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The Viability of Systems of Innovation[1]

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Abstract: The main aim of this essay is to develop the concept of viability as a general theoretical framework for the assessment of systems of innovation, defined broadly, at three main levels of aggregation – the national, the sub-national and the supra-national. In the case of sub-national systems there is already a substantial body of writing on local systems of innovation which is used to draw inferences on viability. In the case of supra-national systems, the volume of research is relatively sparse, perhaps reflecting the relatively short history of economic integration and the generally incipient stage in the formation of economic blocs, except in the case of the European Union (EU).

Keywords: Systems of innovation; economic integration

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1. Introduction

Evolutionary economics, from which the systems of innovation approach to economic change emerged, focuses on institutionally formed behaviour within a context where uncertainty and ignorance are prevalent. Within this context, agents make decisions based on search and feedback mechanisms in an ongoing process of learning, adaptation and evolution. The economic system imagined within this theoretical framework, in contrast to neoclassical economics, is one which is imperfectly known to agents within the system, is in a constant state of flux, and is continuously mutating. It is a system where, over time, the fundamental rules of economics are hard to pin down and where the demarcation lines between commerce, politics, culture and history are always blurred. This school of thought is based on a biological metaphor with the framework of political economy, cast as an organism rather than the clockwork mechanism imagined in the general equilibrium formulation of neoclassical economics. The national system of innovation is firmly set within evolutionary economics (Nelson and Winter, 1982). It can therefore be seen as an evolving organism, a product of history, where the concept of optimisation has minimal relevance when compared to search and interactive learning, and ongoing processes of 'creative destruction' (Schumpeter, 1934) and 'creative forgetting' (Gregersen and Johnson, 1997).

In this essay, the broad version of the systems of innovation approach (Lundvall, 2010), which extends considerably beyond the science, technology and related innovation, is taken as the object of analysis. The broadening of the conceptualisation of the national system of innovation rests on two related elements. The first is the definition of innovation and the second is the consideration of which institutions are relevant to the system. For Schumpeter (ibid: 66), the definition of innovation ranged considerably beyond technology to include a wide variety of measures or, as Schumpeter termed them, 'new combinations' of existing 'materials and forces' which are seen as an improvement on current combinations. Wide as Schumpeter's definition of innovation may be, it is still largely restricted to business enterprises within a capitalist society. It can certainly be widened further to include other categories of economic agents, from the state, civil society, the informal economy, and organised labour. The range of institutions which may be considered as relevant to the national system of innovation is similarly fluid and strongly related to the definition of innovation. As we move away from a strict adherence to innovation as technology, the breadth of the institutional web which constitutes the system of innovation widens. Moreover, as the concern with the specificity of individual national systems grows, so does the focus on the foundation of the system on informal institutions. These are those established routines and practices regulating inter-personal relations which have grown over time in a specific context and which are the font of the tacit knowledge foundation of specific systems of innovation. With this broadening of the concept of innovation and a widening of the range of relevant agents, the idea of the national system of innovation may be conceivably extended to provide an alternative theory of the general political economy (Scerri, 2016).

From an evolutionary perspective, the issue of the viability should be central to the assessment of the health of systems of innovation. 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, to mutate and to evolve. This interpretation is particularly relevant to the centre-periphery analysis of dependence (Amin, 1972; 1975). 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 national economy. Following the Second World War and the end of the era of empire, the modern mosaic of the newly sovereign states emerged and with that there arose an 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 and free trade areas in Africa and Asia to the highly integrated economic and political bloc of the European Union. The other level at which systems of innovation may be considered is the sub-national one where the demarcation lines 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 Britain to forgo its membership in the European Union. At the sub-national level legal demarcations may not necessarily reflect actual local systems of innovation and can sometimes be legally changed. Over time, systems emerge and mutate while some stagnate and even die out. The twentieth century saw the emergence of a large number of new national systems of innovation at the end of the imperial era and the subsequent waves of independence of former colonies. It also saw the destruction of national systems, as with the breakup of Yugoslavia. Whole species, such as the socialist systems of innovation in the Soviet Union, may die out, supplanted by what can arguably be seen as a new world system of a historically unprecedented global hegemony of neoliberal praxis. With the coming of the Anthropocene and climatic change, even the viability of the gloal system of innovation may now legitimately be put in question.

The main aim of this essay 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 – the national, the sub-national and the supra-national. The conceptual framework underlying the various possibilities for the viability of systems of innovation is provided in the following section. This is tied to national systems of innovation since the nation state still provides the foundation on which systems of innovation can be indubitably premised. The next section looks at the criteria for viability in the cases of sub-national and supra-national systems. In the case of sub-national systems there is already a substantial body of writing on local systems of innovation which is used to draw inferences on viability. In the case of supra-national systems, the volume of research is more meagre, perhaps reflecting the relatively short history of economic integration and the generally incipient stage in the formation of economic blocs, except in the case of the European Union (EU). The essay concludes with a brief discussion on the interpretative implications of this approach.

2. The viability of national systems of innovation

The metaphorical base for the concept of viability is a biological one, which enables the consideration of various possibilities of the survival of an organism (a specific national system of

innovation) or the extinction of a species (a class of systems), or the emergence of a new species. It also allows for an exploration of the evolutionary paths and mutations of systems of innovation over time in response to internal forces and environmental shifts. This approach should eschew easy generalisations and it therefore renders the task of comparing systems of innovation complex. This is symptomatic of the tension between specificity and generalisation which runs through the systems of innovation approach to the analysis of economic dynamics. The study of the viability of systems of innovation should be a situational and historical analysis of specific systems but at the same time common lines of comparability across systems have to be drawn out to enable a general approach. Following the biological metaphor, we have to circumscribe the assessment of the viability of an organism, or a species, within the framework of the eco-system where the organism is located. Translated to systems of innovation, the eco-system is the global economic order determined by the specific nature of the global mode of production and innovation. The transition from the global economic order of the bi-polar world prior to the breakdown of the Soviet Union to the neoliberal hegemony of free trade thereafter, the ascendancy of financial markets, and the freedom of movements of people and economic resources across national borders marked a radically new eco-system rendering most of the pre-1990s criteria for viability obsolete. This shift can best be captured by the changes in the global and national regulatory systems governing national, regional and global economic coordination frameworks, and their complex sets of inter-relationships.

2.1 Perspectives on viability

There are five key perspectives from which the viability of national systems of innovation may be viewed. These perspectives are strongly linked in complex multi-directional sets of causalities and may be seen as the different layers, or strata, forming the foundation, albeit an ever shifting one, for the national system of innovation and defining its unique identity. These strata are the predominant accumulation regime, the nature of governance, the range and depth of the national human capabilities stock, the base and structure of the national economy, and the national system of science and technology. While these strata are permeable, their ordering does reflect levels of primacy in the shaping of the national system of innovation, and hence the levels at which its viability may be assessed.

From a *régulation* school approach[2] the accumulation regime forms the base of the national system of innovation in its broad interpretation. The possibilities for the viability of a particular system of innovation may therefore be found at inception in the analysis of its predominant accumulation regime. This defines the modes of regulation which determine the governance system, the formation and deployment of human capabilities, the national economic base, and the specificities of the national system of science and technology within the broader political economy.

In the case of the accumulation regimes of advanced capitalist and emerging economies, Kim (2007) introduces the concept of the knowledge-led accumulation regime in addition to the

[2] See Boyer and Saillard (1995) for a comprehensive review of the *régulation* school and accumulation regime theory. For an early exploration of the perspectives of *régulation* theory on technology, see Boyer (1988).

globally dominant finance-led accumulation regime (Chesnais, 2017) as the two main evolutionary paths of the post-Fordist era. The finance-led regime is the outcome of a systemic shift to a neoliberal ideology and the political choices emanating from that. The knowledge-led regime is strongly contingent on a high level of investment in knowledge and learning, and the intensity and spread of the knowledge base of workers. In the knowledge-led accumulation regime, the capital-labour relations established under Fordism which entrenched a strong element of stability in the political economy transmute into the relationship between knowledge capital and knowledge labour which holds the possibility of a new form of stability. By contrast, the stability of national economies has been severely compromised within finance-led accumulation regimes, with the destruction of organised labour, the liberalisation of labour market legislation, and the entrenched and growing inequality of income, wealth and life chances. These two accumulation regimes are not mutually exclusive, and they are to some extent interlinked within all systems of innovation. However, specific systems, both national and supra-national, and in some cases sub-national, can be characterised by the predominance of one accumulation regime over the other which determines the dominant mode of regulation. The mix of accumulation regimes is further complicated by the endurance of a new globalised Fordist accumulation regime which has been especially prominent in emerging economies such as China and India.[3]

In the case of those ex-colonised states where the new national bourgeoisie (see Fanon, 1962) emerging in newly independent countries continues to draw rent from the role of gatekeeper between global capitalism and local resources, the accumulation regime may be represented as a 'dependency-led' regime. In certain parts of the postcolonial world, notably in Africa, the base of this type of accumulation regime evolved into increasingly complex strategies of extraversion[4], locking national systems of innovation into a *cul-de-sac* defined by a combination of dependence on diverse flows of foreign funding, poor infrastructure, resource-based economies and a narrow base of human capabilities. In the case of crisis-ridden states these conditions are exacerbated by conflict and a state whose sovereignty is in jeopardy.

Different accumulation regimes are generally associated with distinct forms of power and control which manifest in specific governance systems and this holds significant implications for the long-term stability of the national system of innovation. Generally, the type of governance system which prevails in the national system of innovation tends to be closely related to the nature of the accumulation regime. Those associated with mature and emerging capitalist economies tend to exhibit participatory or permissive social contracts and a strong state monopoly on violence (in a Weberian sense). On the other hand, 'dependency-led' regimes tend to have a more coercive social contract with a weak state monopoly on violence which often lacks legitimacy.[5] At the most basic level, the stability of the state depends on the legitimacy of its security. This is in question when there is an external threat such as armed incursion from a foreign power or an internal challenge

[3] See, for example, Jha and Chakraborty (2014) and Lüthje (2014).

[4] Bayart (2000: 222) defines the strategy of extraversion generally as the 'creation and capture of a rent generated by dependency'. This rent can be derived through several avenues, such as concession holding on natural resources extracted by foreign corporations, donor funding and humanitarian aid, strategically directed military aid, or remittances from nationals working abroad.

[5] See Nugent (2010) for an elaboration on coercive, permissive and participatory social contracts.

to legitimacy through internal conflict and civil war. At a less critical level, the ability of the state to maintain its monopoly on legitimate physical violence (Weber, 1921) and symbolic violence (Bourdieu, 2014) is essential to the stability of its internal transactional activities. Finally, the relationship between state and capital, which is closely linked to the type of accumulation regime, shapes the distribution of income, wealth and life chances with a direct bearing on the formation of human capabilities.

Human capabilities are at the core of systems of innovation, providing the base for the learning economy and largely determining the systemic capacity for growth and development. The main issue of concern in assessing the viability of systems of innovation is the breadth and depth of the human capabilities base, and the requirements for its sustainability and growth over time. Human capabilities are here interpreted in Sen's (1999) sense as the achievement of individual and collective human potential. This interpretation of the human factor from a political economy perspective ranges considerably beyond the acquisition of tradeable skills through education which forms the core of human capital theory[6] and is essentially antithetical to its neoclassical/neoliberal foundation.[7] The formation of human capabilities is primarily grounded in social relations and is inextricably bound by institutionalise inequalities of life opportunities, whether defined by class, gender, ethnicity (in its diverse manifestations), disability or location. The formation of human capabilities is therefore a multidimensional process, encompassing a wide range of the social and material conditions of life of the population, as well as education. This process is closely associated with the nature of the predominant accumulation regime. Knowledge-led accumulation regimes by definition rely heavily on a broad and rapidly learning human capabilities base, while this requirement is less pronounced in the case of finance-led accumulation regimes. The mode of regulation required to support dependency-led accumulation regimes, which is generally grounded in diverse strategies of extraversion for its survival, does not require a broad human capabilities base for its endurance. The structural lack of absorptive capacity for human capabilities in such regimes is commonly the primary systemic cause of the skills drain. One proxy measure of the national capability to nurture and retain human capabilities for a learning economy would be the incidence of precarious life (Standing, 2011) within the population. The formation of human capabilities is a long term investment starting with the material and social conditions of life of the family that a child is born to through to its eventual entry into the workplace. It is an investment whose integrity has to be guaranteed, by means which can rarely be private, so as to ensure a secure planning time horizon of more than two decades. Precarious life has been the norm in most of the developing world since the Second World War and its mitigation has been the hallmark of the successful development stories of Japan and the Asian Tigers. Its relatively recent emergence as a structural feature in the historical heartland of capitalism marks a radical shift in the nature of global capitalism with portentous implication for the development of human capabilities and hence the evolutionary paths of national systems of innovation across the globe.

The other level is the economic base of the national system of innovation. The main consideration here is the level of diversification across economic sectors and the location of the economy in global value chains. These defining features of the national economic base are strongly linked to

[6] See Mincer (1958), Schultz (1961) and Becker (1962) for the foundation of human capital theory.

[7] See Bowles and Gintis (1975) for a class based critique of human capital theory.

the dominant accumulation regime and its concomitant conditions for the development and deployment of human capabilities. Knowledge-led accumulation regimes by definition require a strong and growing broad human capabilities base and this is linked to the diversified economy which operates at high levels in global value chains. Finance dominated accumulation regimes tend to be less reliant on a broad human capabilities base and have often sacrificed a diversified economic base, sometimes with de-industrialisation, in the focus on the financial services sector. One of the main characteristics of the dependency-led regimes is a low absorptive capacity for local labour and human capabilities. The main consequences of this are a significant brains and skills drain and the preponderance of the informal economy as a means for the survival of the majority of the population. These regimes are often characterised by resource-dependent economies which have failed to diversify successfully. In their engagement with the global economy, these economies fall squarely within the List (1841) and Prebisch-Singer (Prebisch, 1950; Singer, 1950) categorisation of the impoverishing relationship of trade between resource-based and industrialised economies.

The system of science and technology, encompassing the science and technology sub-sector and the production sub-sector (Cassiolato and Lastres, 2008), and the linkages between them, again depends on the dominant accumulation regime. The main considerations here are the sophistication of the science and technology system in the design and implementation of science, technology and innovation policy, and its inclusiveness. The national system of science and technology may be measured by the standard research and development (R&D) and innovation surveys, which portray the intensity and spread of R&D inputs and activity.

As far as inclusivity is concerned, we may look at the basic model for the interaction of various agents in the planning of the national system is the triple helix model developed by Etzkowitz and Leydesdorff (2000) and Leydesdorff (2005). The triple-helix was eventually reformulated as open-ended which opened up the possibility of participation 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 the possibility 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. In the post-eighties global hegemony of neoliberal economics this antagonism has led to the virtual demise of organised labour across a large part of the world. 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 in the case of Denmark). These provide an actual example, not merely a theoretical possibility, of extending the helix to the sextuple level. The inclusivity of the system of science and technology may also be assessed through the lens of the 'innovation dance' metaphor developed in Kuhlmann et al (2010) and Kuhlmann and Ordóňez-Matamoros (2017) by extending the number of 'dancing partners' in the determination and implementation of innovation policy.

Table 1: Stratification of the national system of innovation

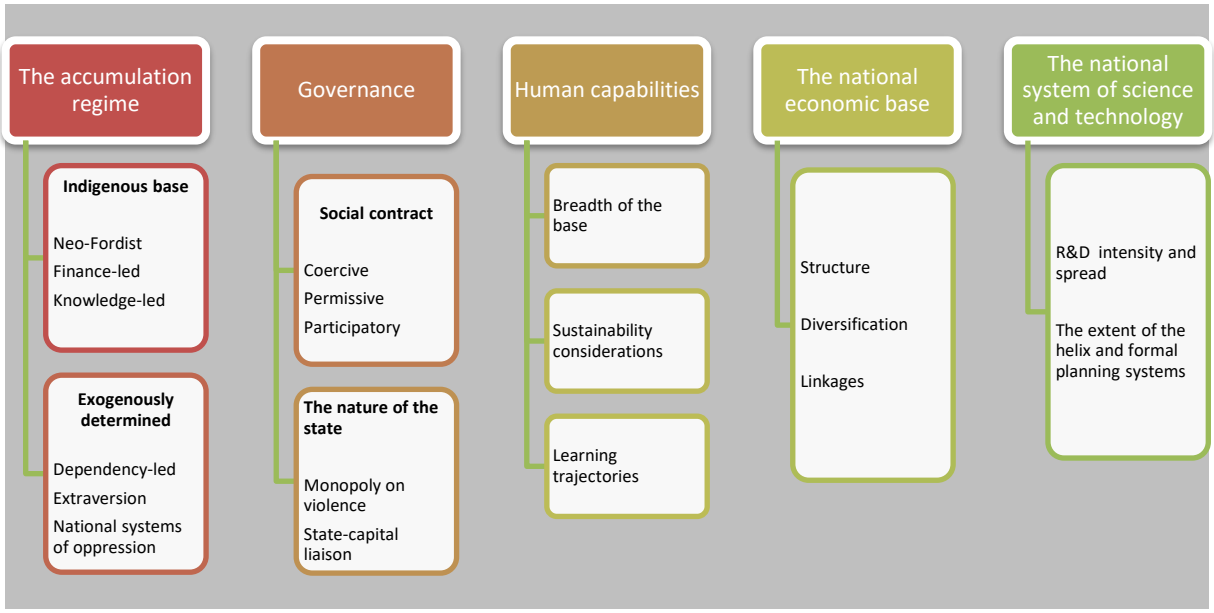

Table 2 depicts the different levels of perspective from which the national system of innovation may be characterised, and its viability assessed. The relationships between these different levels are complex, with a multitude of feedback effects reinforcing and disrupting evolutionary paths. We can however assign levels of formation of the system, hence the adoption of the term 'strata'. From this vantage point we can see the accumulation regime and the nature of governance as co-formative of the other aspects of the national system of innovation. The human capabilities perspective is closely linked to these two and helps form the system of innovation and direct its evolutionary path, which is reflected in the structure and development of the national economy. The form and the participatory level of the national system of science and technology is itself a manifestation of different combinations of the other aspects of the system of innovation in the different strata.

This framework allows a considerable degree of flexibility in the grasping of the national system of innovation from a general political economy outlook. The different aspects of the foundation levels of the accumulation regime and the system of governance may be combined in a variety of configurations which can accommodate a wide range of historical developments of systems of innovation. This range is widened further when the other three strata are incorporated in this approach towards the classification of specific national systems of innovation into viability categories; while wide, these categories will enable a degree of comparability across systems.

2.2 Categories of viability

From within the framework outlined in the previous section, we can look at the viability of national systems of innovation on three broad levels. The first level is where the ability of a specific 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 the 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 infrequently, as an innovation leader which alters the global or regional system of innovation.

In the case of national systems, as already discussed, 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 the economy's capacity for sustainability. 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 cusp between viable and fragile systems is generally determined by issues of governance, poor macroeconomic performance, low human development indicators, persistent inequality and an enduring poverty trap. Typically, these systems tend to be grounded in dependency-led accumulation regimes, reliant on diverse forms of extraversion for their survival.

The viable category is 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 be characterised by 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. The range of accumulation regimes in the case of this category range through dependency-led regimes with varying degrees of dependence and a reliance on extraversion strategies, to neo-Fordist accumulation regimes, and combinations of the two. 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 it is these capabilities which render 'higher end' viability prospects incompatible with enduring poverty, inequality and generally low levels of broad based human development.

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. Of course, most systems are constantly evolving to some degree or other but the transition from the viable category to that of evolving systems requires notable areas of core competence in specific aspects of the national system of innovation, replicable across regional or global contexts, and core competences which can be both science and technology based and institutional. The relationship between the lead areas of the national system of innovation and the stability of its base determines its evolutionary potential of systems of innovation. Typically, these systems would be embedded in knowledge-led accumulation regimes.

Table 2: Viability possibilities of national systems of innovation

Viability	Conditions	Characteristics
Fragile	Uncertain integrity and legitimacy of the sovereign nation state	1. Conflict: civil war, invasion, terrorism 2. Predatory state 3. Highly unstable macroeconomic conditions 4. Reliance on donor funding
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. Sustainable or growing human capabilities base 3. Absorptive capacity for innovation 4. Formulated science, technology and innovation plans
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

Table 2 depicts the three broad category levels in terms of their basic defining conditions and their underlying characteristics, which may be used to locate 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 broader version of the national system of innovation approach rests on an expanded concept of innovation which extends beyond technological change to alterations in the coordination of economic activity which, within a specified context, may be 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 that shape the broadly defined national system of innovation and determine its development potential are broad based human capabilities formation, and governance and stability.

The broader perspective on the national system of innovation is captured by indicators of sound governance, human development indicators, and indicators of economic stability and growth. A number of commonly applicable indicators may be used to represent the various aspects of the viability categories and compare them across national systems. Political stability may be

represented by the Fragile States Index and its various sub-components, the Governance Index, as well as the Corruption Perceptions Index. The state of the human capabilities base may be captured by Human Development Index, while poverty and inequality indicators may be used as indicators of the degree of inclusivity in the economy. The economic base may be represented by the degree of spread of economic output across sectors and by the performance of standard macroeconomic indicators. General economic sustainability conditions may be indicated by a combination of standard macroeconomic indicators and dependency markers such as reliance on overseas development assistance.

While these groups of indicators may be used as proxies for various aspects of the broad national system of innovation, there are more specific indicators which can represent the national system of science and technology. Standard R&D activity indicators can be complemented by the Knowledge Economy Index and the Global Innovation Index, along with their range of sub-indices to provide a comprehensive coverage of the science, technology and innovation sector. The shape and evolutionary path of the system of science and technology may further be assessed by looking at the inclusiveness of its planning and implementation through an assessment of its level of engagement, effectively moving from the triple to the quadruple, quintuple and sextuple helixes.

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 comprehensive country by country analysis considerably beyond the scope of this essay. However, viability classes may be broadly sketched out, as presented in Table 2, to offer an initial set of taxonomic parameters within which different national systems of innovation may be placed. The viability categories depicted in Table 2 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 and comparative studies.

The modern post-empire state is a historically recent phenomenon whose essence and rationale are constantly undergoing questioning and reformulation in the light of unfolding geopolitical transformations, especially since the dissolution of the Soviet Union and the emergence of the pos-1980s world order. If the nature of the state is under question, then so is the significance and centrality of the national system of innovation.

3. The viability of systems of innovation at other levels of aggregation

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. Local specificities have increasingly become a significant factor in the placement of particular national systems in relation to others, with a concomitant corrosion of the constraints of legally defined national borders. 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. At the same time, the importance assigned to specificity in the systems of innovation approach leads to an examination of the internal structural integrity of national systems of innovation, as intra-system specificities are considered. This consideration of sub-national systems of innovation and their viability within the context of the national system would enable a comprehensive understanding of the alignment of evolutionary paths within the national system of innovation. Given path dependence and cumulative development over time, the assessment of intra-system tendencies towards convergence or divergence should strongly enhance the appraisal of the viability prospects of national systems of innovation.

In their review of the prospects for an EU system of innovation Gregersen and Johnson (1997) concluded that while a system on innovation in the narrower sense of the establishment of trans-state STI institutions, as well as other broader EU economic regulatory and juridical institutions, was forming and could be envisaged, the outlook for the emergence of an EU system of innovation from a broader perspective was still quite dim. The broader perspective on the national system of innovation is based on the culture underpinning the learning economy and Gregersen and Johnson (ibid: 434) identify this as 'the demand for clothes, housing, leisure products, welfare service, and so on are a basic ingredient in what we, in everyday language, call national cultures and tradition'. This definition of culture omits an explicit reference to ideology, those commonly held belief systems which underpin nationalisms at various levels. Gellner (1983: 7) tentatively defines culture whose common sharing defines a nation as '…a system of ideas and signs and associations and ways of behaving and communicating'. Gellner's other condition for the existence of a nation is that its members recognise themselves as such; territorial location is not a sufficient, or even a necessary, condition. There is moreover no necessary congruence between the nation and the state, whether current or in their emergence. Nations as imagined communities (Andersen, 1991) have grown without states, with states, within states, and increasingly sharing intra-state space. The relationship between state and nation in history is indeterminate, with the emergence of the state often forming nationalism, through a forced suppression and submersion of ethnic and cultural identities, more often that the other way round (Hobsbawm, 1990). This factor has considerable implications for the survival of the national system of innovation since an internal convergence of the evolutionary paths of the local systems of innovation which are constituent of the national system is a core underlying presupposition of its viability. It is also proving to be, more than any other structural factor, the single most critical impediment to the transition to an EU wide system of innovation in the broad sense of the term, as evident in the exit of Britain from the union and the threats of rising nationalisms to its continued coherence. The deep seated reluctance to relinquish a significant degree of economic and political sovereignty is symptomatic of the tension between the regional and the national, but regional integration can also, by weakening national sovereignty, set the conditions for the re-emergence of sub-state nationalisms, further compromising the emerging regional system of innovation. National identity and nationalism thus constitute the sub-stratum, the bedrock, underlying the strata depicted in Table 1, as the formative foundation of the institutional base of systems of innovation. It is a fluid base, constantly reinventing itself and its claimed origins in response to, and causative of, shifts in the global, regional and national ecologies of systems.

3.1 Sub-national systems of innovation

The specific constitutions of local systems of innovation may be founded on a wide range of defining characteristics which form local formations of tacit knowledge. These characteristics are mostly defined by a combination of location and history which form habits, practices, inter-personal relations and belief systems. The wide range of defining characteristics poses various probabilities of intra-national system inequalities in the viability levels of local systems; as the set of identifying characteristics shifts further towards the bedrock of belief systems, the higher is the probability of destabilising divergences.

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, municipalities, provinces, and states, but a legal demarcation is not a sufficient, or even a necessary, condition for the existence of a local system of innovation. Intra-national legally defined jurisdictions may, and do, change and they 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.

Table 3: Viability possibilities of sub-national systems of innovation

Viability classes	Conditions	Characteristics
Non-viable	Lack of legitimacy of the legally defined local government	1. Corruption 2. Poor record of service delivery 3. Weak local economy
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
Evolving	Mutating institutional base of the local 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 local system of innovation

The viability of a local 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 local systems are those which show a stable, possibly growing, economy with the capacity to absorb labour and skills. The evolving 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 stability and indeed integrity of the national system of innovation depends critically on the reduction of inequalities among the constituent local systems of innovation. This requirement is significantly more binding where local systems are strongly identified with specific cultural and ethnic identities. From this perspective, the assessment of the viability of local systems of innovation should enable development and re-distributive policy aimed precisely at ensuring the continued integrity of the national system.

3.2 Supra-national systems of innovation

As has already been indicated, the discussion of the viability of regional (supra-national) systems of innovation has to revolve around the possibilities of their existence rather than the assessment of any current existing system. The obvious initial indication of the potential for the emergence of a regional system of innovation would be provided by the assessment of the viability of its constituent national systems. A high degree of variation in the viability of component systems would tend to pose a structural impediment to successful regional integration since significant differences in the characteristics of viability would tend to compromise the interface of systems and thus set up the conditions for uneven development within the emerging regional system. As with the arguments for successful customs unions and other types of economic integration, the conditions for successful transitions to regional systems of innovation would include structural commonalities and complementarities in the core competence sets of national systems. Broadly similar accumulation regimes and governance systems set the conditions for the development of a common economic and juridical base. Diversified and rapidly learning economies across the region enable the development of multiple specialisations and intra-regional system trade, reducing the potential for uneven development. While useful, this does not, on its own, offer a sufficient indication of the possibilities for a successful regional integration of systems. The successful integration of systems is premised on a willingness to cede economic and political sovereignty, eroding nationalism in the path towards a new wider trans-national imagined community and identity. This endeavour remains at the core of the integration process and its success depends critically on a demonstrable process of ongoing benefits, in terms of a sustainable improvement in the quality of life and life chances, to all citizens in the new political and economic space.

The viability of supra-national systems of innovation may be therefore be assessed from two primary perspectives. The first is the 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, and 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 main

issue here is the maintenance of even development and convergence across the regional system of innovation as the fundamental condition for success.

4. 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 comparative studies of systems of innovation which apply some general principles of evaluation across different systems.

The proposal of the notion of viability as presented in this essay hopefully gives an indication of its complexity in terms of the multiplicity of interrelated factors which enter into its assessment. Specific applications of this approach towards the evaluation of systems of innovation obviously require a full separate study and the framework for the evaluation of viability still requires considerable further elaboration. The policy inferences which may be drawn from this evaluation approach will also have to be on a case-specific basis, given the strong non-trivial historical idiosyncrasies which form specific case studies. That said, it is hoped that the exposition of this concept of the viability of systems and its capacity for evaluation has been sufficiently clear to lay the basis for future research in this area.

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