex
- 27 on business environment subindex

The methodology outlined in the GCR¹⁰ for the CCI is as follows:

- Analysis of impact of individual microeconomic indicators (as obtained from survey) on level of GDP to verify statistical validity and test functional form

- Creating aggregate measure of microeconomic competitiveness, CCI, together with two sub-indices a) company sophistication/practice and b) quality of the national business environment
- Generate country competitiveness rankings.

The CCI is constructed primarily from survey data as there are difficulties with using quantitative measures consistently over such a large number of countries and the WEF feels that it is important to get the views of participants in economy. The surveys consists of 4600 respondents in 75 countries 37% from large domestic companies; 34 % significant exporters, 15% from multinationals operating in countries and 4% from government.

For South Africa:

- 75 respondents
- 26% Domestic companies
- 40% Domestic/Exporter
- 26 % Multinational
- 9% state owned.
- 35 on the public institutions index

GDP per capita is used as measure of productivity and thus competitiveness. The questions from the survey are tested against this assertion using bivariate analysis for statistical significance. All questions, according to the GCR are proved to be statistically significant. "The stability of results provides an important indication that the relationship between microeconomic circumstances and GDP per capita is robust and not an artefact of a single year"¹¹. The CCI is computed by combining all the individual dimensions by using common factor analysis to provide a single composite picture of microeconomic competitiveness for each country¹². The correlation between two sub indices is high endorsing the central tenant of CCI that the two subindices are integrally related¹³.

When the CCI is plotted against 2000 GDP figures it shows that South Africa is underperforming i.e. the predicted microeconomic competitiveness from factor analysis CCI shows that real GDP is lower than predicted value

Table 5: CCI Survey Questions

<p>1. COMPANY OPERATIONS & STRATEGY</p> <ul style="list-style-type: none"> Production Process Sophistication Nature of Competitive Advantage Extent of Staff Training Extent of Marketing Willingness to Delegate Authority.....New question Capacity for Innovation Company Spending on R & D Value Chain Presence Breadth of International Markets Uniqueness of Product Design Degree of Customer Orientation Control of International Distribution Extent of Branding Reliance on Professional Management Extent of Incentive CompensationNew question Extent of Regional Sales Prevalence of Foreign Technology Licensing <hr/> <p>2. NATIONAL BUSINESS ENVIRONMENT</p> <p>D. FACTOR (INPUT) CONDITIONS</p> <p>1. Physical Infrastructure Overall, Infrastructure Quality</p> <p>a. Basic</p> <ul style="list-style-type: none"> Road Infrastructure Quality Railroad Infrastructure Development Port Infrastructure Quality Air Transport Infrastructure Quality <p>b. Advanced</p> <ul style="list-style-type: none"> Telephone/Fax Infrastructure Quality Availability and Cost of Cellular Phones Speed and Cost of Internet Access <p>2. Administrative Infrastructure</p> <ul style="list-style-type: none"> Police Protection of Businesses Judicial Independence Administrative Burden for Start-Ups Adequacy of Public Sector Legal Recourse Extent of Bureaucratic Red Tape <p>3. Capital availability</p> <ul style="list-style-type: none"> Ease of Access to Loans Financial Market Sophistication Local Equity Market Access Venture Capital Availability <p>4. Human Resources</p> <ul style="list-style-type: none"> Quality of Public Schools Quality of Maths and Science Education.....New question Availability of Scientists and Engineers.....New question Quality of Management Schools 	<p>5. Science & Technology</p> <ul style="list-style-type: none"> Patents per capita (2000) Quality of Scientific Research Institution University/Industry Research Collaboration <p>A. DEMAND CONDITIONS</p> <ul style="list-style-type: none"> Buyer Sophistication Consumer Adoption of Latest Products Presence of Demanding Regulatory Standards Stringency of Environment Regulations Government Procurement of Advanced Technology Products.....New question Laws Relating to Information Technology.....New question <p>B. RELATED AND SUPPORTING INDUSTRIES</p> <ul style="list-style-type: none"> Local Supplier Quality State Of Cluster Development Extent of Product and Process Collaboration.....New question Local Availability of Components and Parts.....New question Local Availability of Specialized Research and Training.....New question Local Availability of Information Technology servicesNew question <p>C. CONTEXT FOR FIRM STRATEGY AND RIVALRY</p> <ul style="list-style-type: none"> Favoritism in Decision of Government Officials Extent of Irregular Payments Extent of Distortive Government Subsidies Decentralization of Corporate Activities Co operation in Labor-Employer relations...New question Tariff Liberation Hidden Trade Barrier Liberation Intellectual Property Protection Intensity of Local Competitors Effectiveness of Anti-Trust Policy Efficacy of Corporate Boards
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2.1.3. Executive Opinion survey

The executive opinion survey forms the basis on which qualitative data is collected for all of the GCR's indexes. The survey helps to infer current economic conditions and the environment within which the firms operate by infusing into the report the experiences of business leaders and entrepreneurs. The Central premise for survey is "that there exists some underlying yet difficult to describe reality that could characterise, at some point in time, any particular growth related factor in any particular economy"¹⁴. By capturing a broad array of intangible factors which compares the local business environment with global standards it seeks to achieve this. It is also argued that the survey allows for comparability in countries where no hard data sources exist.

The instrument has over 100 questions covering the quality of government and public institutions, the macro economic environment, national technological levels and domestic competition structures as well as company and operations strategy. It measures aspects such as the efficiency of government institutions, the sophistication of local supplier networks or the nature of competitive practices. The current version also has section dealing with the environment. Many new questions, with a focus on ICT, have been added to last years survey (this is a weakness as the changing methodology does not allow for true comparability).

The survey reaches 4600 respondents worldwide with an average response of 60 per country. For South Africa 75 responses representing 1.72 surveys per million of population with 30% of respondents from firms of size < 250, 7% from size between 251 and 500, 25% from size between 501 and 5000, 21% from size between 5001 and 20000 and 16% from size between > 20000.

The survey is dependent on the use of partner institutions in the various countries. For South Africa the partner institution is Business South Africa. The sample is chosen from a comprehensive register of firms and whose distribution across the economic sectors is proportionate to the distribution of the countries labour force across those sectors. Samples are chosen to be representative. Respondents (CEO's or senior management) are chosen randomly within the broad economic sectors and data is gathered by telephone or by onsite interviews and follow-ups for clarifications. The questions ask for responses on a scale of 1-7. These are compiled and a country level means are calculated to provide country scores on each question.

The WEF have devised a number of tests to verify the robustness of the surveys and are convinced of its validity. The survey has checks for perception bias included: The phrasing of questions is such that it gives the respondent a global perspective rather than a local one and tries to minimise bias resulting from insular thinking. Survey data is also tested against hard data where possible. Discussion with WEF revealed that in South Africa's case some questions did show a variance in this regard and had to be corrected.

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2.1.4. Conclusion

Constant updates to framework of GCI and CCI and additions to questions in the Executive Opinion Survey, although understandable from the point of view that competitiveness measurement is unfolding, does present a weakness from the policy point of view as it does not allow for comparability from year to year. The use of "soft" data will always be

questionable but it seems to be inevitable in the case of the GCR. For a national system, an exclusive reliance on hard data is necessary.

As the Executive Opinion Survey constitutes a substantial input into the report and calculations of indexes it would be in our interests to ensure that the WEF partner institutions are capable and collect data with truly representative samples. Scope to influence the choice of partner institutes exists. It would serve us best if a research orientated institution coordinates the Executive Opinion Survey in South Africa. In the long term, responsibility should rest with the national structure, if any, responsible for competitiveness.

Many of the hard data is collected from international databases. We thus need to ensure that a solid statistical basis exists to feeding into international databases from where the data is collected. The development of the Science and Technology and Innovation Indicator Systems at Dacst and the National Statistical System at Statistics SA will ensure this in the long term.

Notwithstanding the limitations of the GCR and the ranking in particular the data presented does point to underlying issues around competitiveness (or lack of it). These need to be addressed in a coherent and comprehensive way – the object of this exercise.

2.2. UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO)- COMPETITIVE INDUSTRIAL PERFORMANCE (CIP) INDEX–

The United Nations Industrial Development Organisation (UNIDO), through the work of Professor Sanjaya Lall from Oxford University, is currently preparing an index on industrial activity to benchmark countries by industrial performance rather than direct competitiveness indices such as the one described above. The index is meant to compliment the widely available competitiveness indices. Yet to be published in a forthcoming report on industrial performance, the scoreboard confines itself to variables with hard data, using existing information. It excludes such qualitative variables such as the business environment, the links between firms, and the quality of governance, institutions and legal systems - all difficult to measure and aggregate. It also excludes broad framework conditions like macroeconomic variables and policies on business, trade and finance, which are covered by the other competitiveness benchmarks.

The index focuses on two sets of hard indicators:

- a) for industrial performance and
- b) for the structural drivers of that performance.

The data is collected for two years, 1985 and 1998 (or the closest available year) and for all countries with significant manufacturing activity.¹

Industrial performance is defined as the complex interaction of many factors, including political and social stability, institutional, skill, technological, infrastructure, networking and other factors. To assess industrial performance, the report looks at 4 set of indicators: manufacturing value added

Rankings for South Africa:		
	1998	
	1995	
CIP	39	32
MVA	45	38
Manu Exports	48	35
Tech. structure of MVA	33	30
Tech. structure of Man exports	34	31

¹ The excluded countries include many economies in Central and Eastern Europe, Iran, Iraq and some transition economies in Southeast Asia.

(MVA), Manufacturing exports, the technological composition of MVA and manufacturing exports (high-med-low tech).

The structural influences on industrial performance—termed drivers - are limited to five sets of structural variables that may be considered directly relevant to industry and on which comparable data is available viz. skills (enrolment figures), technological effort (r&D by productive enterprise), inward FDI (technology diffusion), licensing payments abroad and physical infrastructure (traditional and modern separate)

Rankings for South Africa:		
	1998	1995
Skills	42	46
R&D intensity	29	25
FDI	47	51
Royalties and Licences	43	28
Modern Infrastructure	47	39
Traditional Infrastructure	31	23

Data is collected for 87 countries for 1998 and 80 for 1985. This represents the first of four stages in compiling the scoreboard. Indicators were chosen on the basis of the availability of cross-country data. The performance indicators—MVA per capita, manufactured exports per capita, the share of medium- and high-tech activities in manufacturing production and the share of medium and high-tech products in manufactured exports—were chosen for the competitive industrial performance (CIP) index. In the second stage individual indices of performance were standardized. The third stage consisted of testing the feasibility of computing a composite index based on the four performance indicators selected. Positive and statistically significant correlations between the four performance variables confirmed that a composite index could be constructed as a proxy for overall industrial performance. The CIP index was constructed using the standardized values of the four performance indicators.

The CIP index provides useful information on crucial aspects of industrial development and complements GCR and WCYB. It focuses on the national ability to produce manufactures competitively and provides a simple tool that countries can use to assess their position with respect to industrial performance. Of policy and analytical interest, the index illustrates the sources of industrial dynamism in the world, within developing and industrial countries and for each region. Table 6 gives ranking of countries according to the CIP index.

Table 6: Ranking of economies by the CIP index, 1985 and 1998

Rank 1998	Rank 1985	Economy	Index value 1998	Rank 1998	Rank 1985	Economy	Index value 1998
1	6	Singapore	0.883	45	40	Tunisia	0.068
2	1	Switzerland	0.751	46	35	Venezuela	0.060
3	15	Ireland	0.739	47	53	Chile	0.056
4	2	Japan	0.696	48	56	Guatemala	0.056
5	3	Germany	0.632	49	65	Indonesia	0.054
6	5	United States	0.564	50	50	India	0.054
7	4	Sweden	0.562	51	38	Zimbabwe	0.052
8	7	Finland	0.538	52	57	El Salvador	0.051
9	8	Belgium	0.495	53	46	Morocco	0.048
10	12	United Kingdom	0.473	54	41	Saudi Arabia	0.047
11	10	France	0.465	55	49	Colombia	0.041
12	11	Austria	0.453	56	47	Mauritius	0.041
13	13	Denmark	0.443	57	67	Egypt	0.038
14	14	Netherlands	0.429	58	48	Peru	0.035
15	19	Taiwan Province of China	0.412	59	39	Oman	0.032
16	9	Canada	0.407	60	55	Pakistan	0.031
17	16	Italy	0.384	61	58	Ecuador	0.025
18	22	Korea, Republic of	0.370	62	64	Kenya	0.025
19	21	Spain	0.319	63	60	Jordan	0.024
20	20	Israel	0.301	64	66	Honduras	0.023
21	17	Norway	0.301	65	52	Jamaica	0.022
22	30	Malaysia	0.278	66	51	Panama	0.022
23	28	Mexico	0.246	67	69	Bolivia	0.021
24	..	Czech Republic	0.243	68	..	Albania	0.021
25	45	Philippines	0.241	69	71	Sri Lanka	0.017
26	26	Portugal	0.240	70	62	Nicaragua	0.017
27	34	Hungary	0.239	71	63	Paraguay	0.015
28	..	Slovenia	0.221	72	..	Mozambique	0.013
29	23	Australia	0.211	73	74	Bangladesh	0.011
30	18	Hong Kong SAR	0.204	74	54	Algeria	0.009
31	24	New Zealand	0.186	75	72	Cameroon	0.008
32	43	Thailand	0.172	76	59	Senegal	0.008
33	27	Brazil	0.149	77	68	Zambia	0.007
34	25	Poland	0.143	78	75	Nigeria	0.006
35	29	Argentina	0.140	79	79	Nepal	0.006
36	44	Costa Rica	0.129	80	70	Tanzania, United Republic of	0.005
37	61	China	0.126	81	78	Malawi	0.003
38	36	Turkey	0.108	82	73	Madagascar	0.003
39	32	South Africa	0.108	83	77	Central African Republic	0.003
40	33	Greece	0.102	84	80	Uganda	0.003
41	37	Romania	0.095	85	..	Yemen	0.001
42	31	Bahrain	0.089	86	76	Ghana	0.001
43	42	Uruguay	0.087	87	..	Ethiopia	0.000
44	..	Russian Federation	0.077				

Source: UNIDO Scoreboard database

3. NATIONAL SYSTEMS

3.1. FORFAS – COMPETITIVENESS INDICATORS FOR IRELAND

The National Competitiveness Council in Ireland is a high level organ that directs and advises government on competitiveness policy through its work on competitiveness benchmarking. It produces an annual statistical report, through its secretariat at FORFAS, on Ireland's competitiveness position with respect to their main trading partners (mostly OECD countries). Data is collected for a broad range of statistical indicators (200+ in all) from authoritative sources such as EUROSTAT, OECD, UNDP and US labour statistics and covers more or less 30 countries.

The approach to competitiveness is based on an integrated definition derived from both OECD and WEF definitions of competitiveness. The chosen indicators reflect this definition viz: "Competitiveness is the ability to achieve success in markets leading to better standards of living for all"¹⁵.

Using this as a starting point and bearing in mind a national focus, 11 aspects of competitiveness are highlighted (see Table 7). Under each aspect a subset of indicators are designated as key indicators. The key indicators are chosen from the list of 200+ for each of the 30 countries chosen as competitors and are ranked from a competitiveness perspective or by absolute magnitude. In total 95 key indicators are collected for the 11 competitiveness aspects (see a list in Table 8). All indicators are based on hard data and the key indicators are used to calculate a competitiveness score for each aspect. This allows for a ranking for a particular aspect.

The competitiveness score for a particular aspect for a particular country is calculated by averaging re-based rankings (to 10) for each key indicator. The re-based ranking for each key indicator is achieved by using the formula

RBR = (number of country data points – country ranking) x (10 / number of country data points).

$$\text{Competitiveness score} = \frac{1}{n} \sum_{i=1}^n RBR_i \quad n = \text{number of indicators}$$

Example suppose a particular aspect has two key indicators and that the country ranking for the first is 11 out of 23 and for the second is 6 out of 30 then the competitiveness score is:

$$[(23-11) \times (10/23) + (30-6) \times (10/30)] / 2 = 6.6$$

Each indicator is given same weight. The ranking of countries within an aspect emerges when scores for each aspect are calculated for each country in that aspect. Rankings are only given if ¾ or more of key indicator data points are available.

Table 7: Aspects of Competitiveness

Aspect	Description	Description of Sets of indicators	Number of indicators (for description of indicators see following tables)
Economic performance	Measures of national economic success. Macro economic indicators	7 – sets i) Indicators of economic output; ii) investment and savings; iii) export performance; iv) current account balance; v) inflation, interest rates and effective exchange rates; vi) employment and vii) government expenditure	15 key indicators
Internationalisation	trade and FDI focus	3 sets i) trade openness ii) trade performance and diversification and iii) FDI	5 key indicators
Capital	focus on financial capital	4 sets <i>i) cost of capital;</i> <i>ii) return to capital</i> <i>iii) venture capital and the stock market</i>	7 key indicators
Education		4 sets <i>i) population</i> <i>ii) education expenditure</i> <i>iii) participation in education</i> <i>iv) educational attainment</i>	12 key indicators
Productivity	Labour Compensation and Unit Labour costs	2 sets <i>i) productivity</i> <i>ii) labour compensation and unit costs</i>	8 key indicators
Non Labour enterprise costs		3 sets <i>i) telecommunications costs</i> <i>ii) energy costs</i> <i>iii) property costs</i>	9 key indicators
Taxation		1 set	8 key indicators
Science and Technology		2 sets <i>i) R&D activity</i> <i>ii) inputs)</i>	6 key indicators
Information Society		3 sets <i>i) access to ICT</i> <i>ii) e –business</i> <i>iii) investment in ICT</i>	10 Key indicators
Transport Infrastructure		1 set	4 key indicators
Environmental Protection and Management		6 sets <i>i) land and forest ii) water iii) energy use iv air pollution v) waste and recycling and vi) pollution</i>	11 key indicators

The Irish approach to developing indicators balances the tension between more indicators for analysis and fewer for policy makers by introducing competitiveness scores, league tables and key indicators. The sets of indicators ensure congruence with international definitions yet they are tailored to address broad national concerns. There is a lack of reliance on qualitative data and quantitative data is sourced from reliable international databases. From a South African perspective this is an excellent model however the major limitation would be availability of data on countries we consider to be competitors.

Science and Technology

Competitiveness League Table	
Country	Score
1 Sweden	8.4
2 Finland	8.4
3 Japan	7.6
4 Germany	7.6
5 US	7.5
6 France	7.1
7 UK	6.0
8 Denmark	5.8
9 Netherlands	5.4
10 Belgium	4.7
11 Austria	4.5
12 Ireland	4.0
13 Spain	3.0
14 Italy	2.7
15 Portugal	1.6
16 Greece	0.9

Competitiveness Score: Science and Technology

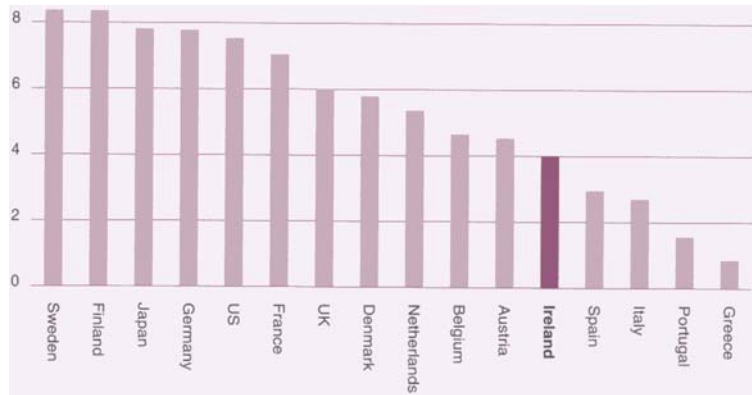


Table 8: List of key indicators

Indicators Used by the Irish National Competitiveness Council										
Economic Performance	Internationalization	Capital	Education	Productivity, Labour Compensation and Unit Labour Cost	Non-Labour Enterprise Cost	Taxation	Science and Technology	Information Society	Transport Infrastructure	Environmental Protection and Management
GDP per capita using current prices and PPPs US	Trade openness: exports + imports (of goods and services)/GDP 1999	Long term interest rates (%) 2001e	Public and private expenditure on educational institutions as %of GDP (GNP for Ireland) 1999	Productivity per employee per annum (US \$ 000s)	2 Mbit/s leased lines national circuits connection cost (euro) 2000	Total tax revenue as percentage of GDP, 1998	Gross domestic expenditure on R&D (GERD) as a percentage of GDP, 1997	Broadband access- lines per 100 population	Rail Infrastructure	Major protected areas (% total area) 1999
Real GDP growth (%) 2001e	Exports performance of total goods (merchandise): percentage change 1997-1998	Short term interest rates (%) 2001e	Annual expenditure per student, US\$ PPPs : secondary	Productivity (US \$ per hour worked)	Cost of internet use (30 minutes, peak rate, US\$) November 2000	Marginal rate of income tax plus employee contributions (married 100,0,2 children)	Business R&D expenditure (BERD) as a percentage of GDP	Secure web servers for electronic commerce per one million population	Percentage of railway line electrified	Nitrogenous fertilizers used (tonnes per km2 of arable land 1998
Real GDP growth over 5 years (1997=100) 2001e	Exports performance of commercial services: percentage change from last period 1997-1998	Interest rate spread – absolute (%) 1998	Educational participation- age 17 (%) 1999	Productivity (annual average change 1999-2000e)	Composite business basket cost of calls (national and international) May 2001	Marginal rate of income tax plus employee contributions (married 100,67,2 children)	Share of Government budget allocated to R&D	Number of PCs per 100 population	Length of road network per 1000 km2	Public waste water plants (% of population connected) 1998
-Real gross fixed capital	Foreign direct	Rate of return on	Percentage of 25 –64	Unit labour costs in the	OECD national	Marginal rate of income tax	Total new science and	Value on online	Length of motorway	Water quality of selected

Indicators Used by the Irish National Competitiveness Council										
Economic Performance	Internationalization	Capital	Education	Productivity, Labour Compensation and Unit Labour Cost	Non-Labour Enterprise Cost	Taxation	Science and Technology	Information Society	Transport Infrastructure	Environmental Protection and Management
formation growth over 5 years (1998 = 100) 2001e	investment inflow as a percentage of GDP (GNP for Ireland) 1999	capital in the business sector 1998e	participating in continuing education and training	total economy (percentage increase) 2000-2001e	(GSM mobile basket May 2001	plus employee contributions (single 100,no children)	technology PhDs per thousand population aged 25-34 years	business –to – consumer transactions-billion (\$) per million population	network per 1000 km2	rivers-dissolved oxygen mg/litre (average) 1997
Gross national saving (percentage of nominal income)5 years average 1999	Foreign direct Investment outflow stock as a percentage of GDP (GNP for Ireland) 1999	Average return on US investment abroad 1995-1999	Mean numbers of hours of participation in continuing education and training	Unit labour costs in the total economy (cumulative increase) 1996-2000	Automotive diesel oil prices for commercial use , quarter 3 2000	Employees and employers social security contributions and personal income tax less transfer payments as % of gross labour cost-married	Inventiveness coefficient (resident patent application per 10,000 population) 1997	Value of online business – to- business transaction-billions (\$) per million population		Water quality of selected lakes – phosphorus mg /litre (average) 1997
Export performance of total goods (merchandise) -% change 1997-1998		Cumulative venture capital raised as percentage of GDP, 1999 (GNP for Ireland)	Percentage of population (25- 64 years) that has at least upper secondary education (%) 1999	Hourly compensation cost for production workers in manufacturing (US\$) 1999	Industrial electricity prices – 10GWh per annum- VAT excluded (euro) January 2001	Standard /top corporate tax rate	USPTO patents granted by country to origin per million population, 1998	Business –to – consumer e- commerce sales – number of buyers per thousand population		Total final consumption of energy per unit of GDP
Export performance		Stock market capitalisation	Percentage of population	Nominal compensation	Gas prices-industrial rate	Taxes on corporate		Percentage of SMEs		Total final consumption

Indicators Used by the Irish National Competitiveness Council										
Economic Performance	Internationalization	Capital	Education	Productivity, Labour Compensation and Unit Labour Cost	Non-Labour Enterprise Cost	Taxation	Science and Technology	Information Society	Transport Infrastructure	Environmental Protection and Management
of commercial services-% change 1997-1998		as a percentage of GDP, 1999	(25 – 64 years) that has attained 3 rd level education (%) 1999	n per employee total economy, - 000s per annum 2000e	exclusive VAT (4186 GJ/200 days) January 2001	income as a percentage of GDP		using internet for distribution purposes		of energy per unit of GDP (% change 1980-1997)
Current account balances (as percentage of GDB) 5 years average 2001e			Percentage of population (25 – 64 years) that has attained 3 rd level education 1999	Nominal compensation per employee, total economy percentage change 2000 – 2001e	Office rent: total occupation costs (US\$/m per year) capital cities			Technology Achievement Index		CO2 emissions per unit of GDP 1998
GDP deflator change over 5 years (1997=100) 2001e			Average achievement in Maths (age 13)		Residential property prices inflation-adjusted indices (1995=100) 1999			Information and communication technology R&D expenditure as a percentage of GDP (GNP for Ireland)		Industrial waste generated per unit of GDP (tonnes per million US\$)
Five year change in total			Average achievement in Science					ICT employment as % of total		Municipal waste generated

Indicators Used by the Irish National Competitiveness Council										
Economic Performance	Internationalization	Capital	Education	Productivity, Labour Compensation and Unit Labour Cost	Non-Labour Enterprise Cost	Taxation	Science and Technology	Information Society	Transport Infrastructure	Environmental Protection and Management
employment 1994-1999			(age 13)					business sector employment		(kg per capita)
Male participation rate (% population 15-64) 2000			Number of Science graduates at third level per 100,000 persons in the labour force (25-34 years)							Pollution abatement and control: total expenditure (%GDP)
Female participation (% population 15-64) 2000			Percentage of the population scoring at IALS literacy level 3 or higher on the document scale (16-25 years) 1994-1995							
Standardised unemployment rate Q2 2000										
Current net lending or										

Indicators Used by the Irish National Competitiveness Council										
Economic Performance	Internationalization	Capital	Education	Productivity, Labour Compensation and Unit Labour Cost	Non-Labour Enterprise Cost	Taxation	Science and Technology	Information Society	Transport Infrastructure	Environmental Protection and Management
borrowing of general government as a percentage of GDP 1999e										
General government consolidated gross debt as a % of GDP										

3.2. EUROPEAN UNION (EU)– IMPACT OF R&D ON COMPETITIVENESS AND EMPLOYMENT

The EU in its work on “Benchmarking National Research Policies”¹⁶ addresses the impact of R&D on economic competitiveness and employment. A number of indicators are presented which rank all EU countries together with Japan and the US. The focus of the work is to measure the impact of R&D as an essential instrument in increasing competitiveness and employment. Labour productivity is seen as an appropriate indicator for economic competitiveness and its growth a direct measure of the impact of R&D.

Economic competitiveness is thus seen as the investment in knowledge and the ability to transform knowledge into economic performance. A number of quantitative indicators are presented in this regard (Table 9). Data is collated from EUROSTAT and OECD databases.

Table 9: Indicators of the impact of R&D on competitiveness

Theme	Indicators
Growth rate of Labour Productivity	<ul style="list-style-type: none"> ● Labour productivity (GDP per hour worked) in PPS ● Labour productivity (GDP per hour worked) average annual growth
High-tech and medium tech industries	<ul style="list-style-type: none"> ● Share of total output and contribution to growth of output ● Share of total employment and contribution to growth of employment
Knowledge intensive services	<ul style="list-style-type: none"> ● Share of total output and contribution to growth of output ● Share of total employment and contribution to growth of employment
Technology balance of Payments (TBP)	<ul style="list-style-type: none"> ● TBP receipts as % of GDP ● TBP average annual real growth
High Tech products	<ul style="list-style-type: none"> ● World share of exports of high tech products ● World share of exports of high tech products average annual growth

3.3. COUNCIL ON COMPETITIVENESS– USA

The Council on Competitiveness is an independent body that has the mission of “setting the action agenda to drive U.S. competitiveness and leadership in World Markets”¹⁷. Their focus is to strengthen U.S. innovation, upgrading the workforce and benchmarking national economic competitiveness performance (defined as the capacity to increase the real income by producing high value products and services that meet the test of world markets.) The benchmarking data, presented in an annual report, examines the status of America’s competitive position. They detail the causes of U.S. economic resurgence in the 1990’s, persistent areas of weakness, the globalisation of innovative capacity and national priorities for sustaining long-term competitive advantage.

Indicators are collated according to these themes some representing comparisons to other competitor countries and some with a purely national focus. No overall ranking index is presented for any of the indicators but each is supported by a statement of how Americas competitive position is affected. Data is collated from a number of national and international databases. A list of indicators is presented in Table 10.

Table 10 : Indicators in US Competitiveness 2001 report

<p>1. AMERICA'S COMPETITIVE RESURGENCE: WHAT DROVE U.S. PROSPERITY</p> <p>1.1 The Economy made striking gains during the 1990s a) Compound annual growth rate in real GDP by decade b) GDP per Capita indexed against the U.S., adjusted for purchasing power parity</p> <p>1.2 Growth in labor, capital investment and productivity drove economic expansion a) labour, capital investment and multifactor productivity (MFP)- Percent contribution to GDP growth</p> <p>1.3 The Workforce expanded a) Civilian workforce, millions More women and minorities Percent of population 25-54 years old civilian labor force</p> <p>1.4 Unemployment fell sharply a) Percent of unemployment among civilian workforce (for all racial and ethnic groups as well comparisons to other countries)</p> <p>1.5 Growth in capital stock soared a) Compound annual growth rate in real net private non-residential capital stock b) Percent of change in capital stock per worker.</p> <p>1.6. Investment in Information Technology fueled much of the rise in capital stock a) real private non –residential investment. b) Percent of real private non-residential investment</p> <p>1.7. Productivity growth hit a 25year high a) Percent of growth in Multifactor productivity b) Average percent growth in Multifactor productivity -</p> <p>1.8. Information Technology played a key role in productivity growth a) Percent Change in multifactor productivity growth (using average growth rates in 1981—95 and 1996-98) and number of internet hosts,1998</p> <p>1.9 High rates of innovation expanded investment opportunities a) Total patents granted , 1986-99 b) Percent growth in patents granted in the U.S.,1986-99</p> <p>1.10 Entrepreneurial activity put Innovation to work – boosting both investment and job creation a) Numbers of new employer firms launched, 1990-98 b) Net new jobs created by firm size, 1990-97.</p> <p>1.11 Abundant risk capital supported new company growth a) Ventura capital investment in the United States, billions of dollars b) Total value of U.S. initial public offerings and Internet IPOs, billions of dollars</p> <p>1.12 Fiscal discipline freed up capital for private investment a) Federal Government surplus or deficit, billions of dollars b) Surplus/Deficit as a percent of GDP</p> <p>1.13 U.S global market opportunities expanded a) Growth in exports 1985-99. Billions of dollars b) Trade balances in services , R&D-Intensive products, licensing revenues and all other goods, billions of dollars</p>
<p>2. UNDERLYING NATIONAL VULNERABILITIES: WHERE ECONOMIC PERFORMANCES FELL SHORT</p>

- 2.1. Many Americans did not share in the Economic Boom**
 - a) Growth in Pre-tax household incomes, including market incomes, adjusted for family size, 1995 dollars
- 2.2 Income disparities widened**
 - a) Comparison between mean income level of households in the lowest and highest quintiles 1997 dollars
 - b) GINI coefficient of income inequality, 1997 or latest year available
- 2.3 Lower Incomes were strongly correlated with lower educational attainment**
 - a) Weekly earnings for workers 25 and older, by level of education, 1998 dollars
- 2.4 National Investment in R&D lagged**
 - a) U.S R&D as a percent of GDP
 - b) Compound annual growth rate in R&D during economic expansion periods, 1992 dollars
- 2.5 Outside of life sciences, support for important research disciplines declined**
 - a) Federal basic & applied research investments by discipline as a percent of GDP, 1992 dollars
- 2.6 The number of college and advanced degrees in Science and Engineering was flat or declining**
 - a) Growth in Science and Engineering degrees, indexed to 1986
 - b) Change in Science and Engineering degrees as a percent of first university degrees, 1985-95
- 2.7 Domestic savings fell short of meeting U.S. investment needs**
 - a) Net national savings, net domestic investment as a percentage of GDP
 - b) Foreign investment as a percent of total domestic investment
- 2.8 Personal savings rates fell sharply**
 - a) Personal savings as a percent of disposable income
 - b) Gross domestic savings as a percent of GDP, 1985 and 1997 or latest year available
- 2.9 The trade deficit persisted and widened**
 - a) U.S trade balance in goods and services, billions of dollars
 - b) U.S. imports and exports as a percent of GDP
- 2.10 The current account deficit reached record levels**
 - a) U.S. Current account deficit as a percent of GDP

3 THE RISING BAR FOR GLOBAL COMPETITIVENESS: WHY U.S. LEADERSHIP WILL BE CHALLENGED

- 3.1 Other countries are increasing their pools of technical talent faster than the United States**
 - a) Ratio of natural Science and Engineering degrees to the 24-year-old population, 1998 or latest year available
 - b) Total researchers per ten thousand workers
- 3.2 Many countries are gaining access to global sources of capital**
 - a) Outstanding amounts of international debt securities
 - b) Percent change in market capitalization
- 3.3 The Information Technologies that powered U.S. productivity growth are being deployed globally**
 - a) State of Info-structure development
 - b) PCs per 100 people
- 3.4 Internet growth will be faster outside the United States**
 - a) Internet users worldwide
 - b) Internet hosts per 10,000 by country
- 3.5 Global R&D investment is expanding rapidly**
 - a) R&D intensity
 - b) Compound annual growth rate in R&D expenditures
- 3.6 International Scientific output is increasing**
 - a) Number of Scientific and Technical articles in peer-reviewed publications per 100,000 population
- 3.7 The number of high-quality foreign patents is a measure of global innovation**

<p>capabilities</p> <ul style="list-style-type: none"> a) The share of a country's patents filed between 1994 and 1998 that were highly cited in 1999 b) The share of a country's patents filed between 1994 and 1998 that were highly cited in 1999 by Sector <p>3.8 A new wave of global innovators is emerging</p> <ul style="list-style-type: none"> a) Innovator nations
<p>4 SUSTAINING COMPETITIVE ADVANTAGE: U.S. INNOVATION PRIORITIES</p> <p>4.1. The real increases in national R&D investment have all come from Industry, focused on near – term product development</p> <ul style="list-style-type: none"> a) U.S. R&D funding as a percent of GDP b) U.S. Industrial performance of basic & applied research and development as a percent of GDP <p>4.2. The government share of R&D funding is declining</p> <ul style="list-style-type: none"> a) The federal share of total U.S. funding of basic research applied Research and Development 1992 dollars b) Percent of U.S industry patents citing publicly-funding research papers, 1993-94 <p>4.3 Critical shortfalls in research funding are emerging in the Physical Sciences and Engineering</p> <ul style="list-style-type: none"> a) Percent change in federal obligations for university research by discipline <p>4.4 Research facilities are depreciating</p> <ul style="list-style-type: none"> a) Millions of net assignable square feet needing renovation or replacement b) Sources of support for new construction, repair and renovation projects at universities <p>4.5 The supply of Technically-Trained talent is static or declining outside the life sciences</p> <ul style="list-style-type: none"> a) Undergraduate degrees by discipline, thousands b) Graduate enrollment by field of study, thousands <p>4.6 Demand for Scientists and Engineers is projected to increase four times faster than overall job growth</p> <ul style="list-style-type: none"> a) Projected new job growth by technical b) Projected number of job openings by technical field <p>4.7 Foreign students, many of whom return home, comprise over 40 % of all PhDs in Science and Engineering in U.S. Universities</p> <ul style="list-style-type: none"> a) Percent of degrees earned by foreign students <p>4.8 Expanding the S&E workforce will require participation by more women and minorities</p> <ul style="list-style-type: none"> a) Percent of women and minorities in the workforce

4. CONCLUSIONS

A number of methodologies on competitiveness rating systems both at the national and international level were presented in this report each with their own limitations and strengths, each giving pointers for the direction in which the development of a national system competitiveness indicators should proceed. Of these the approach by the National Council on Competitiveness in Ireland provides a model that would best approximate an approach for South Africa to follow.

Essentially, from lessons learned during this study, a South African set of indicators should be based on hard data exclusively, reflecting a definition of competitiveness that is congruent with international norms yet addresses South African realities - Irish and USA approach. The system should provide trends and rankings in support of policy making for specified "aspects" or "themes" of competitiveness for a number of countries regarded as our competitors but should avoid developing a singular measure of competitiveness. The choice of indicators can be guided from work already done in the approaches outlined.

The ranking of South Africa in international indexes such as the WEF's Global Competitiveness Report and IMD's World Competitiveness Yearbook is often the subject of vigorous debate, particularly as these depend heavily on perception based indicators and especially when South Africa is portrayed negatively. This reaction is understandable as these reports are enormously influential. As reported earlier scope exists, at least in the case of the WEF, to influence them in their choice of partner in South Africa. This must be exploited to ensure the broadest and best possible coverage given to opinion surveys from which the perception based indicators are derived.

The international rating systems furthermore draw much of their hard data from international databases. It should be a responsibility, as we develop our indicator systems through this initiative and others, to ensure that they robust and comparable enough to be included in such databases. Finally, the surest way of influencing our competitiveness rating is to address the issues around competitiveness robustly and comprehensively – again a product of this exercise.

¹ World Competitiveness Yearbook 2002,pg 444

² McArthur J W, Sachs J D, World Competitiveness Yearbook 2002, Chapter 1.1, pg 32

³ World Competitiveness Yearbook 2002, Executive Summary, pg 16

⁴ World Competitiveness Yearbook 2002, Executive Summary, pg 19

⁵ World Competitiveness Yearbook 2002, Executive Summary, pg 19

⁶ McArthur J W, Sachs J D, World Competitiveness Yearbook 2002, Chapter 1.1, pg 45

⁷ McArthur J W, Sachs J D, World Competitiveness Yearbook 2002, Chapter 1.1, pg 46

⁸ World Competitiveness Yearbook 2002, Executive Summary, pg 16

⁹ Porter M E, World Competitiveness Yearbook 2002, Chapter 1.2

¹⁰ Porter M E, World Competitiveness Yearbook 2002, Chapter 1.2

¹¹ Porter M E, World Competitiveness Yearbook 2002, Chapter 1.2, pg 59

¹² Porter M E, World Competitiveness Yearbook 2002, Chapter 1.2, pg 59

¹³ Porter M E, World Competitiveness Yearbook 2002, Chapter 1.2

¹⁴ Cornelius P, McArthur J W, World Competitiveness Yearbook 2002, Chapter 1.1, pg 166

¹⁵ Annual Competitiveness Report, National Competitiveness Council, Ireland

¹⁶ Key Figures 2001 Benchmarking National Research Policies, European Commission

¹⁷ Council on competitiveness Leaflet