Innovation, Economic Development and Social Upliftment

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1. Introduction to the Problematic

It is now well established in the literature that innovation constitutes a key process underpinning economic change within capitalism. This broad consensus does not however imply that there is a single perspective that informs policy thinking on innovation. Rather what has been evidenced over the preceding decades is the emergence of diverse interpretations that however retain resonance with the general appreciation that "...a national system of innovation can only be judged as healthy if the knowledge, technologies, products and processes produced by the national system of science, engineering and technology have been converted into increased wealth, by industry and business, and into an improved quality of life for all members of society" (DACST, 1996: 18). Whilst the South African reading of the literature has attempted to draw together commercial and social interpretations, both streams have generally derived 'innovation' from the science and technology (S&T) sector of the economy (Scerri, 2009 and Maharajh, 2011).

This derivation typically represented S&T as the core component of 'the engine of growth' and thus, by proxy, the route to increased productivity and competitiveness. This caricature proceeded to argue normatively that an improved S&T sector would result from increased expenditure on research and development (R&D) and thereby indicate a prosperous economy. Within mainstream economics and its attendant planning framework, the S&T sector is generally viewed as an important but essentially exogenous component of the general

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economy. This fundamentalist orthodoxy remains largely embedded within the teaching of mainstream neo-classical economics.

In mainstream economic thinking, innovation is seen as an important determinant of the value added content of production which increases the competitiveness of firms and economies, leading to economic growth and therefore to an increase of overall societal welfare. This summary of the nature and direction of the posited causality, while highly simplified, is an honest representation of the core of orthodox thinking on the economic role of innovation. As we shall discuss below, this reasoning stems from the internal logic of mainstream economic theory.

The model for this perspective is the result of research that focused predominantly on the 34 more advanced; industrialised; and high-income capitalist economies that now constitute the Organisation for Economic Co-operation and Development[2] (OECD). The unevenness of global development has resulted in less developed (including fast emerging and significant middle income) economies only rarely considering innovation as a legitimate area for economic analysis and planning. With the emergence of the concept of national systems of innovation (NSI), which was eventually extended to the sub-national and supra-national systems, there emerged a shift towards a more integrated systemic approach to the understanding of the relationship between innovation, development and economic dynamics.

[2] Member states of the OECD with date of accession in brackets: Australia (1971); Austria (1961); Belgium (1961); Canada (1961); Chile (2010); Czech Republic (1995); Denmark (1961); Estonia (2010); Finland (1969); France (1961); Germany (1961); Greece (1961); Hungary (1996); Iceland (1961); Ireland (1961); Israel (2010); Italy (1962); Japan (1964); South Korea (1996); Luxembourg (1961); Mexico (1994); Netherlands (1961); New Zealand (1973); Norway (1961); Poland (1996); Portugal (1961); Slovakia (2000); Slovenia (2010); Spain (1961); Sweden (1961); Switzerland (1961); Turkey (1961); United Kingdom (1961); and the United States of America (1961).

The advent of NSI-thinking is closely correlated to the emergence of the school of evolutionary economics. Together, these two lines of research provide a valuable theoretical alternative to mainstream neoclassical economic theory which essentially treats technology as exogenously determined outside of the economic system and therefore cannot capture the dynamic elements of the relationship between technology, development and economic change. However, the system of innovation concept does not provide a clearly delineated and integrated body of theory. Rather it is an approach which is grounded in evolutionary (political) economy. As such it is subject to a wide range of interpretations and therein lies a serious problem for its translation into policy directions.

South Africa was one of the first countries to explicitly adopt the NSI concept in its formulation of the White Paper on Science and Technology in 1996 (Scerri, 2009, 2013; Maharajh, 2011). However the 2012 report of the Ministerial Review Committee on the National System of Innovation concluded that

> the country's efforts as a whole are insufficiently supporting a transition from strong reliance on a resource- and commodity-based economy to one that is characterised by value-adding and knowledge- intensive activities. This has implications for government's priorities in relation to employment creation and poverty alleviation (DST, 2012: 11-12).

To a large extent this failure in the design and implementation of an innovation policy framework which was appropriate for the achievement of the country's development goals can be attributed to a lack of clarity, and hence common understanding, of the specific version of the NSI concept which should inform policy. The scope of this study is to draw out the variations of the systems of innovation approach, classify them into broad categories,

discuss their various attributes specifically in terms of their suitability in a development context, and examine their policy implications.

The starting and end point of this exercise will be a questioning of the direction of causality, from innovation to economic development to social upliftment, in the proposed title. It is not simply that this complex chain of causality and co-evolutions are often poorly understood that is problematic. It is rather that, especially within a development context, the proposed single direction of causality is itself a deeply flawed basic premise which has compromised the design and effectiveness of innovation policy. The systems of innovation approach to planning has to be located within the broad context of economic planning which is still largely dominated, locally and globally, by orthodox economic theory grounded in a neoliberal/neoclassical paradigm. The fundamental theoretical rifts between these two schools of thought will be identified as will the areas of contradictions in policy formulation resulting from the simultaneous adoption of the two paradigms for planning purposes.

2. Mainstream Economics and the Systems of Innovation paradigm

The origins of the NSI concept lie in the work of the evolutionary school of economics[3]. The growing dissatisfaction with the explanatory power of the neoclassical analysis of the nature, sources and effects of economic change in the later part of the twentieth century brought this school back to the forefront of economic thinking (Hodgson, 2007) as part of the growing body of heterodox economics. Since the neoclassical paradigm still constitutes the dominating discourse in post-war economic theory, any other discourse which seeks to locate

3 The concept of a national system of production and innovation can be traced back to List (1841) as the basis of his counter argument to Adam Smith's position on free trade. In the late twentieth century its revival was first articulated specifically by Freeman (1987) and Lundvall (1992), but its antecedents are diffused across time and authors (see Maharajh, 2011; for further details). Nelson (1993) locates its origin in the contributions of a number of authors in Dosi et al. (1988).

itself within the discipline necessarily had to be constituted as a counter discourse. In the case of innovation this has been particularly wasteful since neoclassical theory was never designed to account for technological change, let alone innovation, except in a highly stylised fashion. The broadening of the definition of innovation beyond technological change to cover most of the sources of change further weakens the explanatory power of neoclassical economics since the institutional aspects of economic systems are taken as given and constant in this body of theory.

Neoclassical economics is essentially a static, and comparative static, analytical framework which, using an extremely high level of abstraction, aims at drawing out simple universal sets of normative guidelines for welfare maximisation. This school of thought is best exemplified in the general equilibrium model which, at the highest level of abstraction, models an entire economic system and the interactions among its sub-sectors. This mathematically articulated model, formed of sets of simultaneous equations, is fully deterministic and can yield unique solutions which indicate the norms for the constrained maximisation of welfare in an economy. The claim to universality that this model makes is anchored to stringent *a priori* assumptions regarding the universality of a uniform rationality informing optimising behaviour and decisions.

The classical foundations of the welfare implications of the neoclassical school may be traced to Adam Smith (1799), David Ricardo (1817) and Jean-Baptiste Say (1880). These economists laid the foundation for the self regulating, full employment, free trade model which, with Leon Walras's (1874-1877) mathematical formulation of the general equilibrium framework and Alfred Marshall's (1890) mathematical rendition of constrained optimisation for partial equilibrium analysis, essentially defines the perimeters of neoclassical economics.

The most famous rebuttal to the neoclassical model of full employment equilibrium was raised by John Maynard Keynes (1936) who, working within the general set of premises of the neoclassical model, showed how the macro-economy could settle at 'equilibrium' at less than full employment. This work, coming as it did during the Great Depression, invalidated the assumption of optimal markets and provided the policy framework for sustained state intervention which remained the norm in industrialised economies until the early eighties.

A lesser known, and earlier critique of Smith and Ricardo (and by implication of Say, Walras and Marshall) was Friedrich List (1841) who argued that Smith prescription of free trade could only be mutually beneficial to all trading countries if the economies of these countries were at a similar level of development and had similar production bases to start with. Where unequal levels of development exist free trade would reinforce inequality and 'lock in' underdevelopment in the weaker partner. The theoretical base of his argument is the earliest formulation of the NSI from an evolutionary perspective. His policy prescription was the 'infant industry' argument which advocates protectionism to allow an appropriate learning period for local industries to mature before being exposed to global competition.

This includes the area of technology and technological rationality which are treated as universally applicable and as equally available across time and space. The model also requires that the decision making environment is one of full and perfect information (the introduction of risk as probability values is an extension of certainty) which when combined with universal rationality enables unique solutions to be derived. In the case of technology these premises imply that while technological specifications obviously differ across industries

there is a necessary uniformity of technology across geographical and institutional boundaries.

The major influence on the evolutionary economics is the work of Joseph Schumpeter. Schumpeter integrated sociological understandings to his explanation of economic development and growth. According to Esben Sloth Andersen, Schumpeter sought "to establish an economic science in the broad sense which covers economic history, statistics, economic theory, and economic sociology" (Anderson, 1993: 3). In another seminal contribution to the literature, The Theory of Economic Development (1912, revised in 1934), Schumpeter established that a circular flow, excluding any innovations and innovative activities, leads to a stationary state which could be described as Walrasian equilibrium. In contrast, Schumpeter introduced his concept of the entrepreneur who as the maker of 'new combinations' would act as the driving force for the dynamic evolution of a capitalist economy[4].

The concept of 'creative destruction' is another major contribution to the literature from Schumpeter. In Capitalism, Socialism and Democracy (1942), Schumpeter defines the concept to denote a "process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one" (Schumpeter, 1942: 81). Anderson argues that it is through Schumpeter "upheld an opening toward a more comprehensive understanding of the evolutionary process by emphasising that his analysis did not only cover process innovation and product innovation

[4] The five new combinations described by Schumpeter were: 1) production of new types of goods, or change of properties of the existing goods; 2) introduction of the new method of production, that may be based on the new scientific discovery; 3) opening of a new market; 4) use of the new sources of raw materials and intermediate goods; 5) new organisation of production.

but also organisational innovation, the opening up of new geographical regions and innovation with respect to economic inputs" (Andersen, 2010: 10).

Joseph Schumpeter helped define for subsequent scholars, the role of technological and organisational innovation in driving and shaping the growth trajectory of capitalist economies (Solow, 2007). Notwithstanding these advances, technology and technological change continued to be treated as exogenous to the neoclassical general equilibrium model and optimisation models in general. However, the increased awareness of the role of technology in economic growth from the fifties onward led to attempts to endogenise technological change, especially in the analysis of firm behaviour within neoclassical theory.

Within the neoclassical framework, the factors of production which underlie the economic system are land, labour and capital. Technology is basically seen as a given exogenous contextual element which determines the optimal allocations of these three factors. The origin of the growing concern of neoclassical economics with technology can perhaps be traced to Solow's (1956) estimation of the total factor productivity of the USA economy which threw up a substantial portion of productivity growth which could not be explained by the conventional inputs of capital and labour. Solow attributed this unexplained contribution to output growth to technology and since then neoclassical theorists have tried to render technological change endogenous to the paradigm.[5] Most of these attempts, especially since

5 The two areas of neoclassical economics where these efforts were most pronounced were the analysis of the firm's decision making (constrained optimisation) mechanism and the refinement of total factor productivity analysis through the extension of the production function to include technology as an input. In both cases there are serious theoretical and logical shortcomings. In the first place the full and perfect information requirement of constrained optimisation models strips the proposed analysis of technological change from its crucial characteristic, i.e. that it concerns the less than fully known or predictable. Moreover, the introduction of a variable representing technology as an input on the right hand side of the production function equation violates the logical basis of the neoclassical production function itself since technology is the fabric that defines and determines production relations and cannot therefore be included as a variable. Within the neoclassical formulation, technological change requires a re-specification of the production function, a redrawing of the isoquant map, and cannot therefore itself constitute a part of the function or the map.

the seventies, boiled down to 'shaving the residual', i.e. trimming down the huge portion of economic growth which remained unexplained by conventional inputs. This project was further fuelled by the accelerating productivity and competitiveness of the Japanese economy at the time. 'Shaving the residual' essentially amounted to finding plausible determinants of output, other than the conventional inputs, quantifying them, and introducing them as explanatory variables in an extended national production function specification. The main sets of variables which were considered were education and technology. However, there are two related fundamental theoretical impediments to the ability of the neoclassical paradigm to incorporate technology in its modelling of the economy.

In the first place there is the requirement to translate theorised economic relationships into stochastic specifications for the purpose of econometric estimation. In the case of technology it is particularly difficult to capture quantitatively this highly heterogeneous 'product' in a uniform manner across economies. Patent data, as a measure of technology was used (see, for example, Schmookler, 1966) but was eventually generally abandoned as unsuitable as a macro measure of technology. Subsequently input data, such as R&D expenditure statistics, were used as a proxy measure for technological change. The attraction of this measure was that it apparently offered comparable uniform measures across countries and sectors over time. However, the problems with the usage of R&D statistics for modelling the role of technology in the economy were also acknowledged. These included under-reporting and the inability to capture innovative activity outside formal R&D laboratories; these factors tend to skew the representation of innovative activity across sectors and countries. A more problematic implicit assumption underlying the use of R&D data, an input measure, as a proxy measure for technological change is that the 'productivity' of R&D is taken as given and essentially unchanging. This relegates the analysis of innovative activity to a 'black box'

(see Rosenberg, 1982). This serious shortcoming was recognised by a number of mainstream economists (see Griliches, 1979, 1980a, 1980b and Griliches and Lichtenberg, 1984) who argued that the accumulated stock of knowledge is a major determining variable in the firm's decision on R&D expenditure and who tried to estimate these stocks as past streams of R&D expenditure liable to depreciation over time.

These attempts have however been severely constrained by the assumption of uniformity in neoclassical analysis which extends to institutions and institutional networks across contexts. Without this assumption, the predictive and prescriptive prowess stemming from the internal logic of the neoclassical approach would be severely compromised. This assumption does however badly impair the explanatory power of the paradigm with respect to the analysis of dynamics in general and of innovation in particular. In her comprehensive survey of game-theoretic models covering the timing of research activity, the licensing of innovations and their adoption and diffusion, Jennifer Reinganum (1989), herself a pioneer of game-theoretic modelling of innovation, concludes that such models are highly stylised and counter factual[6].

The more critical issue dogging neoclassical attempts to explain the role of technology and its determinants was the assumption of full and perfect information which is inescapable in neoclassical economics. This flies directly in the face of the essence of innovation in general and R&D programmes in particular which are only partially amenable to an actuarial estimation of probable outcomes and where ignorance is a non-trivial element of the decision making environment. The binding and restrictive effect of the premise of certainty based on the twin pillars of a full known decision space and a universal rationality is also starkly

6 Reinganum (1989: 905) states categorically that the game-theoretic model has

> "...not had a significant impact on the applied literature in industrial organisation; its usefulness for policy purposes should also be considered limited. For these purposes, one needs a predictive model which encompasses the full range of firm, industry and innovation characteristics."

evident in the analysis of institutions and institutional change. Orthodox economic theory has looked at institutions, their formation and their change in terms of their transactions cost reducing function.[7] From this perspective, institutions come into being when their cost reducing benefits outweigh the costs of their establishment and operation. Changes in these parameters will alter the nature and evolutionary paths of institutions. This highly reductionist account of institutional change is particularly damaging to the analysis of innovation when the notion of innovation is extended beyond technology and technological change.

The emergence of a systems approach to the study of innovation brought in a much richer, albeit a less elegant, account of the evolution of networks of institutions. A systems approach to the understanding of economic change allowed for specificities to emerge within a less than fully known and predictable world, thus opening up for the systematic study of differences, as well as the commonalities, among different economies. A less than fully specified model also allows for a richer analysis of multi-directional causality with, for example, the institutional web viewed as simultaneously determining and determined by the production of knowledge.[8] The direction of causality, from innovation, however that is defined, to development and finally social upliftment, also becomes less determinate and obvious once the extreme reductionism of orthodox economics is abandoned.

Evolutionary accounts of innovation focus on contextual contingencies as a core determinant of innovation and thus provide the basic foundation of the concept of national systems of

7 See Coase (1937) and North (1981). Johnson (1988) defines institutions terms as those

> "... sets of routines, rules, norms and laws, which by reducing the amount of information necessary for individual and collective action make society, and the reproduction of society, possible." (p. 280).

8 Simpson (1995) explains this dichotomy in terms of the tension between the autonomy of technology in terms of its internal logic which renders it potentially formative of human needs and technology as instrumental, i.e. as subservient to needs. In the latter aspect needs, which are mediated through social institutions, form the constraints on technological development paths, but needs are themselves affected by changing technological opportunities.

innovation. The adoption of the NSI approach brings in the specificities of individual systems to the study of the nature and effects of innovation, thus significantly reducing the capacity for generalisations, be they at the analytical or at the prescriptive level. Dosi (1991: 354) captures this succinctly when he says that

> "...evolutionary theories attempt to model economic systems rich in positive feedbacks (that is, self-reinforcing mechanisms such as dynamic increasing returns in innovation). Relatedly, such systems tend to exhibit non-linear dynamics and multiple dynamic paths, *also dependent on their history*." (emphasis added)

The evolutionary base of the NSI approach is quite central to its departure from mainstream economics. However, care must be taken not to equate the evolution metaphor developed by evolutionary economics with a vulgar pseudo-Darwinian 'survival of the fittest' version which has been adopted, at least implicitly, by neoliberal economists. Evolution, as it is used in NSI analysis is a systems development analysis with the acceptance of ignorance, contingency, partial success, dead ends and calamities as inescapable properties of the search and development paths.[9]

Evolutionary economics, unlike neoclassical theory, is plagued by the tension between the focus on specific cases of national development and the imperative to identify some underlying common principles governing the mutation of various innovation systems over

9 Dosi clearly specifies that manner in which the biological metaphor of evolution is applied to innovation theory:

> "... (the) economic and social environment affects technological development in two ways, first selecting the 'direction of mutation' (i.e. selecting the technological paradigm) and then selecting among mutations, in a more Darwinian manner (i.e. the *ex post* selection among 'Schumpeterian' trials and errors)." (Dosi, 1982: 156)
>
> "... 'evolutionary' does not imply a notion of necessary gradualism: it is also consistent with abrupt changes, instabilities, revolutions (even in biology, evolutionary theories allow for discontinuities). Moreover, an 'evolutionary' theory should not be merely equated to simple Darwinian metaphors on selection tournaments based on near-tautological criteria of differential fitness. ... in the social domain, evolution is certainly quite Lamarkian, involving both learning and selection." (Dosi, 1991: 354)

time. The search for commonalities is required especially for prescriptive purposes, but is prejudiced by the fundamental assumption of contingency which renders cross-national comparisons particularly problematic.

3. Variations within the General Systems of Innovation paradigm

Plausibly, the origin of the recent upsurge in the countervailing discourse on the economic role of innovation may be traced to Nelson and Winter's (1982) seminal text which put up an eloquent critique of the limitations of economic orthodoxy from within the internal logic of the neoclassical paradigm. This was the re-introduction of evolutionary economics close to the centre of the practice of the discipline and it opened the way to a volume of literature which brought the NSI concept to the fore not only in academia but also into the lexicon of policy makers globally (Maharajh, 2011). Dosi et al (1988) presented a volume of work which brought together an array of writers fleshing out the multifaceted approach that would constitute a strong heterodox contender to the mainstream account of economic dynamics. Lundvall (1992) and Nelson (1993) brought out collections of writing specifically on the NSI concept. Lundvall was especially important in the introduction of the concept of the 'learning' economy in preference to the commonly used one of the 'knowledge' economy.

From its conception, as early as List in the first half of the nineteenth century to its revival since the eighties the NSI concept has been prone to a wide range of interpretations. As a political economy school it can never present a clearly delineated deterministic 'model' of the economy, due to its abandonment of high levels of abstraction in its analysis of systems and its focus on the specific circumstances of individual cases. Its incorporation of the study of historical streams as path dependent cumulative development streams which mould the nature of specific NSIs further leads the systems of innovation approach away from the neatness and

apparent clarity of neoclassical economics. As already pointed out, the lack of an explicit articulation of the particular variation of the approach which is adopted can be disastrous for policy formulation. There have been numerous definitions of the NSI and the following are the more notable ones:

> " ..the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies." (Freeman, 1987)
>
> " .. the elements and relationships which interact in the production, diffusion and use of new, economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state." (Lundvall, 1992)
>
> "... a set of institutions whose interactions determine the innovative performance ... of national firms." (Nelson, 1993)
>
> " .. the national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country." (Patel and Pavitt, 1994)
>
> ".. that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies." (Metcalfe, 1995)

At the basic level, all of these definitions focus on institutions and inter-institutional relations as providing the fabric of the NSI within which innovation happens. The two main sources of variations in the interpretation of the NSI concept are (a) the type of activity and output which are seen as innovative and as an innovation, and (b) the nature of the institutions which are considered as relevant to the NSI. Therefore the determinant factors in the articulation of

the different versions are the basic constituents of the NSI – innovation and institutions. The different definitions of these two categories, in various combinations, yield a wide definitional spectrum of the NSI.

In the case of innovation, the common usage of the term tends to equate innovation with technology and technological change, as in the definitions of Freeman, Patel and Pavitt, and Metcalfe. The restriction of the term to technology excludes the analysis of all other forms of change which are therefore, at least implicitly, seen as contextual 'enablers' for innovation. An alternative approach is to consider as innovation all novel forms of organising economic activity which, within a specific context, are seen as preferable to existing forms. Lundvall expand the notion of innovation to 'economically useful knowledge', while Nelson talks broadly of 'innovative performance'. In an earlier work Nelson (1991) had made a strong case for the expansion of the concept of innovation to include organisational and institutional change when he proposed that the

> "... devising and learning to use effectively a significantly new organizational form involves much the same kind of uncertainty, experimental groping, and learning by making mistakes and correcting them, that marks technological innovation and invention. New modes of organisation are not simply 'chosen' when circumstances make them appropriate as neoclassical economists are wont to argue. They, like technologies, evolve in a manner that is foreseen only dimly." (Nelson, 1991: 351).

The other component area of the NSI concept which is open to a wide range of interpretations is the type of institutions which are to be considered as forming the system. At the formal level of organisations, the choice of institutions which should be considered as part of the NSI depends on the definition of innovation which is adopted and its perceived integration

with the economy. At the most restrictive level, the relevant institutions would be firms (with R&D laboratories), higher education institutions, independent research laboratories, and government agencies of science and technology. A widening of the range of institutions which are considered relevant would normally include government agencies in charge of industrial and trade policy, as well as firms without formal R&D laboratories. The other type of institutions which form part of the NSI are informal institutions which can be generally defined as established, but not codified, routines and practices which are accepted as a fundamental part of the governance of inter-personal relationships in society.

While formal institutions with explicit statutes and goal sets are often structurally identical across NSIs, the specific nature, which is historically determined, of individual NSIs is formed by the informal institutional context. It is this context which mediates the formal institutional structure and shapes its implicit form. Informal institutions are a product of history, are not codified, unlike laws and regulations, and are therefore difficult to locate. The main function of informal institutions is the conservation of social structures and formation but they also have (varying) degrees of adaptability in order to enable a successful evolution within a changing global environment. Johnson (1988) points to the ever present tension between the drive to conserve and the drive to adapt within any institution, formal and informal. A high degree of conservatism, while protecting entrenched values and norms, also renders institutions inflexible and vulnerable in a rapidly mutating global environment. At the same time too high a degree of adaptability would start dissolving the existent social fabric and generate possibly disastrous erosion of values and norms. Informal institutions can, and often are, also inimical to overall societal welfare and serve to enforce entrenched

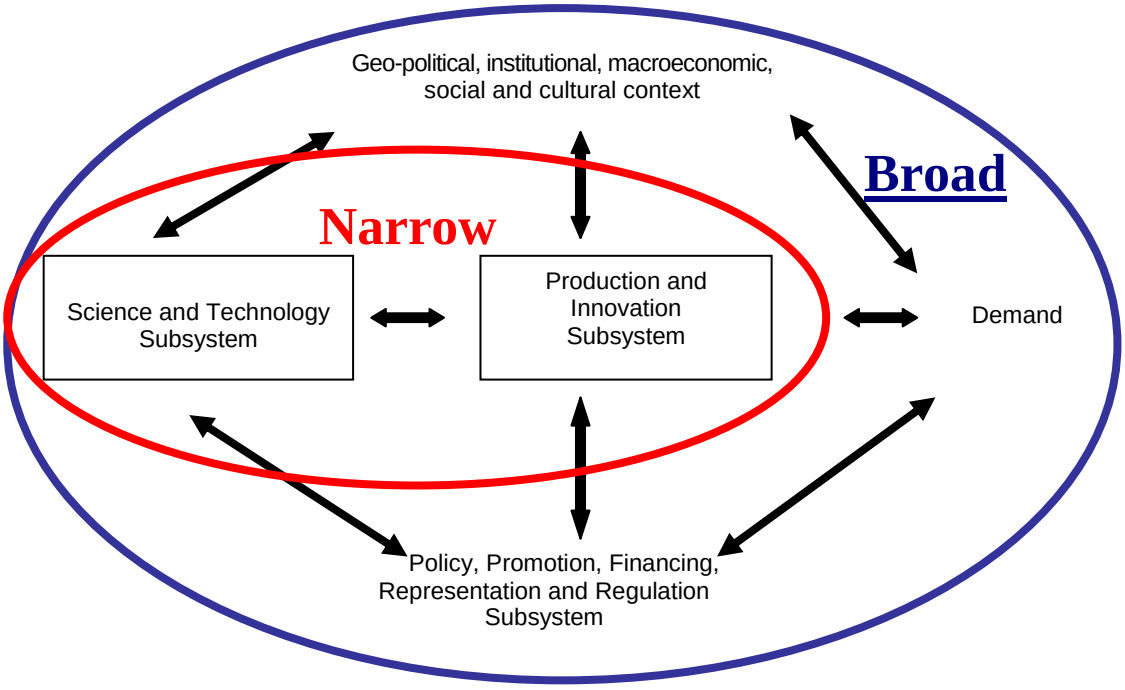
privilege. Structural inequality often co-evolves with innovation[10] while corruption in its various context specific manifestations is often an integral part of national and global[11] economies.

This brief discussion, of the various interpretations of innovation and of the institutional network within which innovation emerges, should give an idea of the wide array of interpretations of the NSI concept. The advent of the systems of innovation approach to the understanding of economic dynamics provided a badly needed theoretical alternative to the static mainstream body of economic theory. It has enabled a deeper and more comprehensive analysis of the role of innovation in the development of national economies. The variety of its interpretations is due to the theoretical richness of this approach but it is also possibly the major weakness of this approach, at both the analytical and the prescriptive levels. The numerous versions of the NSI approach can range from a narrow system of science and technology conceptualisation at one extreme to the NSI as an alternative account of the political economy of a country at the other. Figure 1 provides a succinct depiction of the interrelatedness of the various interpretation of the NSI approach.

[10] See Cozzens and Kaplinsky (2009) and Soares et al (2013) for literature on the co-evolution of innovation and inequality.

[11] The global financial crisis can be traced to a global financial markets and regulatory framework which have become institutionally entrenched and remain so in spite of their core role in the crisis.

Figure 1- The Narrow and the Broad Perspectives on NSI



Source: adapted from Cassiolato & Lastres 2008

The space contained by the red oval in Figure 1 depicts the narrow version of the NSI with the main interaction between the S&T subsystem, including all sources of S&T and promotion mechanisms, and the production and innovation subsystem, which covers output sector of the economy, and its specific structuring by sub-sector. The link between the two refers to diffusion pathways. All R&D surveys and most Innovation surveys implicitly take this version of the NSI as their object of analysis.[12] This may be called the National System of Science and Technology (NSST). The opening up to the broader perspective on the NSI allows the consideration of the relationship between the two sub systems within the NSST and the policy environment within broader economy which directly and indirectly affects innovative activity. It also brings in the role of demand in the overall nature and evolution of the NSI. A breakdown of the demand for innovations into the public sector, household consumption, the production sector, and export markets would provide an important indicator

[12] See Blankley et al (2006) for a critique of the OECD Innovation Survey methodology.

of the base of the specific NSI. The two ovals in Figure 1 should not of course be taken as two distinct options of viewing the NSI. They are rather the two poles of a range of perspectives on the NSI. Thus, as one moves out of the narrow perspective circumscribed by the red oval the NSI concept becomes progressively inclusive. When the limits of the broad version, circumscribed by the blue oval, are reached, then the NSI becomes indistinguishable from the national political economy.

We can therefore see a progression in the understanding of the placement of the NSI within the national political economy as we move from the narrow to the broader perspective. From the narrow perspective the NSI is normally conceived as a sub-sector of the economy, which may or may not exist, and which may or may not be integrated with the overall economy. As we move towards the broader interpretation of the NSI, we move towards an integration of the NSI with the national political economy and we see the NSI as an organic entity which exists as an integral part of the political economy. Conceivably, the broadest definition of the NSI can render the systems of innovation approach an alternative general theory of the political economy and the NSI thus becomes the national political economy.[13]

As we move to the broader version of the NSI other factors, including institutional, social and cultural elements, enter as determinants of the shape and evolution of the NSI. The broader version of this approach goes beyond the focus on the science and technology sector to incorporate institutions other than those directly related to science and technology. Rather, it focuses on the institutional formations which serve to translate innovation into sustainable economic growth and development. As the idea of the system of innovation broadens, so does the definition of innovation and consequently that of technological capabilities to reflect

[13] For an elaboration of this argument, see Scerri (2012b).

the capabilities base of the general population. As we move from an economic to a political economy approach to the understanding of systems of innovation we increasingly locate economic factors in a political, cultural and historical context. In the process the definition of institutions is also expanded to include informal institutions in the form of established routines and practices which implicitly govern, through established values and norms, interpersonal relationships within the societal fabric of specific political economies. This is where the analysis of the nature and evolution of national systems of innovation becomes increasingly context specific.

4. Systems of Innovation and the Capabilities literature

The one core factor which is identified by the NSI approach as crucial to the evolution of the NSI is human capabilities. However, the definition of relevant capabilities differs substantially among the different versions of the NSI approach. Conventionally, from the narrow perspective on the NSI analysts think of the determining human factor in terms of scientists, engineers and technologists. As the perspective of the NSI broadens, however, an increasing importance is placed on the technological capabilities, defined as the ability to generate, absorb, deploy and adapt innovations, of the labour force. This is normally interpreted as the country's skills base. Conventionally the human factor in the NSI is articulated as human capital, usually measured in terms of education indicators.

The origin of the currently commonly accepted definition of human capital lies in neoclassical economics which (see Schultz, 1971 and Becker, 1993) proposes that skills and knowledge embedded in human beings may be viewed as capital, in a manner equivalent to other forms of capital. From this perspective human capital can be analysed in terms of

investment flows, costs, depreciation rates, and the returns on investment. While its theoretical basis lies in neoclassical theory, the concept has been co-opted by neoliberal economics, and this poses theoretical and normative problems. The general equilibrium framework of neoclassical economics is a fully determined system which depends critically on the premise of fully specified objective and constraint functions in order to derive unique welfare maximisation solutions. The fundamental underlying assumption is that of full information governing the constrained optimisation decisions of economic agents (called consumers, producers, etc.) whose conceptualisation is a highly abstracted construct far removed from any real life counterparts.

Machlup (1967) warned against confusing the consumer or the firm in neoclassical theory with any real life equivalents. He was quite clear that these constructs were designed to trace changes in one market, under strict simplifying assumptions into effects in another market. This is where the 'as if' assumption comes into operation, where a body of positive economics and its normative implications are built on the basis of assumptions which are never meant to be realistic. This is the inherent contradiction of a theoretical framework whose sheer elegance and clarity of exposition render it a formidable pedagogic aid (see Scerri, 2008 and Scerri, 2012a) and simultaneously a poor empirical analytical instrument. The transition from the liberal economics of Adam Smith to modern neoliberal economics twinned with neoclassical theory constitutes the theoretical fallacy that Machlup warned about. The fact that neoclassical theory has no place for competitive behaviour (see Stigler, 1957 and McNulty, 1968) has been ignored in the pursuit of bestowing on neoliberal economics the mantle of scientific validity claimed by the mathematical exposition of the general equilibrium model.

The neoclassical formulation of human capital theory rests on the model of full information based decision making guided by a specific, highly restrictive, definition of rationality. The high level of abstraction which is fundamental to the neoclassical paradigm enables it to claim a universality of application which is independent of time and place. However, as soon as we relax the fundamental assumptions of a specific, asocial and universal, type of rationality, and that of full information, we are no longer working within the parameters of neoclassical economics. This implicitly invalidates the conflation of neoliberal economics with the neoclassical analytical framework which has evolved since the late seventies to buttress the translation of a *laisssez faire* ideology into policy. Schumpeter, and even Hayek and von Mises for that matter, held little regard for the analytical limitations of the general equilibrium model, while Becker derives his free market prescriptions from the constrained optimisation and marginal cost-benefit models of neoclassical economics.[14]

As applied by Becker (1993), human capital theory was co-opted to eliminate labour as a meaningful economic category with the proposition that human capital, accepted as equivalent to other forms of capital, implies that all are capitalists. This enabled Becker (1993: 16) to state that

> ...if capital exploits labour, does human capital exploit labour too – in other words, do some workers exploit other workers? ...are skilled workers and unskilled workers pitted against each other in the alleged class conflict between labour and capital?

[14] Chang (2001: 11) argues that "(n)eoliberalism emerged out of an 'unholy alliance' between neoclassical economics, which provided most of the analytical tools, and what may be called the Austrian-Libertarian tradition, which provided the underlying political and moral philosophy [Footnote in text: 'I say an .unholy alliance., because the gap between these two intellectual traditions is not a minor one, as those who are familiar with, for example, Hayek's scathing criticism of neoclassical economics would know (e.g., see essays in Hayek, 1949)]

in an attempt to eradicate labour as distinct analytical category in economics. The quotation from Becker uses the human capital concept to dismiss the validity of a Marxian theory of exploitation. Since, as it goes, only owners of capital can exploit labour and since some workers are also owners of human capital, we would end up with, for Becker, the apparently derisible conclusion that those workers who are skilled exploit those who are not. In fact this quotation stops short of carrying the argument through to the possible extreme of its logical absurdity. If all workers are assumed to own human capital, of course to varying degrees, then, as the argument would go, exploitation would require that workers, to various degrees depending on the amount of human capital they own, exploit themselves.

An alternative approach to the analysis of the human factor in economic systems may be found in the concept of technological capabilities which are at the core of the systems of innovation approach. Within the narrow version of the NSI the focus is on the relation between the science and technology (S&T) subsystem and the institutional mechanisms which translate the S&T output into commercially viable innovations. The human capabilities requirements for the functioning of this version of the NSI are scientists, engineers and technologists within formal R&D institutions, mostly embedded within the production sector, and the managerial capabilities to translate innovations into production. This translation itself requires certain levels of human capabilities within the work force on the shop floor for its success.

Technological capabilities are a manifestation of the human factor in economies and systems of innovation. This factor may be rendered in a restrictive and reductionist sense as the set of skills in a country's population. The introduction of the notion of capital when discussing the human factor in economic dynamics brought in considerations of time, investment, returns on

investment and depreciation. Most of the theoretical development of the human capital concept within the neoclassical paradigm has focused on the relationship between education and human capital development. The determination of education, and subsequent human capital formation, is treated as a standard constrained optimisation exercise for the family unit and the individual agent, while allowing for externalities and public goods. While Becker (1993: Ch 2) considered factors other than education, such as health, values and non-monetary returns in terms of the aesthetic quality of life, as determinants of human capital formation, he still formulated the process within a broad marginal cost-benefit analysis framework. It was Sen (1999) who advanced the concept of human capabilities as a more general set within which the neoclassical version of human capital lies. He does not however enter into the essentially ideological basis of the neoclassical/Marxian contestation on human capital.

Bowles and Gintis (1975) acknowledge that human capital theory had enriched neoclassical analysis by bringing in social institutions as important determinants of the supply of labour and enabling the analysis to allow for the differentiation of labour. Their critique of the neoclassical articulation of human capital theory rests on the implicit and explicit equivalence between human and other more conventional types of capital. In the process the issue of power and class formation had been excluded from economic analysis. In its equivalence with other forms of capital in neoclassical human capital theory, labour has been commodified as a tradable commodity along with other inputs into a production process which in a neoclassical world is itself completely removed from a social, political and historical context.

The placement of human capabilities at the core of the broadly defined national system of innovation requires that we adopt a version of the concept which anchors the formation of human capabilities as a process within specific social formations and orderings. With the introduction of specificity we would then have to entertain the possibility of appropriate human capabilities. As with knowledge, certain categories of skills and competencies are codified and hence universal across contexts. The engineering competencies to build bridges are of this type, as is the technique required for arc welding. These are those competencies ranging from the higher SET tiers to basic skills, which are transferable regardless of context. However there are other sets of capabilities, relating to broader problem solving and problem formulation, which are nurtured and formed in particular social contexts, and are largely tacit and 'sticky'. These capabilities form the learning and conceptualisation framework for the formation of more explicit codified competencies acquisition, usually through formal education.

The formation of implicit tacit capabilities is usually value and ideology laden and the formation process is normally informal and tied into various socialisation and internalisation processes. It is also inevitably tied to power/knowledge configurations and class structures. Normally this component of human capacities formation serves to reinforce established social and political power configurations. Bowles and Gintis (1975: 77) argue that

> (t)he allocation of workers ... and the definition of 'productive' worker attributes simply cannot be derived, as the human capital theorists would have it, from a market-mediated matching of technically defined skills with technically defined production requirements. Issues of power, and ultimately of class, enter on a rather fundamental level.

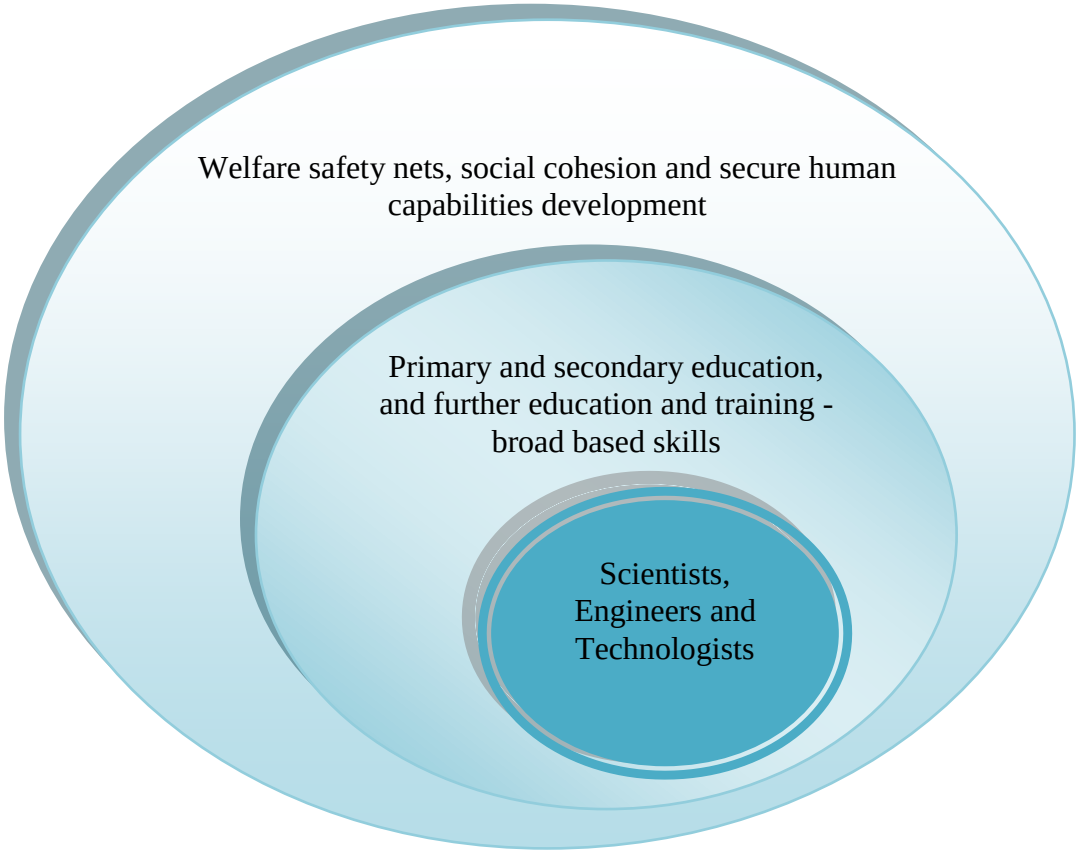
The supply of human capital, through education, is similarly grounded in the prevalent structures of capitalist domination specific to a particular political economy. Marxian analysis rejects the individual, or household, rational constrained optimisation choice model of the supply of human capital. Bowles and Gintis (1975: 78) dismiss individual choice as a case of 'misplaced emphasis' (see Scerri, 2008) where a true axiom is largely irrelevant as an explanation when set against other more weighty explanations of the formation of human capabilities. Bowles and Gintis also caution against the assumption inherent in neoclassical human capital theory that skills and competencies are homogeneous. Not only *what* is taught but *how* it is taught vary according to class, race, ethnicity and gender. Power configurations along these lines help explain the path dependence of systems and bring to the fore the role of an extra market agent, such as the state, normally as a reinforcing factor but also occasionally, in the case of historic ruptures, as a possible disruptive force in the established order of power.

The systems of innovation account of the political economy, with its emphasis on knowledge and learning as the base of all economic activity, brings in the human factor as a core element of the NSI. The availability of indigenous skills, the ability to generate them and absorb them, is often one of the main challenges faced by developing economies. However, foregoing discussion should indicate that the provision of appropriate capabilities is not simply a function of education, even less that of tertiary education as is often the case in the analyses of NSIs and their innovation potential. The supply and impact of scientists, engineers and technologists within the NSI is strongly dependent on the strength of the primary and secondary education sector for two reasons. In the first place this sector provides the through feed for the post school education sector and the size and quality of the tertiary education sector depends crucially on that of pre-university education. Secondly, as

mentioned earlier, the absorption of innovation at the national productive level depends on the broad based technological capabilities of the labour force. In the absence of this factor, the impact of a small complement of higher end capabilities on the evolutionary part of the NSI would be severely constrained.

However, again following from the earlier argument, the provision of broad based human capabilities is not simply a function of education. Education itself is rooted in a specific historically determined social and economic context and its effectiveness in skilling a population is strongly contingent on the nature of this context. If one were to conceive of the human capabilities pipeline whose outlet is the provision of highly skilled citizens, then the commencement of this pipeline should be sought even before the birth of a child in the social and material conditions of life of the representative family unit. The secure provision of basic needs (nutrition, energy, water, health, shelter and safety) and pre-school education facilities, as well a stable societal context would ensure an effective and assured lifelong learning process which is at the heart of human capabilities formation.

Figure 2: The layers of human capabilities provision



These relationships may be visualised as layers in a topographical map, as depicted in Figure 2, rather than the linear progression implied by the 'pipeline' analogy. Here the provision of high end capabilities is premised on a sound pre-tertiary education, not only in terms of the supply chain but also in providing the technological capabilities base for the system wide absorption of innovation. Without this base, not only will the supply of higher end capabilities be limited but their absorption will also be compromised because of the constraints on the production base of the economy imposed by the low availability of technological capabilities. Furthermore these two layers are placed on a wide base of complex societal relationships which may be loosely captured as versions of the social contract, where in various specific forms there exist explicit and implicit sets of agreements and guarantees for secure livelihood engendered by combinations of various components of civil society, the state, labour federations and the private sector. This is the base that can

secure the long term national investment in human capabilities development and it is a breakdown at this level that would compromise the entire supply chain of capabilities in the NSI.

Once this understanding of the source of human capabilities is adopted, then the direction of causality from innovation to economic development to social upliftment comes into question. From the perspective of mainstream economics the elements which enter into the base foundation layer of the human capabilities formation process, which essentially amount to the assurance of a minimum quality of life (or alternatively addressed by the Millennium Development Goals) are normally seen as the outcome of economic growth and development which may to some extent be attributed to innovation. From the broad perspective on the NSI the provision of all the elements at the foundation level of human capabilities formation are the instruments of the growth and long term development of the NSI which, again from the broadest perspective, approaches an increasing degree of equivalence to the national political economy.

5. Policy Implications of Innovation, Development and Upliftment

The multiplicity of interpretations of the NSI concept obviously yields a wide range of possible policy scenarios, specifically in terms of what should be included and excluded as a legitimate area of innovation policy. Again, the discussion on innovation policy will have to be set within the context of economic orthodoxy which sees the NSI as a subsector of the general economy and innovation policy consequently as a usually minor part of the macroeconomic policy framework. It can be argued (see Scerri, 2006) that this approach may be suitable for industrialised economies where the institutional framework for innovation can be assumed to be in place and reasonably efficient. Even in the case of industrialised

economies, however, there is an increasing emphasis on the broader approach to innovation policy, ranging considerably beyond conventional science, technology and innovation (STI) policy, as may be seen from the taxonomy of innovation policy proposed by the OECD (2005) and presented here as Table 1.

The first row in this taxonomy of innovation policies stems from the narrow interpretation of the NSI and represents the standard elements of STI policies which address the S&T subsystem and the production and innovation subsystem depicted in Figure 1. The second row in Table 1 extends innovation policies somewhat into the broader perspective on the NSI with a consideration of innovation in areas, other than the directly productive sectors, which affect social welfare and areas with a high public good content.

Table 1: A taxonomy of innovation policy

Goals	Sectoral Innovation Policy	Multi-sectoral Innovation Policy
Innovation policy, i.e. aimed primarily at innovating industries and economic growth	Innovation policy in a limited sense (basically technology and industrial policies	Integrated STI policies
Innovation policy in a wider sense, i.e. aimed at economic growth and quality of life	Innovation policies in other sectoral domains, e.g. innovation policies innovation policies in health, innovation policies in the environment	Horizontal/comprehensive/integrated or coherent/systematic innovation policies

Source: OECD (2005: 22)

In the case of developing economies the requirement for a broader perspective on the NSI and for innovation policy to be designed on this basis is significantly stronger. Development planning is, at least implicitly, premised on the understanding that current institutional structures are ill suited to the development needs of the country and that an often radical process of structural transformation is required. In this case the conceptualisation of the NSI from the narrower perspective becomes dangerously misleading, resulting in policy

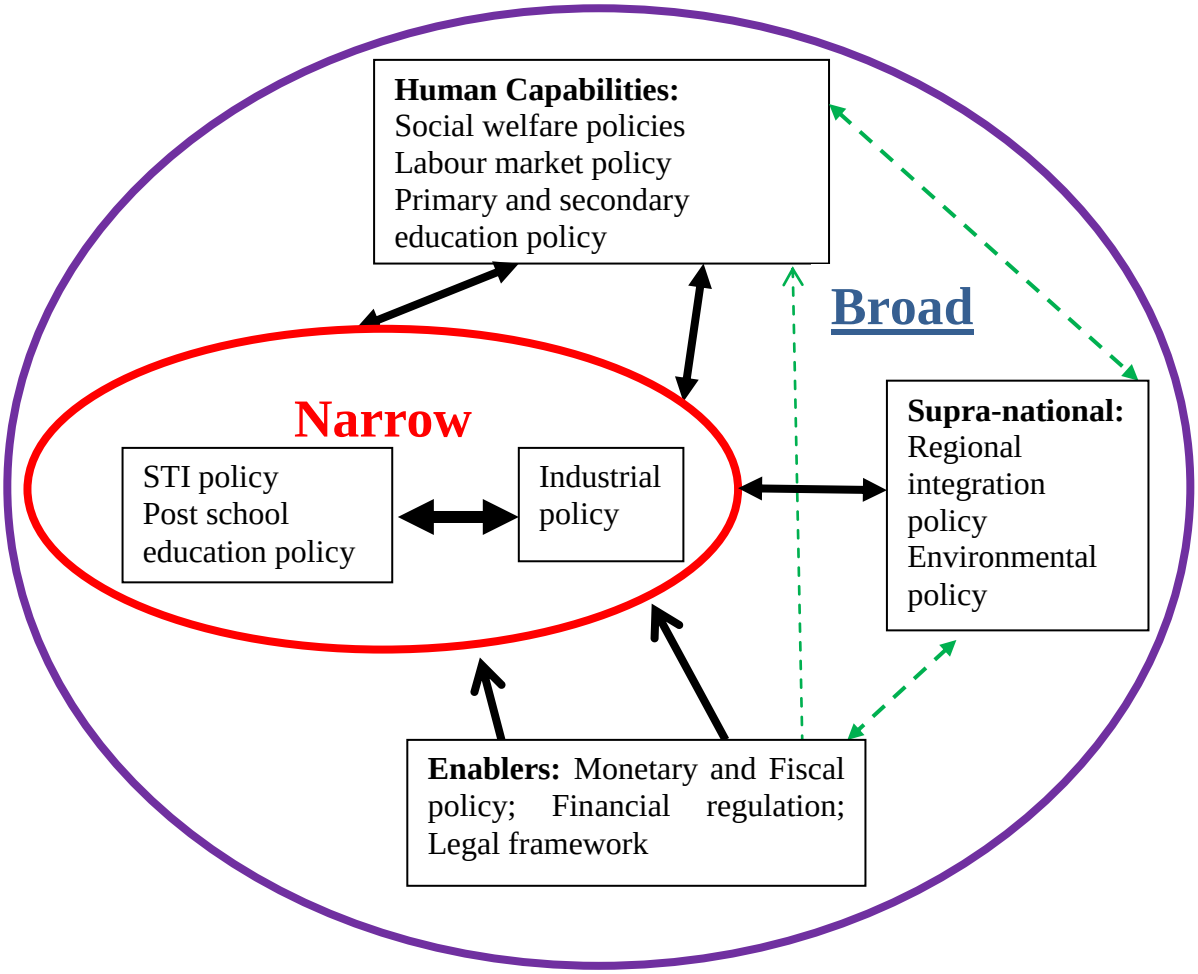
fragmentation. It is therefore important to map out the policy implications of the different versions of the NSI concept, covering primarily issues of policy integration and the ambit of innovation policy. From this exercise we can derive some conclusions on the relationship between innovation policy and development planning. The two main areas which we have to look at therefore are the policy implications of the general systems of innovation approach compared to those of mainstream economic theory, and the policy implications of the contending versions of the NSI approach, specifically in a developing economy context. As already indicated the range of which elements of the development policy environment are adopted as relevant to the NSI is considerably wide and depends on the choice of a specific definition of the NSI; this is why clarity is so critical to policy design emanating from a grouping of various, and often competing, stakeholders such as the state cabinet. Clarity is perhaps more important than the actual choice of the NSI version since a lack of clarity often causes an effective breakdown of communication among stakeholders who may commonly use the NSI term in devising policy but who have significant differences in their understanding of the concept.

Should the narrow definition be adopted then it is possible to conceive of the non-existence of the NSI unless it is planned and implemented. State policy in this case would be to decide on the minimum critical conditions required for the NSI to come into existence, to create such conditions, and to ensure that this sub-sector of the overall economy is sufficiently linked into the economic system so as to act as a catalyst for economic growth and development. As we move towards the broader definition the possibility of the non-existence of the NSI disappears and this system is seen to exist, whether planned or unplanned, as long as the legal integrity of the state is inviolate. Thus, except in extreme cases such as civil war or foreign invasion, even those countries which have no public R&D expenditure, or STI planning

agencies, or even any private sector R&D activity would still be seen as having an NSI from the broad perspective.[15]

From the broadest perspective, where the NSI becomes an alternative account of the national political economy, the role of the state becomes that of the shaper and the architect of the system in order to align its evolution to the structural transformation and development requirements of the national political economy.[16]

Figure 3: Policy spheres relative to the Narrow and Broad Perspectives of the NSI



[15] The case is quite different in the case of sub-national systems of innovation, such as provincial or municipal systems whose legal definition is usually not tied to sovereignty. In the case of these entities, the conditions for the existence of a system of innovation, other than the legal definition, would have to be specified.

[16] See Scerri and Lastres (2013) for a discussion of the various perspectives of the role of the state in the evolution of the NSI.

Figure 3 depicts the different policy spheres aligned to different perspectives of the NSI and possible relations among them. From the narrow perspective of the NSI the typically relevant policy areas are those which are directly STI policy, normally allocated to ministries and departments of science and technology, as well as trade and industry, and higher education policy. Industrial policy in general should work closely with STI and higher education policy to ensure the absorption and deployment both of innovation and of higher end human capital which from the narrow perspective is seen as the prime generator of innovation. In the case of STI related policies, listed within the narrow definition of the NSI, as depicted in Figure 3, the state can enact policy in a number of ways. It can itself be a performer of R&D activity, directly or through parastatal enterprises. It can address bottlenecks in basic research, usually through subsidising university research. The state also traditionally acts as the facilitator of R&D partnerships between the private sector and universities. Tax and other incentives are also normally used to promote R&D activity and the supply of university graduates.

As we move to the broader definition of the NSI the policy areas which become relevant as innovation policy include those which address what is normally labelled as 'social development', pre-university education and labour market conditions. These policy areas would now both feed into, and be affected by, policies which are drafted within the narrow range of policies traditionally associated with the narrow perspective on the NSI. The same relationship exists with respect to policy areas which govern relationships with the global economy. The more important policy areas in this case are those relevant to economic integration, as well as environmental policy which is the one area which has become the concern of global regulation. The last set of policy areas which would fall within the broadest possible definition of the NSI are the standard macroeconomic policy tools, financial regulation and the country's legal framework. This set of policy areas could best be seen as

enabling policies *vis-à-vis* the narrowly defined NSI policy area. This is an inversion of the orthodox thinking where STI policy is normally seen as being a subsector within the overall macroeconomic policy. With the adoption of the broad version of the NSI, macroeconomic policy is now seen as the regulator of the amplitude of short term economic fluctuations around an upward trend which is created by effective innovation policy. Policies on the financial regulatory regime and on the national legal framework also act as enabling policies. In the case of this set of policy areas their relationship to the space of narrowly defined NSI policy areas is unidirectional. These policies affect but are not affected by the traditional STI policy environment.

Similarly, the relationship between the 'enablers' policy areas and those in the 'human capabilities' is unidirectional with policies on social welfare, pre-university education and labour markets affected by but not affecting the 'enablers' policy areas. On the other hand, the relationship between the 'enablers' policy areas and 'supra-national' policy area set is multidirectional. Policies on the macroeconomic, the financial and the legal fronts have an impact on the other policy area sets but are also are affected by policies on regional integration and on the environment. Finally, the relationship between the 'human capabilities' set and the 'supra-national' one is multidirectional, reflecting the increasingly globalised nature of the NSI.

The debates on what constitutes appropriate state involvement with the economy have ranged from an extreme *laissez faire* positioning to that of the command economy until late into the twentieth century. These two extreme positions have largely disappeared, first with the collapse of the USSR in the late eighties and more recently with the global financial crisis since 2008. The basis for the neoliberal proposition of the minimal state is the assumption of

efficient markets as the optimal allocator of resources but only the most extreme of neoliberal economists would nowadays argue for no intervention at all. Even extreme neoliberals would not go as far as to exclude a legal system which guarantees property rights and individual safety and security. Those economists labelled by Lall (1994) as 'moderate neoliberals' see the role of the state as correcting for market failures, mainly in the presence of externalities and public goods; in general these economists would argue for a neutral intervention which generally leaves inter-sectoral price ratios untouched. In the case of STI policy there is recognition, even within neoclassical economics, of inevitably high externality effects. These tend to arise from a combination of intra and inter-industry spillover effects and the difficulties in the private appropriation of all the returns on R&D expenditure. Here a case can be made for state intervention, through incentives, subsidies, partner, performer of basic research, etc, to correct for what would otherwise be an under spending on R&D.

The alternative positioning for state intervention is based on a strong sense of scepticism about the claim for efficient markets made by neoclassical/neoliberal economists. This scepticism is strongest when it comes to the context of developing economies where current economic structures and the functioning of markets within those structures are normally seen as inadequate for, or even inimical to, the goal of a self-sustained development and growth trajectory.[17] One of the earliest rationales for strategic intervention was proposed by List (2005), the pioneer of the NSI concept. List's infant industry argument indicated that free trade in the case of trading partners which were at different levels of economic development would lead to a widening of the development gap. He consequently advocated protectionism as a means to ensure that infant industries in the underdeveloped economies had sufficient

[17] One common manifestation of this approach in a development context is the policy of 'picking winners' on the basis of scenario building. This exercise is based on the assumption that current market structures would not by themselves result in an industry mix which is best suited for the development needs of the economy.

time to go through the learning period within the context of the home market to mature into global competitors.

The debate has been re-visited numerous times since the nineteenth century and one of its more famous resurgences occurred in the early 1990s when Japan challenged the World Bank's account of the success of the Asian Tigers as the epitome of successful neoliberal market friendly policies (Wade, 1996). The Japanese government argued that its post war success story, and that of the other South East Asian Tigers was the result of a strongly strategic interventionist policy which was, moreover, quite specific to each of the Tigers (Lall, 1994). Increasingly there is a recognition, which has been buttressed by success stories such as the Asian Tigers and more recently the Brazil, Russia, India, China and South Africa (BRICS) group of emerging economies, that the dichotomy between the state and the economy is a false one. The role of the state, as the enforcer of the 'rules of the game' of the political economy, as a partner in production and innovation, as a sole provider in specific areas of production and innovation, and as a major component of the demand sector, especially for innovation intensive products and services, is inextricably intertwined with the business sector, organised labour and civil society. The form which these sets of relationships take is specific to individual NSIs.

The broad perspective on the NSI offers a novel approach to 'social upliftment' policies. If these policies are now seen to be addressing the human capabilities requirements of the NSI then the separation between the social and the economic in the national political economy becomes blurred. Instruments of 'social upliftment' become the instruments for long term economic development and in the process the standard neoliberal prescription of economic

growth being the antecedent of 'social upliftment' is rendered invalid and detrimental to development.

6. Conclusions

In conclusion, a few salient features of the review undertaken in the previous sections are summarily outlined below:

1. The wide range of perspectives on the NSI is a source of confusion in debates on innovation policy which can be particularly damaging for sound policy formulation and implementation. It is therefore important that innovation policy forums should be expressly explicit about the specific formulation of the NSI concept, with all its defining delimiters, which have been commonly adopted as the basis for policy formulation.
2. The narrow perspective on the NSI exhibits a strong correspondence with orthodox neoclassical economic thinking on the placement of innovation in the general economy. This is especially the case if the perspective is restricted to the science and technology subsystem depicted in Figure 1. Policy implications for the narrow perspective on the NSI effectively limit innovation policy to the solution of 'market failures'.
3. The broader perspective on the NSI provides a more appropriate understanding of the role of technology in the process of structural transformation. This version of the NSI interprets innovation as extending far beyond technological change to include institutional and organisational change. In the process it allows for feedback and learning mechanisms which extend across the national political economy.[18]
4. The adoption of the broader perspective allows for the consideration of multidirectional causalities among innovation, economic development and social upliftment. This opens

[18] See Smits, Kuhlmann and Shapira (2010: Introduction) for an elaboration of the 'Innovation Policy Dance' model of interactions and feedback relationships among the various innovation partners in the NSI.

up the national policy space on innovation to consider social welfare as a core policy area of innovation policy.

Based on these four main aspects, we conclude with a brief reflection on the recommendations of the South African Ministerial Review on the performance of the NSI (DST, 2012). The encouraging first recommendation in the Review Report proposes the establishment of a National Council on Research and Innovation (NCRI) as a supra-ministerial planning authority for the NSI. This is a crucial move towards a move away from the narrow to the broad vision of the NSI in the recognition of the need for an overarching planning level which places innovation policy closer to the centre of macroeconomic planning.

However, the body of the subsequent recommendations in the Ministerial Review tend to circumscribe, *a priori* through the levels of emphasis, the scope of innovation policy for the NCRI to the narrower definition of the NSI. The brunt of recommendations, apart from those pertaining to public sector agency reforms, addresses the stimulation of business sector R&D and post-school education. While the dire need for social innovation is recognised, the only recommendation (13) in this regard is vague and still largely limited to a poverty alleviation approach.

In this formulation policy in this area may yet again miss out on the adoption of social innovation as a core instrument of innovation policy, rather than simply its objective. In the case of human capabilities formation, all of the eight recommendations (14-22) refer to the post-school sector. The starting position of the Ministerial Review document is an acceptance of the OECD (2007) review of the performance of the South African NSI.

While the critical findings of the OECD report are certainly valid, the conceptual base of the document is still tied to the narrow definition of the NSI as a sub-sector of the economy. In its addressing the failures of the NSI as identified in the OECD report, the Ministerial Review seems to have locked itself into an assumed policy space which reproduces the narrow version of the NSI with damagingly limiting implications for the future elaboration of a more progressive and inclusive innovation policy.

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