The viability of systems of innovation in Southern Africa

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Introduction

Relatively recently the focus on the economic role of science, technology and innovation within the context of developing economies has shifted to its relationship with inclusive growth and development, and its contribution to the raising of the quality of life of the general population (see Akhtar et al, 2016). Since the nineties, the conceptual framework which has rapidly gained ascendance in this field of enquiry has been that of systems of innovation with a particular grounding in the national system of innovation. This framework is open to various interpretations, depending on the definition of innovation which is adopted. Those approaches which focus more closely on technological innovation tend to be restricted to an analysis of the science, technology and innovation sub-sector and its relationship to the production sub-sector within the economy (Cassiolato and Lastres, 2008). A broader definition of innovation which includes institutional and organisational change tends to incorporate increasingly wider aspects of the political economy. While the narrower interpretations of the national system of innovation may be more suitable to developed economies where it may safely be assumed that the institutional sub-structures are well developed and reasonably efficient, this assumption is less tenable in a developing economy context where development implies the need for a structural transformation of the economy and of the national system of innovation. This premised distinction is perhaps less stringently valid since the 2008 shocks to global financial markets and the global economy. It is therefore this broader interpretation of the national system of innovation concept which informs the analysis presented in this paper.

Evolutionary economics focuses on institutionally formed behaviour within a context which is marked not only by uncertainty but also by ignorance, and behaviour which is in a constant state of flux affected by continuous learning and adaptation. This school of thought is based on a biological metaphor with the system of political economy cast as an organism rather than the clockwork mechanism imagine in the general equilibrium formulation of neoclassical economics. The national system of innovation, viewed from the broad version of the systems of innovation approach (Lundvall, 2010), which may be conceivably extended to provide an alternative theory of the general political economy (Scerri, 2016), is therefore seen as an evolving organism, a product of history. From this perspective, the issue of the viability of innovation systems then arises. Following the biological metaphor, we can assess the viability of systems of innovation in terms of their ability to survive outside a host system, i.e. to be self-sustaining, to reproduce, to grow, and to mutate and evolve. The specification of the parameters of these several viability categories depends to a large extent on the type of juridical/territorial space with which a particular system is linked. The original, and still the most common, formulation of the system of innovation is tied to the sovereign (multi)nation state which forms the basic delineation of governing authority over a clearly specified political economy. Following the end of the Second World War and the end of the imperial state, the modern mosaic of sovereign states emerged and with that the increasing relevance of a wide range of inter-state associations which led to the consideration of the supra-national system of innovation as an object of study. These can range from the various regional economic communities in Africa to the highly integrated economic bloc of the European Union. The other level at which systems of innovation may be considered is the sub-national one which

[1] This paper is partially based on background work for Kraemer and Scerri (2015) and is part of an ongoing research project at the DST/NRF Centre of Excellence in Scientometrics and STI Policy, South Africa.

may or may not be legally defined. The national system of innovation has to be assumed as given in the case of the sovereign state, as long as that sovereignty is not threatened by internal strife or cross border military interventions. In the case of both supra and intra-national systems the legal enforcement of the system is significantly less binding, as was demonstrated recently by the decision of the United Kingdom to forgo its membership in the European Union. At the sub-national level legal demarcations into provinces, municipalities and districts may not necessarily reflect actual local systems of innovation and can often be legally changed.

The main aim of this paper is to develop the concept of viability as an assessment tool which can be applied to systems of innovation, defined broadly, at three main levels of aggregation – national, supra-national and sub-national. The specific application of this tool in this paper is located in the Southern African Development Community (SADC), with a proposed evaluation of the national systems of innovation of individual member states and that of the SADC system of innovation as a whole. South Africa will be used as the case for the evaluation of the viability of sub-national systems of innovation at the provincial level.

The conceptual framework underlying the various possibilities for the viability of systems of innovation is provided in the following section. The section after that looks specifically at the viability of national systems of innovation within the SADC group; that is followed by an exploration of the implications for the viability prospects for a SADC system of innovation. The following section then looks at the viability conditions for sub-national systems of innovation and applies this evaluation tools to South African provinces. The paper concludes with a brief discussion on the interpretative implications of this approach.

The viability of national systems of innovation

From the perspective of evolutionary economics, we can look at the viability of national systems of innovation on three broad levels. The first level is where the ability of a particular system to survive and reproduce its institutional base is compromised. This is a critical threshold between viability and collapse. The second level of viability is where the survival of a particular system is secure with the possibility of growth, while retaining its basic science and technology, and production and innovation sub-systems. The third level of viability is where a national system of innovation successfully mutates, either to adjust to changes in the global system of innovation or, more rarely, as an innovation leader which alters the global or regional system of innovation.

The viability of the system of innovation *per se* can of course often be compatible with high levels of poverty and income inequality, especially where the availability of ample natural resources enables the survival and even the growth of the national system of innovation. However, the ability of systems to evolve is strongly predicated on the availability of broad based technological capabilities and this renders 'higher end' viability prospects incompatible with enduring poverty, inequality and generally low levels of broad based human development.

The basic division in viability categories is between systems which are viable and those which are not. In the case of national systems, as already argued, a secure state of sovereignty necessarily defines a national system of innovation; the question of viability at the basic level of survival therefore essentially boils down to the issue of political stability. In those cases where the legitimacy of the sovereignty of the state is in question, due to critical internal dissent arising from overtly predatory states or credible threats of war, the basic premise for the existence of the national system of innovation is in question. In these cases the survival of the national system of innovation can further be compromised by a critical weakening of the state's monopoly on

violence, by bad and rapidly worsening macroeconomic conditions, and by an excessive reliance on foreign donor funding which reflects an inability to survive independently. On their own these last three conditions are not enough to push a national system of innovation into a fragile state where its survival is in question – that is predicated on an overtly predatory state or war – but they are enough to place systems on the categorical border between fragile and viable systems.

The viable category is possibly the widest one, containing systems which are thriving as well as those which are doing poorly. The common characteristic here is system continuity, underpinned by political stability, with little or no change in the fundamental structure of the national system of innovation. In this category flourishing systems would be marked by sound macroeconomic indicators, a growing human capabilities base and an established system of science and technology. Ailing systems within this category would tend to be marked by a poor economic performance, low human development indicators and a poorly developed, or non-existent, system of science and technology. The commonality among them would be the continuity of the sectoral composition of the economy but flourishing systems, especially those with a growing human capabilities base and an established system of science and technology are likely to move into the category of evolving systems.

Evolving systems are those whose structure is mutating to adapt to changes in the global system of innovation. Their mutations are occasionally significant enough to alter the regional or global context, thus affecting other national systems of innovation. These systems are characterised by an established and growing national system of science and technology, an increasingly inclusive national system of innovation and a growing human capabilities base. Their macroeconomic performance at any given point or over a specific period is less important than their growing capacity to alter the systemic features of their political economy. Critically, the more rapidly evolving systems are those which progressively include various agent groups in their planning and implementation processes. The basic model for the interaction of various agents in the planning of the national system model is the triple helix (Etzkowitz and Leydesdorff, 2000, and Leydesdorff, 2005) which was then opened up further to allow for an unspecified number of participants (Leydesdorff, 2012). The quadruple helix model now incorporates non-governmental organisations representing civil society. The increasing recognition of the role of the informal sector in the system of innovation, especially in developing economies, has opened up for the participation of representative organisations from this sector, further extending the helix. The formal inclusion of organised labour in the planning and working of the national system of innovation is a controversial issue in most parts of the world where the relationship between organised labour and capital, and often the state, is normally antagonistic; across a large part of the world this has led to the virtual demise of organised labour. There are however a number of economies, most notably in Nordic countries where the relationship between organised labour, private business enterprises and the state is a collaborative one (see LO, 2007 and 2008 in the case of Denmark). These provide an actual example, not merely a theoretical possibility, of extending the helix to the sextuple level.

Table 1: Viability possibilities of national systems of innovation

Viability classes	Conditions	Characteristics	Indicators
Fragile	Uncertain integrity and legitimacy of the sovereign nation state	1. Conflict: civil war, invasion, terrorism 2. Predatory state 3. Weak internal security (absence of the state's monopoly on violence) 4. Highly unstable macroeconomic conditions 5. Reliance on donor funding	1. Fragile States Index 2. Governance Index 3. Poverty and Inequality Indicators 4. Corruption Perceptions Index 5. Overseas Development Assistance share in Gross National Investment 6. Macroeconomic indicators 7. Low Knowledge Economy Index and Knowledge Index rankings 8. Poor Human Development Indicators
Viable	Stable political economy with largely unchanging institutional base. This type of national system of innovation can be static or growing.	1. Stable macroeconomic conditions 2. Growing human capabilities base 3. Absorptive capacity for innovation 4. Formulated science, technology and innovation plans	1. Macroeconomic indicators 2. R&D indicators 3. Middle range Knowledge Economy Index and Knowledge Index rankings 4. Rising human Development Indicators 5. Training of scientists, engineers and technologists 6. Science, technology and innovation policy documents
Evolving	Mutating institutional base of the national system of innovation to: (a) adapt to a changing regional and global environment, or (b) to affect the regional or global environment	1. Integrated science, technology and innovation planning environment with a strong Futures Planning component 2. A thriving and increasingly inclusive national system of innovation	1 Implementation strategies for science, technology and innovation policy and current state of implementation 2 Science, technology and innovation Foresight exercises 3 Trade in high-tech goods 4 High Knowledge Economy Index and Knowledge Index rankings 5 Outward Foreign Direct Investment 6 Regionally replicable projects 7 Level of engagement – triple, quadruple, quintuple and sextuple helixes

Table 1 depicts the three broad category levels in terms of their basic defining conditions, their underlying characteristics and possible quantitative indicators which may be used to located specific national systems within them. As may be seen from this table, the various characteristics of the three viability classes reflect both the narrow system of innovation and the broader political economy specification. The former is captured by R&D data, the Knowledge Economy and the Knowledge indices, and science and technology planning and implementation. The broader perspective on national system of innovation is captured by indicators of sound governance, human development indicators, and poverty and inequality as indictors of inclusivity. General economic sustainability conditions may be indicated by a combination of standard macroeconomic indicators and dependency markers such as reliance on overseas development assistance.

The assessment of viability thresholds is necessarily a complex exercise which should take into account a wide range of factors and a level of detail which places a detailed country by country analysis considerably beyond the scope of this paper. However, viability classes may be broadly sketched out, as presented in Table 1, to offer an initial set of taxonomic parameters within which different national systems of innovation may be placed. The viability categories depicted in Table 1 are obviously crude and do overlap. The threshold areas lie between categories and a number of national systems of innovation can exhibit characteristics from a number of viability categories. However, this classification, crude as it may be can provide an initial placement of individual national systems of innovation which can be used as the basis for further elaboration.

The viability of national systems of innovation in the SADC

The SADC contains a highly diverse group of countries with different histories, economic profiles and governance structures. There is also a very wide variation in the performance of the member economies in this group and in the viability prospects of their national systems of innovation. In this section three primary diagnostic tools are used for the purpose of this admittedly preliminary classification, with Knowledge Indices (shown in Table 2) reflecting the narrow national system of innovation, the Fragile States Index (shown in Table 4) as an indication of the broader political economy context, and Human Development Indictors (shown in Table 3) representing the broad based human capabilities component of the broad national system of innovation. Table 5 shows the viability classification of the national systems of innovation in the SADC which results from the consideration of these diagnostic tools.

Table 2 represents the Knowledge Economy Indicator (KEI) and Knowledge Indicator (KI) data for SADC countries. The KEI is a composite of sets of indicators reflecting (a) indicators of the incentives offered by the economic and institutional regime for the efficient use of existing and new knowledge and the flourishing of entrepreneurship; (b) the education and skills levels of the population; (c) an efficient innovation system of firms, research centres, universities, consultants and other organisations; (d) information and communication technology. The KI is a composite of indicators sets (b), (c) and (d) while the "knowledge economy index" adds on the market grounding of the knowledge system. While these indices are largely based on the perceptions of the business sector and offer an inevitably biased view of the national system of innovation, they do offer a basis for comparison across different national systems.

It is evident from Table 2 that only two SADC countries, Mauritius and South Africa, fall in the top half of the world KEI ranking. Moreover, all SADC economies except Mozambique and Mauritius have fallen in international ranking over 2000-2012, with Botswana, South Africa and Lesotho suffering the highest drops. The other evident fact is again the wide range of values of these indicators across SADC, with a KEI high of 5.5 for Mauritius to a low of 1.1 for Angola. The four countries which show the highest KEI values are Mauritius, South Africa, Botswana and Namibia. South Africa is seen as having the most developed innovation system (as indicated by the value of its innovation index) while Mauritius offers the strongest incentives regime.

Table 2: KEI and KI values rankings (out of 145 countries) – 2012

Rank	Change in rank 2000-2012	Country	KEI	KI	Economic Incentive Regime	Innovation	Education	ICT
62	1	Mauritius	5.5	4.6	8.22	4.41	4.33	5.1
67	-15	South Africa	5.2	5.1	5.49	6.89	4.87	3.6
85	-18	Botswana	4.3	3.8	5.82	4.26	3.92	3.2
89	-9	Namibia	4.1	3.4	6.26	3.72	2.71	3.7
106	-9	Swaziland	3.1	3	3.55	4.36	2.27	2.3
115	-4	Zambia	2.6	2	4.15	2.09	2.08	1.9
119	-6	Zimbabwe	2.2	2.9	0.12	3.99	1.99	2.6
120	-12	Lesotho	2	1.7	2.72	1.82	1.71	1.5
122	-6	Malawi	1.9	1.5	3.33	2.65	0.54	1.2
127	-2	Tanzania	1.8	1.4	3.07	1.98	0.83	1.3
128	-2	Madagascar	1.8	1.4	2.79	2.37	0.84	1.1
129	5	Mozambique	1.8	1	4.05	1.76	0.17	1.1
142	-1	Angola	1.1	1	1.48	1.17	0.32	1.4

Source: World Bank, at http://info.worldbank.org/etools/kam2/KAM_page5.asp or https://knoema.com/WBKEI2013/knowledge-economy-index-world-bank-2012?action=download

The broader version of the national system of innovation rests on an expanded concept of innovation which extends beyond technological change to any alteration in the coordination of economic activity which, within a specified context, is seen as being in some way preferable to the status quo. This broad version brings into consideration a wide range of institutions, both formal and informal, which affect the generation, adaptation, deployment and absorption of new knowledge within the borders of the national economy, and which determine its interaction with other systems of innovation. The two main general factors which shape the broadly defined national system of innovation and determine its development potential are broad based human capabilities formation, and good governance and stability.

Broad based human capabilities form the base of the innovation capacity of the national system of innovation. Their formation is a complex multifaceted process which is grounded in the material conditions of life of the general population with education as only one of the several components which enter as determining factors. One of the more comprehensive measures of these material conditions is provided by the Human Development Index which may be seen simultaneously representing both the goal of development policy and its instrument.

The index values for SADC countries which are provided in Table 3 show a wide range from a high of 0.806 for the Seychelles to a low of 0.300 for Mozambique. Only two of the SADC economies, Mauritius and Seychelles, lie in the upper fifty percent and in the 'high human development' category of world ranking. The UNDP reports place countries into four groups of human development: very high, high, medium and low. Botswana, South Africa, Namibia and Zambia fall into the 'medium human development' category while the rest are listed as 'low human development' countries. Eleven of the SADC countries, constituting just under 80% of the SADC, fall into the bottom third of world ranking of the Human Development Index. On the whole, the growth rates of the index compare well with the averages for the different categories and for sub-Saharan Africa as a whole.

Table 3: Trends in the Human Development Index, 2000-2014, for SADC countries

HDI rank (188 countries)	Country	Human Development Index (HDI)			Average annual HDI growth (%)		Inequality-adjusted HDI		Gini coefficient 2005-2013
		Year					Value	Difference from HDI rank	
		2000	2010	2014	2000-2010	2010-2014			
63	Mauritius	0.674	0.756	0.777	1.15	0.68	0.666	-2	35.9
64	Seychelles	0.715	0.743	0.772	0.39	0.97	..	..	65.8
106	Botswana	0.561	0.681	0.698	1.96	0.61	0.431	-23	60.5
116	South Africa	0.632	0.643	0.666	0.18	0.87	0.428	-15	65.0
126	Namibia	0.556	0.610	0.628	0.94	0.70	0.354	-25	61.3
139	Zambia	0.433	0.555	0.586	2.52	1.36	0.384	-6	57.5
149	Angola	0.390	0.509	0.532	2.70	1.11	0.335	-8	42.7
150	Swaziland	0.496	0.525	0.531	0.57	0.28	0.354	-2	51.5
151	Tanzania	0.392	0.500	0.521	2.46	1.05	0.379	4	37.8
154	Madagascar	0.456	0.504	0.510	1.02	0.27	0.372	4	40.6
155	Zimbabwe	0.428	0.461	0.509	0.75	2.50	0.371	4	..
161	Lesotho	0.443	0.472	0.497	0.62	1.30	0.320	-2	54.2
173	Malawi	0.340	0.420	0.445	2.14	1.49	0.299	2	46.2
176	Congo (DR)	0.329	0.408	0.433	2.18	1.52	0.276	0	44.4
180	Mozambique	0.300	0.401	0.416	2.96	0.94	0.273	3	45.7

Source: Derived from UNDP, Human Development Reports, at http://hdr.undp.org/en/composite/trends and http://hdr.undp.org/en/content/inequality-adjusted-hdi

The implications of these poor human development indicators are twofold. In the first place they show a historically low base for human development indicators across most of the SADC countries with strong implications for the development of broad based capabilities which are critical for development. At the same time these indices are an indicator of the wellbeing of the population, pointing to a degree of achievement of development goals and a degree of stability in the political economy. The encouraging feature of the indicators listed in Table 3 is the rates of growth of the index across most of the SADC, even though starting from a low base. The less encouraging aspect is the incidence of inequality among the SADC economies and its effects on broad based human development, as indicated in the last three columns of Table 3. The especially high incidence of inequality among the top ranking countries in knowledge indices and human development indices, except for the case of Mauritius, holds worrying implications for the constraints to the future growth of the human capabilities base.

The Fragile States Index is a composite of a wide range of factors which is used to indicate the degree of governance risk and may be used as a composite indicator of the stability of the political economy underlying the national system of innovation. Table 4 presents the world rankings of the Fragile States Index for SADC countries. The first seven indicators reflect various aspects of potential political instability due to legitimacy issues *vis-à-vis* the state. The other five reflect various aspects of economic performance and its effects. The values reported here show that only five of the SADC states fall into the bottom global 50% of risk assessment of the political economy. This carries worrying implications for the stability of the individual national systems of innovation in the SADC region and for the prospects for effective integration across the region.

Table 4: Fragile States Index ranking (of 178 countries) – SADC

Rank (2016)	Rank (2015)	Rank (2007)*	Country	Total (2016)	Total (2015)	Total (2007)	Legitimacy of the State	Human Rights	Factionalized Elites	Group Grievance	Refugees and IDPs	Security Apparatus	External Intervention	Human Flight	Uneven Development	Poverty and Economic Decline	Demographic Pressures	Public Services
8	**5**	**7**	Congo (D. R.)	**110.0**	**109.7**	**105.5**	9.3	10.0	9.8	9.7	9.7	9.2	9.7	6.8	8.9	8.1	9.1	9.7
16	**16**	**4**	Zimbabwe	**100.5**	**100.0**	**110.1**	8.9	8.4	9.8	7.5	8.7	7.8	7.7	8.1	8.2	8.3	8.6	8.5
37	**41**	**53**	Angola	**90.5**	**88.1**	**84.9**	8.8	7.5	7.2	7.7	7.3	6.2	5.6	6.3	9.6	6.1	9.0	9.2
42	**45**	**80**	Mozambique	**87.8**	**86.9**	**76.9**	6.7	5.8	6.9	5.6	5.5	6.7	7.6	7.7	8.9	7.7	9.5	9.2
44	**45**	**29**	Malawi	**87.6**	**86.9**	**92.2**	6.6	6.4	7.7	5.1	6.3	4.5	8.4	8.1	8.5	8.6	9.3	8.1
44	**48**	**61**	Swaziland	**87.6**	**86.3**	**81.3**	8.8	8.8	6.8	3.4	4.8	6.0	7.3	7.2	8.4	9.4	8.9	7.8
49	**53**	**69**	Zambia	**86.3**	**85.2**	**80.6**	7.2	7.1	5.7	5.4	6.6	4.7	6.9	8.1	8.9	8.1	9.5	8.1
56	**56**	**82**	Madagascar	**84.2**	**83.6**	**76.5**	7.3	5.8	7.8	4.3	3.6	7.3	7.0	6.4	8.8	7.8	8.8	9.3
62	**63**	**75**	Tanzania	**81.8**	**80.8**	**79.3**	6.1	6.1	6.0	5.4	6.9	5.2	7.4	7.3	7.3	6.4	8.9	8.8
66	**66**	**62**	Lesotho	**80.9**	**79.9**	**81.2**	6.1	4.7	7.3	4.1	4.8	5.9	8.0	7.7	7.6	8.2	8.2	8.3
103	**106**	**106**	Namibia	**71.1**	**70.8**	**71.3**	3.5	4.0	3.5	6.0	5.2	5.2	6.6	6.8	8.4	7.0	7.3	7.6
108	**113**	**132**	South Africa	**69.9**	**67.0**	**57.4**	5.0	4.4	5.6	6.3	5.6	5.8	3.2	5.2	7.7	6.6	7.3	7.2
120	**122**	**118**	Botswana	**63.5**	**62.8**	**66.4**	3.5	4.7	3.3	5.1	4.7	3.8	4.3	5.2	8.0	6.0	7.9	7.0
125	**124**	**106**	Seychelles	**60.2**	**62.1**	**71.3**	5.7	4.3	6.0	4.5	2.9	6.3	7.2	5.6	5.7	4.3	4.8	2.9
147	**145**	**147**	Mauritius	**43.2**	**45.2**	**42.7**	3.2	3.6	3.2	3.8	2.4	2.5	4.9	4.1	4.0	4.2	3.8	3.5

* Ranking out of 177 countries

Source: Foundation for Peace, at http://fsi.fundforpeace.org/rankings-2016, http://fsi.fundforpeace.org/rankings-2015, and http://fsi.fundforpeace.org/rankings-2007-sortable

The trends in the index over time show a marked worsening of the index for a number of countries, especially the Congo, Angola, Mozambique, Swaziland, Zambia and Madagascar. The sharpest drop in the index, and in ranking, has been for South Africa, which is particularly worrying given the prominent position which the country holds within SADC. The rest of the countries within SADC have experienced no significant change in their index or, as in the case of Seychelles and to a lesser extent Botswana, have seen marked improvements. In the cases of three of the five countries which fall in the upper half of world ranking - Namibia, Botswana and South Africa – the main shortfalls are in the areas of uneven development, poverty, demographic pressures, and the provision of public services. Pulling together the various indicators for the SADC countries we can tentatively locate the various national systems of innovation within the three viability categories as depicted in Table 5.

Table 5: Classification of SADC national systems of innovation by viability categories

Viability category	Country	Characteristics
Fragile	Congo (DR)	Ongoing low level civil war; low legitimacy of the state; highest Fragile States Index and human rights violation among SADC
	Zimbabwe	Collapsed economy; low legitimacy of the state;
	Swaziland	Absolute monarchy; low legitimacy of the state; highest poverty indicator in SADC
	Angola	Highest and worsening levels of corruption; high indicators of poverty and uneven development; worst KEI ranking in SADC
Viable	Madagascar	Present government formed from recent *coup d'état*; rapidly deteriorating Fragile States Index; indications of poor economic performance
	Lesotho	Political instability with two attempted *coup d'état* and foreign interventions in recent history; stable Fragile States Index; indications of poor economic performance; low and rapidly worsening KEI ranking
	Malawi	High but improving Fragile States Index ranking; strong indications of poor economic performance
	Mozambique	High and rapidly deteriorating Fragile States Index ranking; indications of poor economic performance; one of the two highest indicator of demographic pressures; second worst, but improving KEI ranking; lowest ranking HDI in SADC
	Tanzania	High and deteriorating Fragile States Index ranking; stable government since independence; regional catalyst for integration;
	Zambia	High and rapidly deteriorating Fragile States Index ranking; stable government since independence; narrow economic base; one of the two highest indicator of demographic pressures
	Seychelles	Second lowest and improving Fragile States Index ranking; narrow economic base; second highest HDI but highest Gini index
	Namibia	Good Fragile States ranking; narrow economic base; high HDI but third highest Gini index
Evolving	Botswana	Stable government since independence; rapidly evolving NSI with a high KEI ranking(significant changes in the STI institutional infrastructure since the last KEI reading in 2012)
	Mauritius	Lowest and stable Fragile States Index; rapid deepening of the knowledge base of the NSI, with an emphasis on sustainability and the highest KEI
	South Africa	Most diversified economy in SADC with a sophisticated STI infrastructure and second highest KEI ranking (although rapidly deteriorating); low Fragile States Index but the highest deterioration in ranking and the second highest in the value of the index; high HDI but second highest Gini index

The selection for the fragile group is based almost entirely on the issue of political stability. This is seen as the basic *sine qua non* for the viability of the basic political economy structure within which the national system of innovation evolves. The four countries which have been placed in the fragile category all exhibit indications of systemic political instability. As may be seen from Table 5, Zimbabwe and the Democratic Republic of Congo have had the worst Fragile States Index ranking among SADC countries since 2007.

Since the late 1990s, the Zimbabwean political economy has been wracked by successive political crises, the destruction of its currency and an accelerating financial crisis, and a mass emigration of its labour force. The economy of Zimbabwe is virtually wrecked and the loss of the majority of its human capabilities base holds grave implications for the evolutionary potential of is system of innovation. The ongoing political crisis has locked the national system of innovation into a downward trajectory which will last for some time beyond an eventual resolution of the crisis.

The Democratic Republic of Congo has been marked by internal and cross-border armed conflict and insurrections since its latest formation after the overthrow of Mobutu Sese Seko in 1997; as may be seen from Table 5 it scored the highest ranking on most of the components of the Fragile States Index which reflect the security of the state. It shows the lowest Human Development Index value, the highest poverty rate and the lowest GDP per capita within SADC. In spite of a large higher education sector and an established Ministry of Scientific Research and Technology with research institutes in areas of agriculture, nuclear energy, geology and mining, biomedicine, and environment and conservation (Kraemer-Mbula and Scerri, 2015), the ongoing political instability and the underdevelopment trap will continue to block the evolution of the national system of innovation until they are resolved.

Swaziland is an absolute monarchy which scores very poor ratings on the legitimacy of the state and human rights. Its economy is heavily reliant on subsistence farming with an endemically high unemployment rate and poverty levels. Although Swaziland has a science, technology and innovation infrastructure and policy stance which are modestly developed, its relative expenditure on R&D is negligible (Kraemer-Mbula and Scerri, op. cit.). The implementation of plans to develop the science, technology and innovation sector is structurally impeded by the autocratic political regime which, with its repression of civil rights movements and labour unions, has effectively excluded the majority of the population from an effective participation in its national system of innovation.

From the perspective of economic performance Angola is doing well, with a high growth rate and GDP value, even though its economy is almost totally reliant on the oil sector. Its higher education sector has expanded rapidly since 1998 with a massive increase in higher education institutions and the establishment of two centres of excellence in sustainable development (Kraemer-Mbula and Scerri, 2015); this points to a drive to diversify the basis of the national system of innovation away from its reliance on the oil sector. However, its high and rapidly worsening Failed States ranking, with extremely low legitimacy of the state, high levels of corruption and very poor public service delivery, in combination with its reliance on oil places it within the fragile category.

The second category, consisting of viable national systems of innovation, should be seen as a wide spectrum ranging from national systems which are on the verge of becoming fragile, through those which are politically stable but doing poorly, to those which are thriving while still retaining their basic underlying structures. Conceptually we may identify these three sub-categories, while recognising that the demarcation lines between them may be quite blurred.

The first consists of those national systems which are on the verge of falling into the fragile category primarily due to considerations of political stability. Madagascar has had a recent history of instability and a government which was formed on the basis of a political coup. Although it has been politically stable since the 2013 elections its economic performance has been very poor. Its Fragile States Index has been stable over the last few years, although it fell rapidly from its 2007 ranking. In the case of Lesotho most of the sub-indicators of the Failed States Index are low and its overall index places it in bottom half of the world ranking. Its political history since the late

1990s has been one of sporadic unrest, marked by external SADC military intervention and a military coup. However, its Fragile States Index has been stable over the ten year period under consideration. While both Lesotho and Madagascar have a recent history of severe political instability which may be systemic there are also signs that the current political environments in both countries have stabilised. Their Knowledge Economy Index values are low and the world ranking for that of Lesotho fell sharply over 2000-2012. The science technology and innovation infrastructure in Lesotho is poorly developed and its R&D activity, measured in terms of expenditure relative to national income, is very low (Kraemer-Mbula and Scerri, op. cit.). In the case of Madagascar the science, technology and innovation sector is significantly more developed with a number of established universities and research institutes, with national research plans in a number of areas related to sustainability (Kraemer-Mbula and Scerri, op. cit.).

The second sub-category consists of those national systems which are stable but mostly static and struggling with attaining economic self-sustainability. Malawi and Mozambique both fall into this sub-category with stable political systems but exhibit high Failed States index values, mostly due to extremely poor economic performance and public poor service delivery, as well as a high reliance on foreign funding. Mozambique registered the second lowest Knowledge Economy Index value in SADC, although with some improvement over the period considered. Mozambique also attained the lowest Human Development Index in SADC with Malawi also showing a very low value. Malawi's economy is heavily reliant on agriculture, with little signs of diversification and a heavy reliance on donor funding for its investment requirements (Kraemer-Mbula and Scerri, op. cit.). In the case of Mozambique the exploitation of natural gas deposits and the production of aluminium since the 2000s has raised the rate of economic growth but risks locking the national system of innovation into a resource-based evolutionary path. All of these indicators point to national systems of innovation which, while politically stable, as yet show little promise of developing the required capacity, especially in terms of human capabilities development, to attain a sustainable growth trajectory.

Tanzania and Zambia are marked from Mozambique and Malawi by virtue of their relatively higher Human Development Index values and the consequent implications for human capabilities development. Zambia's national system of innovation is heavily based on copper, with a poorly developed agricultural sector which still employs the large majority of the population. Its shows a low Human Development Index, a high poverty rate and a high level of income inequality. Tanzania has a virtually unparalleled history of post-independence political stability, exhibits the lowest income inequality within SADC, and a Human Development Index value which, while low, has been increasing at a rapid rate. It has also been consistent in its advocacy of regional integration and a strong political driver for the East African Community. These factors strongly mitigate against the detrimental effects of high poverty rates and an economy which is still strongly reliant on a non-industrialised agricultural sector. The science, technology and innovation institutional infrastructures of the two economies are relatively young, with formal science and technology plans since the late 1990s and established state science and technology institutions.

The third sub-category refers to those national systems of innovation which are flourishing within the framework of a relatively unchanging underlying structure. Namibia and Seychelles are two systems which fall squarely within this sub-category of viable systems. Both show low values of the Failed States Index. The indicators of economic performance and public service delivery for the Seychelles are among the best within SADC while those for Namibia are significantly poorer. Bothe countries show high Human Development Indices, although with extremely high levels of income inequality (Seychelles shows the highest Gini index within SADC). The economy of the Seychelles has grown remarkably rapidly since the early 1980s, mostly on the back of tourism; there are indications of the start of diversification towards manufacturing and commercial farming which

hold an early promise of the start of a mutating national system of innovation. The economic growth rate of Namibia has consistently been high but its economy is still largely based on the primary sector, mostly minerals. It shows the highest Knowledge Economy Index value among the viable group of national systems of innovation within the SADC, with the second highest economic incentive regime value. There are indications of the start of the diversification of the economy away from the reliance on the primary sector but the single most binding constraint on this process is the probably the extremely high level of inequality within the Namibian economy with its implications for human capabilities development.

The group of evolving systems refers to those whose form is mutating through the effects of policy and the three national systems of innovation which fall into this category are Botswana, Mauritius and South Africa. These systems register the highest three Knowledge Economy Index values within the SADC, fall into the lowest bracket of the Failed States index and rank among the highest Human Development Index values in the SADC. There are however significant difference between these three national systems. South Africa is the largest and most diversified economy within the SADC and has the most highly developed innovation infrastructure as evident in the innovation sub-indicator in the Knowledge Economy Index. However, along with Botswana, it shows an extremely high level of income inequality which substantially affects the reported Human Development Index. While Mauritius scores low on all the sub-indices of the Failed States Index, Botswana and South Africa both score considerably higher on all aspects of economic development and public service delivery. South Africa has shown a significant increase in its Failed States index value, which is particularly alarming given its size and prominence in the SADC.

The viability prospects for a SADC system of innovation

The viability of supra-national systems of innovation may be assessed from two primary perspectives. The first is institutional one which includes the different formal, legal, quasi-legal and informal institutional liaisons. The formal links include formal regional economic community agreements, cross border inter-institutional agreements, the programmes for the implementation of the various stages of integration. At the less formal level integration happens primarily through processes of learning by association and learning through exchange. It is often the informal interactions which help development and cement the cross-border communities of practice which form the base for the emergence of supra-national systems of innovation. The second perspective is more structural in terms of the type and relative regional power of the component national systems of innovation within the envisaged supra-national system.

The SADC was formally been established in 1992 with the dissolution of the Southern African Development Coordination Conference whose agenda, as informed by front line states, was to contain the depredations of the apartheid states in the region. That mission ended with the demise of apartheid and the SADC effectively came into being in 1994 with the membership of the newly democratic South African state. In its relatively short history the SADC has laid down a number of protocols towards the transition to a SADC system of innovation.

The 2008 *SADC Protocol on Science, Technology and Innovation* (SADC, 2008) is ostensibly based on the broad definition which extends considerably beyond the science and technology sectors[2] but the areas which it covers are limited to the system of science and technology.[3] The protocol

[2] "'National Systems of Innovation' means a set of functioning institutions, organisations and policies, which intervene constructively in pursuit of a common set of social and economic objectives" (SADC, 2008: 4)

[3] These include policy training, the role of women in science, science, technology and innovation strategy, intellectual property rights, indigenous knowledge systems, climate change and the Blue Gene project.

identifies the main drivers of the regional integration of science and technology systems as the development of institutional mechanisms for regional cooperation and coordination of science, technology and innovation programmes, the development and harmonisation of national science, technology and innovation approaches, and the raising of public and private investment in R&D within SADC. While it focuses on the narrow version of the system of innovation, on a broader contextual level the protocol is set within the framework of the *Regional Indicative Strategic Development Plan* (SADC, 2003) and the *Africa's Science and Technology Consolidated Plan of Action* (NEPAD, 2005). The *South African Department of Science and Technology* (RSA, 2011) notes that the SADC protocol is an essential first step toward regional integration, with considerable progress in regional interventions, and a steady growth in self-financed bilateral cooperation; as a consequence SADC has become the leading regional economic community on the continent.

The *SADC Regional Indicative Strategic Development Plan* (SADC, 2003: 47) identifies a number of critical obstacles to the development of national and supra-national systems of innovation in the region. These include a common economic dependence the primary sector with a poorly developed manufacturing sector, low bases of human capabilities exacerbated by poor education systems, as reflecting the development prospects of the broadly defined system of innovation. With regard to the narrow version of systems of innovation the obstacles identified by the plan include a low R&D/GDP ratio, poor incentive mechanisms for R&D investment, weak intellectual property rights legislation, and insufficient cross-border cooperation in science and technology. These obstacles are very similar to those identified by the AU/NEPAD African Action Plan (AU/NEPAD, 2009: 59) in its investigation of the development potential for systems of innovation in the continent. Intra-SADC trade has not grown to any significant degree, due to the similarity of the resource based economies across the region. Intra-SADC trade as a percentage of total trade remained at roughly 15% of total SADC trade since the implementation of the *SADC Protocol on Trade* in 2000 and the sectoral composition of SADC exports has not diversified over this period, whether within SADC or to the rest of the world (RSA, 2014). This failure of the *SADC Protocol on Trade* to alter the incidence and composition of intra-SADC trade points to underlying structural features within SADC which continue to obstruct the path to a SADC system of innovation.

The first, and perhaps the foremost, characteristic is the issue of political governance systems and the political will to cede some degree of national sovereignty as a pre-requisite to a successful process of regional integration. Apart from the island states of Madagascar, Mauritius and Seychelles, all of the current SADC countries were the outcome of a colonial creation which bore little acknowledgement to pre-existing political, cultural and economic affiliations. In a number of cases, as in many parts of the rest of Africa, the postcolonial system of innovation which was created with independence stood little chance of ever becoming viable. This problem is most evident in the case of the six countries listed as fragile or quasi-fragile in Table 5 where there is a notable degree political instability and a questioned legitimacy of the state. These countries are often those whose political leaders are most reluctant to yield any significant degree of sovereignty and whose inherent instability threatens that of the region through the mass movement of economic and other types of refugees, and cross-border conflict.

The second related impediment to successful regional integration is the highly uneven distribution of the attributes of viability. In general, South Africa, Mauritius, Botswana, Seychelles and Namibia are relatively strong with a marked gap between them and the other member countries of the SADC. Within this skewed distribution of viability the South African system of innovation stands out as the regional power in terms of the size and diversity of its economy, and the extent and

sophistication of its physical and institutional knowledge infrastructure.[4] South Africa's post-colonial is distinct in that it started early with the formation of the Union of South Africa in 1910 and the granting of dominion status to an indigenous white minority government. This historical departure marked the start of a process of accumulation considerably ahead of the rest of post-colonial Africa. At the same time the fundamentally racial nature of the mode of innovation[5] which emerged, especially when consolidated under apartheid, resulted in the apparent contradiction of a highly sophisticated system of science and technology set within the context of a highly compromised national system of innovation. This contradiction may well slow down the evolution towards a SADC system of innovation for two reasons. In the first place, too highly skewed a distribution of intra-SADC economic power may jeopardise the avoidance of a zero-sum game which often proves to be the death knell of economic integration. There is no question that in the case of science, technology and innovation – the narrower end of the system of innovation – South Africa is a useful partner in the establishment of science and technology infrastructures, as may be seen in the development of an innovation hub in Botswana, based on South African experience or the development of a continent wide survey, based on the South African model. At the same time, the poorly developed South African system of innovation, with a human capabilities base which is highly deficient when compared to the rest of the continent[6], endemically high level of inequality, poverty and unemployment, and a continued reliance on the minerals-energy complex, does not provide the set of guidelines appropriate for the development of a SADC system of innovation.

The viability of provincial systems of innovation in South Africa

In the highly connected globalised world economy which emerged since the early 1990s the demarcation lines between global, national and sub-national systems has been rapidly eroded. While the sovereign state is still the single most important departure point for systems analysis it is increasingly being analysed, at least implicitly, as a local system in relation to regional blocs and the global system of innovation. In this interconnected world of the early 21st century local specificities have become the determining factors in the placement of particular systems in relation to others, with a diminishing regard to the constraints of legally defined national borders.

The assessment of viability may be extended to local systems of innovation with one proviso. Local systems may be identified by their legal status as districts, boroughs, municipality, provinces, etc. but a legal demarcation is not a sufficient, or even necessary, condition for the existence of a local system of innovation. Intra-national legally defined jurisdictions may, and do, change and do not automatically imply the existence of a local system of innovation. Consequently, the assessment of the viability of legally defined sub-national systems holds different implications from that of national systems. An evaluation of non-viability may well indicate that a local system of innovation may not exist or holds no promise of existing, regardless of legal demarcation lines. This holds strong implications for intra-national regional policy where the assessment of locally defined systems as non-viable, viable or evolving may prompt the re-drawing of local government topographies. The different viability categories for local systems of innovation, referring to

[4] One indicator of the size and diversity of the South African system of innovation relative to other SADC national systems is the value of its trade in hi-tech products (aerospace, computers and office machines, electronics-telecommunications, pharmacy, scientific instruments, electrical machinery, chemistry, non-electrical machinery and armaments) which is a number of multiples of the rest of the SADC economies (COMTRADE Database of the United Nations Statistical Division, at http://comtrade.un.org/)

[5] See Scerri (1994) for an elaboration on this concept.

[6] See, for example, the TIMSS (Trends in International Mathematics and Science Study) results for South Africa as an indication of the performance of South African pupils in mathematics and science, relative to other countries (HSRC, 2012)

provinces for the South African case used as the specific application of this study, are presented in Table 6.

Table 6: Viability possibilities of provincial systems of innovation

Viability classes	Conditions	Characteristics	Indicators
Non-viable	Lack of legitimacy of the legally defined local government	1. Corruption 2. Poor record of service delivery 3. Weak local economy	1. Low proportion of unqualified audits 2. Number of service delivery protests 3. Corruption indicators 4. GINI coefficient 5. Net outflow of working age population
Viable	Stable local economy with a generally unchanging institutional base. This type of local system can be static or growing.	1. Transparent and accountable governance 2. Stable local economy 3. Growing human capabilities base 4. Absorptive capacity for innovation	1. Macroeconomic indicators a. Employment rate b. Gross local output 2. Human development indicators 3. Developed institutional base for the local economy
Evolving	Mutating institutional base of the provincial system of innovation to: (a) adapt to a changing national, regional and global environment, or (b) to affect the national, regional or global environment	1. Integrated science, technology and innovation planning with a strong Futures Planning component 2. A thriving and increasingly inclusive provincial system of innovation	1. Implementation studies for science, technology and innovation policy and the current state of its implementation 2. Science, technology and innovation foresight exercises 3. Regionally replicable projects 4. Level of engagement – triple, quadruple, quintuple and sextuple helixes

The viability of a local (provincial) system of innovation is predicated on the legitimacy of the local government which depends on a transparent and accountable governance system and a sound local economy. The absence of both of these pre-requisites threatens the viability and even the possibility of its existence as a legally defined entity. The viable provincial systems are those which show a stable, possibly growing, economy with the capacity to absorb labour and skills. The evolving provincial systems are those which are at the cutting edge of the national system of science and technology and whose economic base is moving up the global value chain.

The origins of the current provincial map of South Africa lie in the spatial economics developed under apartheid which apportioned land and ownership rights on the basis of race. The plan for separate development under apartheid resulted in the creation of Bantustans (Bophuthatswana, Ciskei, Transkei and Venda) and homelands (Gazankulu, KaNgwane, KwaNdebele, KwaZulu, Lebowa, and QwaQwa) reserved for the various African populations. These allocated areas were never economically viable and were maintained through budget transfers from central government in order to retain the apartheid model of separate development (Scerri, 2010). The post-apartheid re-drawing of the South African provincial map was the result of a complex process of compromise among the various historically vested interests, resulting in significantly different combinations of those provinces, deemed 'white' under apartheid (Cape Province, Natal, Orange Free State and Transvaal) whose economies had grown organically and the bantustans and homelands, the ersatz creation of apartheid essentially as reserves for Africans. Table 7 shows the composition of the nine post-apartheid states. Not unsurprisingly, the subsequent

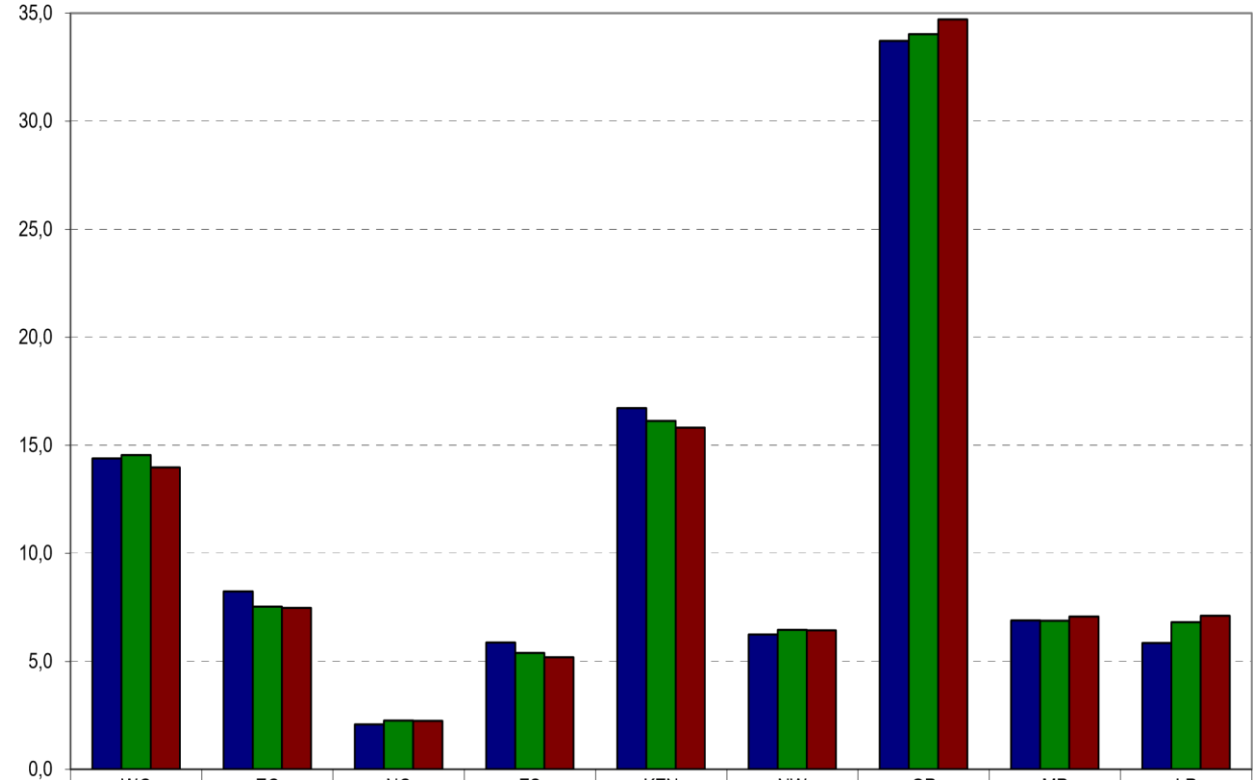
development paths of the various provinces came to depend critically on their composition with the higher component of the old 'white' provinces resulting in viable systems and the converse. This was not only due to the essential non-viability of the Bantustans and homelands but also because of the institutionalised systems of patronage and corruption which were integral to the maintenance of the separate development model under apartheid and their path dependency after apartheid (Scerri, 2010).

Table 7: The post-apartheid provincial map

Province	Composition	Core economic structure
Gauteng	The Pretoria-Witwatersrand-Vereeniging industrial heartland of the Transvaal	A fully fledged economy which contributes more than 30% of the GDP; the innovation hub of south Africa
Western Cape	The economic concentration of the Cape province	The main economic sectors are tourism, services and viniculture
KwaZulu-Natal	The amalgamation of the Natal Province and KwaZulu	Diversified economy with agriculture, ports and a spread of industries, and a growing tourism sector
Free State	The Orange Free State combined with QwaQwa and parts of Bophuthatswana	Agriculture and mining
North-West	A combination of parts of Bophuthatswana, Transvaal and the Cape province	Mining and agriculture
Northern Cape	The mining part of the Cape Province	Mining and agriculture
Limpopo	A combination of the northern part of the Transvaal, Venda, Gazankulu and Lebowa	Agriculture
Mpumalanga	A combination of the eastern part of the Transvaal, a part of Bophuthatswana, KaNgwane and KwaNdebele	Mining and agriculture
Eastern Cape	Mainly a combination of Transkei and Ciskei	Automotive industry cluster

The relative contributions of the different provinces to the South African economy are shown in Figure 1 and it is clear that Gauteng constitutes the core of the national system of innovation. An early assessment of the viability prospects of provincial systems of innovation may be evaluated through a combination of the various indicators listed in Table 6. In this paper a preliminary assessment looks at the capacity to absorb labour, at aspects of human capabilities formation and at indicators of local government legitimacy in each province.

Figure 1 – Provincial contribution to South African economy: 1997, 2007 and 2012



	WC	EC	NC	FS	KZN	NW	GP	MP	LP
1997	14,4	8,2	2,1	5,9	16,7	6,2	33,7	6,9	5,8
2007	14,5	7,5	2,3	5,4	16,1	6,5	34,0	6,9	6,8
2012	14,0	7,5	2,2	5,2	15,8	6,4	34,7	7,1	7,1

Source: Stats SA (2013)

Table 8 presents the employment levels for each provinces and it is evident the picture of the distribution of output across provinces shown in Figure 1 is reflected in the distribution of the absorptive capacity for labour in each province but this has to be qualified by the unemployment rate to get a clearer idea of the absorption capacity of each province.

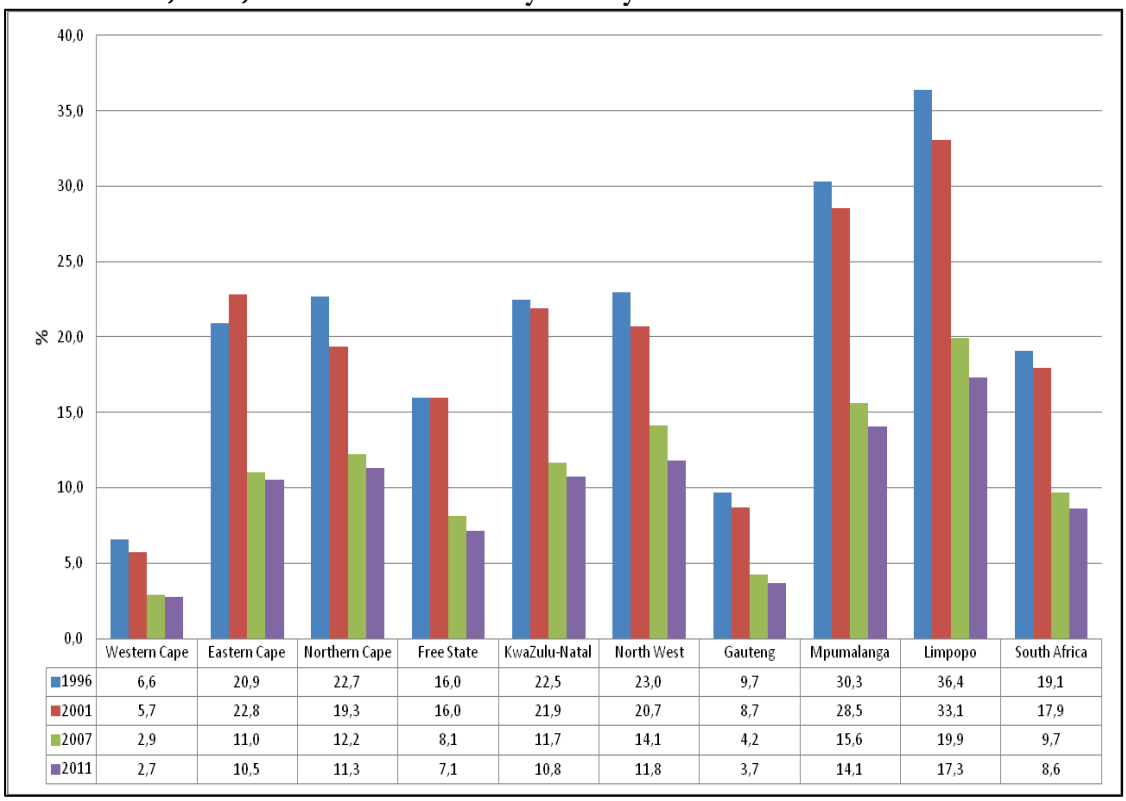
Table 8: Employment levels and unemployment (expanded definition) rate by province

	Employment ('000)			Expanded Unemployment Rate (%)		
	Oct-Dec 2014	Oct-Dec 2015	Year-on-year change (%)	Oct-Dec 2014	Oct-Dec 2015	Year-on-year change (%)
South Africa	**15 320**	**16 018**	**4,6**	**34,6**	**33,8**	**-0,8**
Gauteng	4 881	5 090	4,3	29,6	30,2	0,6
KwaZulu-Natal	2 520	2 529	0,4	37,9	36,8	-1,1
Western Cape	2 170	2 380	9,7	24,5	22,0	-2.5
Eastern Cape	1 336	1 411	5,7	41,9	40,3	-1,6
Limpopo	1 235	1 311	6,1	37,2	38,6	1,4
Mpumalanga	1 138	1 191	4,7	40,5	39,4	-1,1
North West	948	969	2,2	40,0	38,9	-1,1
Free State	772	825	6,9	39,5	36,3	-3,2
Northern Cape	320	312	-2,7	38,4	38,9	0,5

Source: Stats SA (2016)

While Gauteng clearly has the largest economy and associated employment levels, the Western Cape records the highest rate of growth of employment coupled with the lowest unemployment rate among the provinces. In the case of the human capabilities formation, a preliminary idea of provincial disparities may be obtained from selected education statistics. Figures 2 and 3 show the percentage of the population of each province which has no formal schooling and those which have a higher education, respectively.

Figure 2: Level of education (No Schooling) for those aged 20 years and older by province: Census 1996, 2001, 2011 and Community Survey 2007

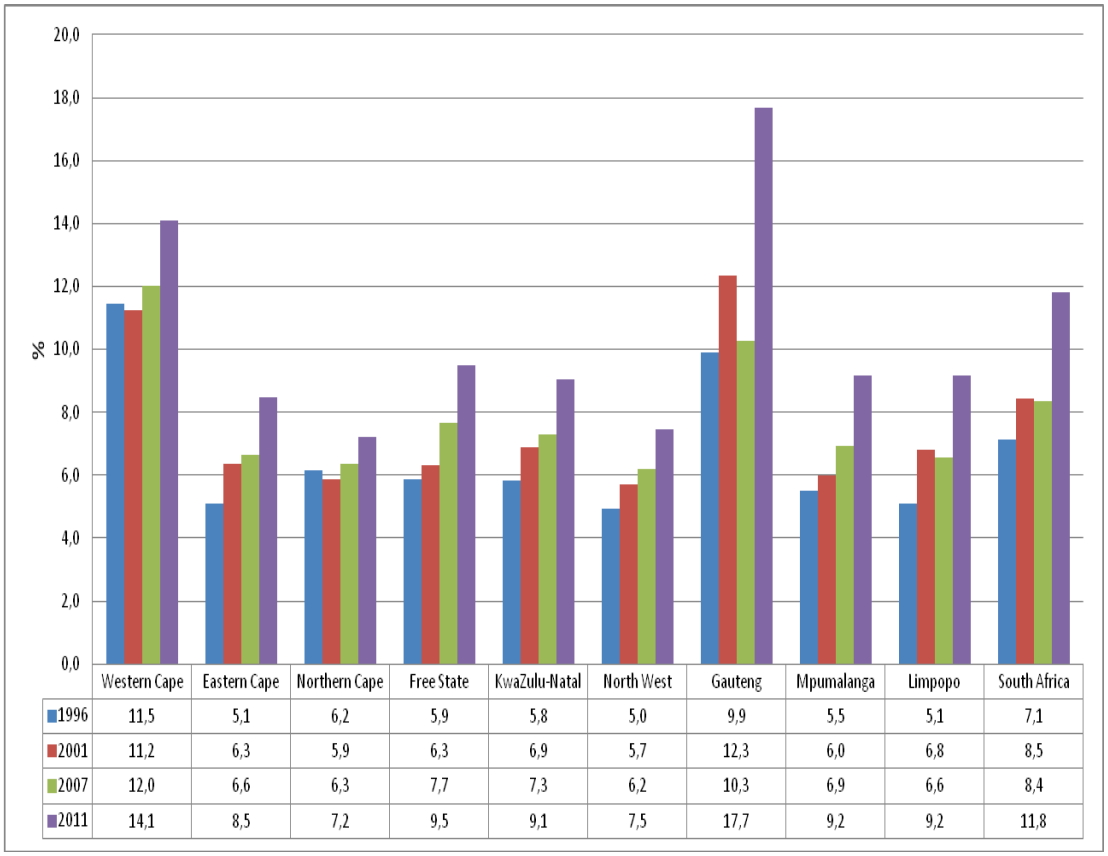


	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpumalanga	Limpopo	South Africa
1996	6,6	20,9	22,7	16,0	22,5	23,0	9,7	30,3	36,4	19,1
2001	5,7	22,8	19,3	16,0	21,9	20,7	8,7	28,5	33,1	17,9
2007	2,9	11,0	12,2	8,1	11,7	14,1	4,2	15,6	19,9	9,7
2011	2,7	10,5	11,3	7,1	10,8	11,8	3,7	14,1	17,3	8,6

Source: Stats SA (2012)

As may be seen from Figure 2, there is a considerable disparity in the proportion of the population without schooling among the provinces. The Western Cape and Gauteng again stand out as the provinces with significantly lower proportions than the rest of the provinces. When it comes to the proportion of the population with higher education, as depicted in Figure 3, the two provinces again stand out from the rest of the provinces; in this case though, the relative position of the two provinces is reversed with Gauteng showing a significantly higher proportion of its population with a tertiary education.

Figure 3: Level of education (Higher Education) for those aged 20 years and older by province: Census 1996, 2001, 2011 and Community Survey 2007



	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpumalanga	Limpopo	South Africa
1996	11,5	5,1	6,2	5,9	5,8	5,0	9,9	5,5	5,1	7,1
2001	11,2	6,3	5,9	6,3	6,9	5,7	12,3	6,0	6,8	8,5
2007	12,0	6,6	6,3	7,7	7,3	6,2	10,3	6,9	6,6	8,4
2011	14,1	8,5	7,2	9,5	9,1	7,5	17,7	9,2	9,2	11,8

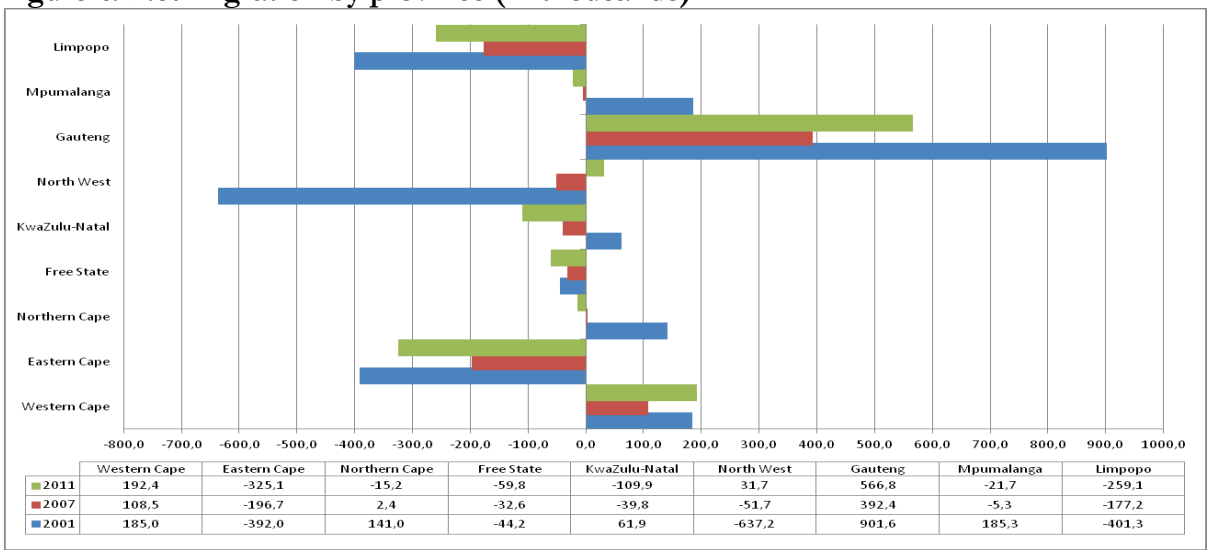
Source: Stats SA (2012)

The initial indicator of the legitimacy of provincial government which has been chosen for this paper is the number of clean audits of municipalities as a proportion of all audits for each province. The provinces with the highest proportion of municipalities with clean audit opinions in 2014-15 were the Western Cape (73%), Gauteng (33%) and KwaZulu-Natal (30%). The Eastern Cape, the Free State and Mpumalanga are still lagging considerably behind although they have shown improvements in the number of municipalities with clean audits. The provinces of Limpopo, North West and the Northern Cape had shown no significant improvement from an already extremely low proportion of clean audits (Auditor General, 2016).

From the foregoing discussion of the various indicators considered here we may tentatively propose that Gauteng and the Western Cape can be comfortably placed in evolving category of provincial systems of innovation. KwaZulu-Natal and the Free State would fall into the viable category of systems which are sustaining their growth trajectories within a relatively static structure. The other five provincial systems have to be placed in the non-viable category due to serious failings on a number of fronts.

These data on the size of provincial economies, their employment levels and unemployment rates, and the level of education are both reflected in and reinforced by migration patterns across provinces. This is reflected in Figure 4 and again the contrast between Gauteng and the Western Cape on one side and the rest of the provinces on the other is stark. These patterns hold strong implications for the path dependence of development trajectories of the various provinces since the current flows imply an ongoing enhancement of the human capabilities base of the two provinces with the depletion of those for the others.

Figure 4: Net migration by province (in thousands)



	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpumalanga	Limpopo
2011	192,4	-325,1	-15,2	-59,8	-109,9	31,7	566,8	-21,7	-259,1
2007	108,5	-196,7	2,4	-32,6	-39,8	-51,7	392,4	-5,3	-177,2
2001	185,0	-392,0	141,0	-44,2	61,9	-637,2	901,6	185,3	-401,3

Source: Stats SA (2012)

These patterns hold significant implications not only for provincial systems of innovation but for the national one as well. There is a sizeable literature on the limiting effects of inequality and exclusion on the evolutionary path of national systems of innovation (see Soares et al, 2014) and the regional disparities in the evolutionary paths and potentials in South Africa are particularly worrying in this regard. These strong regional disparities exacerbate the effects of other inequalities (class, race and gender) which are still pronounced in South Africa. In order to be sustainable the growth and evolutionary path of a national system of innovation requires a convergence of its various regions in terms of their ability to offer a realisable potential for the growth in the wellbeing of the population as a whole. The continuing failure to attain this primary development goal on the part of more than half of the provinces may occasion a re-drawing of the provincial map in South Africa. As argued earlier, the jurisdiction of local government is not non-violable and there is scope in assessing which of the provincial systems which fall into the non-viable category have the potential to become viable and which, for a multiplicity of reasons, do not. In the case of the latter the possibility of a legal dissolution and integration into other, viable, provincial systems of innovation is worth consideration.

Concluding remarks

Based as it is on a biological metaphor, the concept of the viability of systems of innovation is never going to be conducive to neat measurement and unambiguous interpretation. Within the systems of innovation approach the emphasis on the specific nature of different systems, especially with respect to their history and path dependence, raises a strong cautionary note against easy generalisations and inter-system comparisons. This tension between the specific and the general is an integral part of the approach and the analyst has to be mindful of this when engaging in studies of systems of innovation which apply some general principles of evaluation across different systems for the purpose of comparison.

The proposal of the notion of viability as presented in this paper hopefully gives an indication of its complexity in terms of the multiplicity of interrelated factors which enter into its assessment. The specific applications which have been chosen here each merits a full separate study considerably beyond the scope of a single paper and the framework for the evaluation of viability still requires considerable further elaboration. The brevity of the treatment of each of the three

related applications has also virtually excluded the discussion of the policy implications of the evaluation of the viability of these systems. That said, it is hoped that the exposition of this concept and its limited application to specific cases has been sufficiently clear to lay the basis for future research.

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