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# Modes of Innovation and the National Systems of Innovation of the BRICS Economies <sup>†</sup>

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## Abstract

*The Brazil, Russia, India China and South Africa (BRICS) group has emerged as a collection of large economies which are outside the traditional groups of industrialised “first world” economies and which have altered the global distribution of economic power. The basis of their emergence is a combination of their size and growth rates, and the fact that they lie outside the established centres of global economic power. As such, they have “diversified” the power base of the global economic order. The question which is asked in this paper is whether the phenomenon of the BRICS goes beyond this to mark the start of a possible challenge to the neoliberal orthodoxy which emerged as the globally dominant policy paradigm since the collapse of the Soviet Union. This paper develops and uses a “modes of innovation” approach to explore the potential of the BRICS to constitute a structural rupture in the current globally dominant neoliberal mode of innovation. This question is important since, in the absence of this rupture, the remarkable development trajectory of the BRICS will serve to reinforce the legitimacy of the global orthodoxy. The paper first articulates the modes of innovation concept and then proceeds to locate the BRICS systems of innovation within the current globally dominant mode. On this basis it then provides an appraisal of the possible impact of the BRICS on the evolutionary path of the global system of innovation.*

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Keywords

BRICS, economic systems, systems of innovation, modes of innovation

## 1. INTRODUCTION

The Brazil, Russia, India China and South Africa (BRICS) grouping has emerged as a collection of large economies (excepting South Africa) which are outside the traditional groups of industri-

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alised “first world” economies. The countries belonging to this group are remarkable not only for their size but for their growth rates over a period which, following the financial and economic crises since 2008, has seen the traditional economic centre experiencing negative or at best stagnant growth rates (even though these growth rates have recently slowed down considerably and even, in the case of Brazil, become negative over the first two quarters of 2014 and in South Africa over the first quarter of the same year). The impact of the BRICS on the global economy should however be assessed on levels other than the obvious ones of size and novelty. The question that is asked in this paper is whether the BRICS phenomenon constitutes, or holds the possibility of constituting, a rupture in the evolution of the global system of innovation or whether it represents the emergence of a new variety of capitalism with a high degree of structural continuity within the existing world order. The approach adopted to address this question is a “modes of innovation”<sup>1</sup> framework which traces the role played by the five constituent economies of the BRICS in the progression of the globally dominant modes of innovation and production. The following section sets out the basis of the modes of innovation framework while the one after that seeks to locate the BRICS systems of innovation within this framework. The final section provides a brief appraisal of the possible impact of the BRICS grouping on the evolutionary prospects of the global system of innovation.

## 2. MODES OF INNOVATION

A national system of innovation (NSI) is seen as the web of institutions, both formal and informal, within which new knowledge is produced, introduced, adapted, absorbed, diffused and deployed within nationally defined borders.<sup>2</sup> The narrow version of the NSI focuses on a definition of innovation restricted to science and technology and on the diffusion mechanisms to the production system. The broader version of the NSI is linked to a definition of innovation which ranges considerably beyond technological change and which incorporates the various aspects of the political economy and its interactions with a supra-national context. If the broad version of the systems of innovation approach<sup>3</sup> is adopted as a starting point and innovation is defined broadly enough to include all changes in the organisation of economic activity which are seen to be an improvement on the current state, we could then place innovation at the core of the national economy. Schumpeter (1934) opened up innovation to range far beyond technology, while March and Simon (1993), and Williamson (1985) introduced behavioural and organisational theories of firm behaviour as explanations of the sources of innovation. Johnson (1988) and North (1990) bring in the broader institutional framework and institutional change to the core of the analysis of dynamic systems. The com-

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<sup>1</sup> My use of the term “modes of innovation” is distinct from its common usage in innovation literature as referring to two types of learning and innovation, primarily applied at firm level (see among others, Jensen et al, 2007).

<sup>2</sup> “...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), and “...a set of institutions whose interactions determine the innovative performance ... of national firms.” (Nelson, 1993)

<sup>3</sup> See Cassiolato and Lastres (2008) and Lundvall (2010) for an elaboration of the broad systems of innovation approach.

bination of these broad perspectives on the meaning of innovation can therefore expand the term to encompass all changes within dynamic systems.

The NSI approach, whose modern articulation dates from the seminal texts of Nelson and Winter (1982), Lundvall (1992), Nelson (1993), and Freeman (1995), provides a fundamental rebuttal of the explanatory power of neoclassical economics, especially in the area of economic dynamics. The explanatory strength of the NSI approach rests on its consideration of specificities and historical determination of systems, and the refutation of the assumption of universality in mainstream neoclassical economics. However, the breadth of the definition of innovation that can be considered opens the NSI approach to a wide range of interpretations. This revolution in the orientation of the discipline does not have an ideological grounding, except by proxy due to the unwarranted twinning of neoliberal economics with the neoclassical paradigm.<sup>4</sup> The looseness of this approach implicitly allows for a wide range of ideological appropriations, from a market-oriented neoliberal positioning to a Marxian account of the evolution of systems of innovation. While this potential variety in the orientation of this approach, akin to that in classical economics, is a testimony to its analytical richness, the common lack of an explicit articulation of an ideological grounding can be theoretically and normatively confusing. Fine and Rustomjee (1996) recognise this when they propose that the

[NSI] framework is unduly descriptive in content, merely pointing to the various institutional components driving technical change, albeit breaking with received notions in orthodox economics. However, it can be complemented by a specification of the dynamic of capital accumulation associated with a particular [NSI]. (p. 244)

However, the required theoretical grounding of the NSI approach in Marxian economics requires more than the specification of the accumulation regime for a particular NSI. It should be based on a specific articulation of the foundations of the NSI approach from a Marxian perspective. In order to develop this articulation we would have to revisit the theory of value, specifically the labour theory of value, from an innovation perspective. Effectively this means that the value of goods and services is based on their innovation content.

In this sense the “knowledge economy” becomes an empty term since all economies become by definition “knowledge economies”; attention should rather shift to the “learning economy” (Archibugi & Lundvall, 2001; Lundvall, 1996) to capture the dynamic evolutionary aspect of systems of innovation. On this basis labour power, the “capacity to do work” (Fine & Saad-Filho, 2004), may be seen as the knowledge content embodied in labour at all levels of skills. From this perspective even the most apparently unskilled labourer, say someone digging a ditch, is an embodiment of

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<sup>4</sup> Chang (2001) 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’ (p. 11).

all past streams of innovation and accumulated knowledge which have gone into the very concept of the ditch itself and the manner of the engagement of the labourer with the ditch. The various historical streams of innovation culminate in the production of goods and services, in the tools of their production, and in the forms of coordination of the economies of their production. Labour is still central to this theory of value but is now rendered as human capability, in the sense used by Sen (1999) and seen as the source of innovation which defines value. The fragment in the *Grundrisse* on the pervasive role of knowledge in the political economy is worth quoting here:

Nature builds no machines, no locomotives, railways, electric telegraphs, self-acting mules etc. These are products of human industry; natural material transformed into organs of the human will over nature, or of human participation in nature. They are *organs of the human brain, created by the human hand*; the power of knowledge, objectified. The development of fixed capital indicates to what degree general social knowledge has become a *direct force of production*, and to what degree, hence, the conditions of the process of social life itself have come under the control of the general intellect and been transformed in accordance with it. To what degree the powers of social production have been produced, not only in the form of knowledge, but also as immediate organs of social practice, of the real life process. (Marx, 1973, p. 706)

Raniero Panzieri and the *operaismo* school argue that the implications of this fragment from the *Grundrisse* indicates a shift in the “source of value” away from labour, as in standard Marxism, to knowledge (Keucheyan, 2013). This formed the basis of the concept of “cognitive capitalism” which was developed by the *operaismo* movement and the perceived shift from labour to knowledge as the base of value in the economy brought in a kind of categorical divide in the ranks of labour. With the emergence of cognitive capitalism a difference was posited between knowledge workers and material workers which is essentially tied to the nature of the product or output that a worker produces, depending on whether it is tangible or an “immaterial” service. Hardt and Negri (2000) define immaterial labour as “... labour that produces an immaterial good, such as a service, a cultural product, knowledge or communication.” At the higher end of the “value chain” of labour Hardt & Negri (2000) quote Reich (1991) in identifying immaterial work as “problem-solving, problem-identifying and strategic brokering activities.” This category of labour has also been called the “cognitariat,” a term created by Peter Drucker and adopted by Antonio Negri to indicate purely mental or artistic workers who are still workers subject to the same relations of production as workers in general. Cognitive capitalism with knowledge as its value base marks a break in the evolution of capitalism equivalent to that between industrial capitalism and mercantile capitalism which preceded it (Boutang, 2008). This break is evident in the increasing side-lining of the traditional input categories of labour and capital, with a possible distinction between skilled and unskilled labour. The input classifications that are now seen to be more relevant in the era of cognitive capitalism are hardware, software, wetware, and netware.

This classification of labour is, as already mentioned, tied to the nature of the product of labour which defines its materiality or otherwise. However, if all output is eventually aimed, through vari-

ous intermediate stages, at final consumption then the exploration of the nature of final consumption may be opportune. Consumption is conventionally tied to tangible products or services which in neoclassical theory typically yield individual welfare effects through a presumed utility function. Kelvin Lancaster (1966) provides an alternative account, within the parameters of neoclassical economics, of the fundamental nature of consumption by proposing that use value (to take some liberty with the neoclassical concept of “utility”) is derived from vectors of characteristics yielded from consumption activities which combine a number of inputs in a manner analogous to the neoclassical production function. Purchased goods and services form only a portion of these inputs and are not themselves the direct source of use value. Other inputs include the time and effort spent in the consumption activity, the stock of human capabilities relevant to the consumption activity, as well as the social and cultural context which to a large extent determines the sets of characteristics associated with specific consumption activities. This account essentially alters the nature of consumption in manner which implicitly renders all consumption immaterial and, if this proposition is accepted, the distinction between material and immaterial labour becomes increasingly vague and possibly misleading. The posited shift in the value base of the economy from labour to knowledge then similarly becomes a misleading dichotomy anchored in the implicit assumption of the possibility of the separation of knowledge from labour. The alternative account developed here is that labour is inseparable from knowledge and that all labour is immaterial by virtue of the nature of the final objective of production which is essentially an activity yielding characteristics which form use value. The argument here is that the acknowledgement of cognitive capitalism as a distinct stage of capitalism, even perhaps constituting the “total paradigm shift” proposed by Boutang (2011), does not imply the categorical divide between cognitive and other (non-cognitive?) labour.<sup>5</sup> Andre Gorz shifts the value base of the economy to knowledge when he states that “the exchange-value of commodities, material or otherwise, is *no longer determined* in the last instance by the quantity of generalised social labour they contain but mainly by their content in terms of general information, knowledge and intelligence” (Gorz, 2013, emphasis added). This may reflect the shift in the manner in which labour power is appropriated with the end of the era of embedded liberalism (Harvey, 2005) and the increasing demand that labour “produces itself” (Gorz, 2013) but this should not reflect on the tenet that knowledge and innovation may be seen as always having formed the base of economic value.

Cognitive labour, in this case defined to include all labour, is combined with conventional means of production as well as those factors which are directly engaged with the production of knowledge to produce the streams of innovation which coalesce into inputs into consumption activities. Together these comprise the means of innovation and the patterns of the ownership and control of the means of innovation which, in conjunction with other associated characteristics, define particular modes of innovation. These other characteristics may be grouped into the following sets:

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<sup>5</sup> “...as a cognitive activity, *labour* is the main characteristic and, broadly speaking, the essence of man. By definition, human labour is an activity that reunites within it both thought and action [which] are tightly entangled and embedded, and remains distinct from any repetitive and instinctive activity performed by other living creatures” Vercellone (2005: 2-3).

- a. the patterns of ownership and control of the means of innovation which both form and are a product of the specific institutional relations which underpin any given political economy,
- b. the pace and nature of technological change
- c. the human capabilities requirements of the NSI
- d. the power relations between labour and capital
- e. the periodisation of the evolutionary stages of the global political economy with which a prevalent mode of innovation is associated

These various characteristics are inter-determinate in the formation of specific modes of innovation, with complex and multidirectional causalities, and feedback and reinforcement mechanisms. Over time these systems also exhibit recurrent crises which to a large extent determine the transitions from one mode to another. The related sets of characteristics are laid out in Table 1 in relation to three modes of innovation which are loosely tied to different stages in the evolution of global capitalism. The early industrial mode marks the transition from merchant to industrial capitalism. This transition was ushered in by the techno-economic paradigm shift introduced with the invention of printing and the mass production of books (Febvre & Martin, 1976), termed by Anderson (1983) as “print capitalism”. Wallerstein (1983) proposes that “...the genesis of (historical capitalism) is located in late-fifteenth-century Europe, that this system expanded in space over time to cover the entire globe by the late nineteenth century...” while Arrighi (1994) identifies fifteenth century Venice as the prototype of modern capitalism. This mode covers the first industrial revolution and ends with the beginning of the second one. It is characterised by owner-managed firms and the emergence of the new class formations of the capitalist mode of innovation. This period saw the start of a widespread mechanisation of production led by the textile industry.

The mature industrial mode sees the rise of the modern public corporation with the separation of ownership and management, and the emergence of a bifurcation of the global system of economic coordination with the rise of the Soviet Union. The second industrial revolution saw massive increase in the demand for resources and the formalisation of in-house R&D. The Second World War brought about the age of “big science” and its spillover into manufacturing. The labour skills requirements by industry rose dramatically and formal broad-based and technical education was established in industrial economies. The twentieth century saw the simultaneous rise of organised labour and the creation of welfare systems within the context of “embedded liberalism” (Harvey, 2005) in capitalist economies. It also saw the rise to prominence of the counter-capitalist modes of innovation in the Soviet Union and the People's Republic of China. The aftermath of the war saw the start of the post-colonial period and a re-definition of global centre-periphery relations.

The post-industrial mode arises with the collapse of the Soviet Union, the global hegemony of neo-liberal economics and the associated variety of globalisation. This new globalised world is marked by historically unprecedented low restrictions on the global movement of trade, financial capital and labour. The increasingly liberalised global economy also alters the relevance of individual NSIs in the determination of their evolutionary paths and sees the emergence of regional (supra-national) systems of innovation with the emergence of economic blocs. This mode is characterised by the rapidly increasing recognition of the knowledge or “immaterial” component of economic output

and the transition to “cognitive capitalism” where a claim is made that the “economies of learning” have superseded “economies of scale” as a determinant of productivity (Boutang, 2008). It is a period marked by an accelerating rate of innovation, including the frequency of techno-economic paradigm shifts.

From the perspective of the NSI, the control over the means of innovation in the post-industrial mode may be understood as those sets of factors which enable a particular national system to act as a locus of a range of innovation activities, from invention, to adaptation, absorption, diffusion and deployment within its national borders. This type of control is based on “sticky” pools of tacit knowledge, and informal networks and institutions which have become the main determinant of persistent and emerging nodes of core competencies and competitive advantage in a globalised economy (see Maskell & Malmberg, 1999). In the post-industrial phase of largely unregulated globalisation and the de-nationalisation of corporations, this type of control has become more important than ever as a determinant of the spatial specification of the economic core and periphery.

The classification of the rate and direction of technological change is linked to specific modes of innovation as a partial determinant of each mode. The other determinant consists in those shifts in the geopolitical order which manifest not only the changing power bases of states and political/economic blocs but also of ideologies. The balance of these two sets of determinants is historically specific. Broadly speaking, we can propose that the shift from the early to the mature industrial mode of innovation was largely driven by the technological breakthroughs of the second industrial revolution with implications for the nature of imperial power and its shift towards extractive colonisation, specifically with respect to Africa. The shift from the mature industrial mode of innovation to the post-industrial one may have been facilitated by the historically unprecedented rate of techno-economic paradigm shifts but the global hegemony of neoliberalism and the type of globalisation with which is now associated with it are the outcome of the collapse of the Soviet Union.

One of the more notable effects of the post industrial mode of innovation has been the alteration of the power relations between labour and capital. The liberalisation of global markets has seen the general demise of the power of organised labour and the progressive dismantling of welfare systems in the economic centres. Security of employment in the old industrialised centres has virtually disappeared and “precarious life,” with increasingly shortened individual or family planning horizons, has moved from being a feature of underdeveloped economies to the global norm. Class formations have also been structurally altered with this shift with the traditional proletariat progressively being displaced by the class which Guy Standing (2011) terms the “precarariat,” made up of people who drift from one short term job to another between periods of unemployment, with little or no lifetime prospects of upward career or class mobility. The implications for human capital (capabilities) formation are quite significant and could represent a structural break with previous modes. With generally lax labour laws and the ability to source labour across national borders, the incentives to invest in NSI-based capabilities formation through state (tax) funded education and social safety nets have decreased considerably.

Although these modes are represented as historical stages, any one mode may be the more relevant



for specific NSIs. In fact several modes may be exhibited in a particular NSI. Individual NSIs can therefore be analysed in terms of their relationship to a globally dominant mode of innovation. We also need to keep in mind that the classification depicted in Table 1 refers to capitalist modes of innovation and in the case of the mature industrial mode of innovation excludes the mode of innovation which evolved in the communist blocs over the greater part of the twentieth century. The characteristics categories that would be primarily affected when considering what we may term the “socialist mode of innovation” are the patterns of the ownership/control of the means of innovation, technological change, and labour/capital power relations. Within this alternative mode of innovation the state owned and controlled the means of innovation, deploying them in the rapid industrialisation of economies, especially those of the Soviet Union and the People’s Republic of China. Technological change was driven entirely by the state in pursuit of strategic political and economic programmes. By definition labour relations were formed in configurations which were categorically distinct from the labour-capital dichotomy.

**Table1. Capitalist Modes of Innovation and Their Characteristics**

Mode of innovation	Ownership/control of the means of innovation	Technological change	Human capabilities requirements	Labour/capital power relationship	Periodisation of the global political economy
Early industrial	<ul style="list-style-type: none"> <li>• equation of the ownership and control of the means of innovation</li> </ul>	<ul style="list-style-type: none"> <li>• preceded by the advent of print capitalism</li> <li>• increasing rate of incremental innovation</li> <li>• widely spaced radical innovations</li> <li>• infrequent techno-economic paradigm shifts</li> </ul>	<ul style="list-style-type: none"> <li>• shift from artisan to factory labour</li> </ul>	<ul style="list-style-type: none"> <li>• proletarianisation and the emergence of the bourgeoisie</li> <li>• state backed formation of a capitalist mode of accumulation</li> <li>• rapid increase in resource requirements</li> </ul>	<ul style="list-style-type: none"> <li>• preceded by state sponsored voyages of discovery and trade</li> <li>• age of enlightenment</li> <li>• industrial revolution</li> <li>• the emergence of national identities and the formation of European states</li> <li>• the age of imperial powers and the establishment of the hegemony of the “West”</li> </ul>
Mature industrial	<ul style="list-style-type: none"> <li>• separation of ownership and management</li> <li>• diffusion of the ownership of means of production</li> <li>• managerial labour and the rise of the technocracy</li> <li>• the bifurcation of the world economic order with state ownership and control of the means of innovation in socialist economies</li> </ul>	<ul style="list-style-type: none"> <li>• “big science” and the R&amp;D push in the private sector</li> <li>• in-house research leading to formalisation of the R&amp;D function</li> <li>• the microelectronics revolution</li> </ul>	<ul style="list-style-type: none"> <li>• increasing skills requirements</li> <li>• the formalisation of human capital formation through broad based education</li> <li>• the rise of SET higher education</li> <li>• scientific management (Fordism and Taylorism)</li> </ul>	<ul style="list-style-type: none"> <li>• growth of organised labour</li> <li>• “embedded liberalism” and the welfare state</li> </ul>	<ul style="list-style-type: none"> <li>• the post-colonial period and the emergence of new countries</li> <li>• post-colonial ties and the emergence of neo-colonial dependencies</li> <li>• re-definition of centre-periphery</li> <li>• the cold war and the bi-polar global political economy</li> <li>• protectionism</li> <li>• Bretton Woods and the regulated global financial markets</li> </ul>



Post-industrial	<ul style="list-style-type: none"> <li>transnational (private) control of the means of innovation accepted as the global norm</li> <li>global diffusion and the de-nationalisation of ownership</li> <li>the co-option of managerial labour into the capitalist class</li> <li>the shifting national grounding of control over the means of innovation</li> <li>the global sourcing of the human means of innovation</li> </ul>	<ul style="list-style-type: none"> <li>increasing frequency of radical innovations and techno-economic paradigm shifts</li> <li>accelerating codification of knowledge</li> <li>ICT, nanotechnology and biotechnology, robotics and automation, and short batch production runs</li> <li>the "economies of learning"</li> </ul>	<ul style="list-style-type: none"> <li>the emergence of formal cross disciplinary education</li> <li>rapid obsolescence rate of human capital</li> <li>the end of life time jobs and careers</li> <li>global sourcing of human capital</li> <li>the worker as the continuous "producer of himself"</li> </ul>	<ul style="list-style-type: none"> <li>erosion of organised labour</li> <li>the displacement of state provision by outsourcing and privatisation</li> <li>the erosion of welfare safety nets and the normalisation of precarious life</li> <li>globalisation of capital and the localisation of labour</li> </ul>	<ul style="list-style-type: none"> <li>start marked by the end of Bretton Woods, the crisis of the Keynesian economy and the collapse of the Soviet Union</li> <li>the hegemony of the neoliberal paradigm</li> <li>global financial and real economy integration</li> <li>the erosion of the economic integrity of the nation state</li> <li>the emergence of economic blocs</li> <li>global financial and economic crises</li> </ul>
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Source: developed from Scerri (2013)

### 3. MODES OF INNOVATION AND THE ECONOMIES OF THE BRICS MEMBER COUNTRIES

The placement of the BRICS group within the global progression of modes of innovation may be undertaken on two levels. The first is the examination of the historical part played by the individual economies in this group, before they were constituted as a group, in the evolution of the global system of innovation. The second level will be a tentative assessment of the current and possible future effect of the BRICS group on the globally dominant mode of innovation.

Historically, the emergence of the Soviet Union opened up a bifurcation in the progression of the global economy with the implementation of a socialist mode of innovation on a continental scale, a rupture which was reinforced, approximately three decades later, by the formation of the People's Republic of China. For the greater part of the twentieth century the existence of the Warsaw Pact and the People's Republic of China acted as the counter-hegemonic front to the geopolitical and ideological dominance of the mature industrial capitalist mode of innovation. Whatever the internal contradictions in the mode of innovation developed in the Soviet bloc, which would eventually help lead to its collapse, its main global role was to offer an alternative which was not only praxis but which, in its often tortuous evolution, altered economic theory across the globe.

The collapse of the Soviet Union and the Soviet economy, along with the dissolution of COMECON, and the manner in which it happened spelled the geopolitical death knell of the counter-hegemony to the capitalist mode of innovation. There were two main reasons for this. In the first place, it is doubtful if *realpolitik* would have allowed one side of a polarised world to implement the extreme form of the post-eighties liberalised global economy which would have been unthinkable within the phase of the mature industrial mode of innovation even in the heartland of capitalist economies. Secondly, the logical *non sequitur* which linked left wing economic policies in general with the Soviet model severely curtailed the influence of Marxian theory on the role of the state in

the economy for most governments around the world after the collapse of the Soviet Union. It dramatically shifted the ideological base of most left leaning parties in capitalist economies, and then throughout the world, towards the now apparently self evident “pragmatic” dictates of neoliberal economics, as happened with the transformation of the British Labour Party under Blair. More than any technological advance it brought about the post-industrial mode of innovation, with the increasingly deregulated financialisation of global and local economies, and the unfettered global sourcing of all economic inputs, including labour. Moreover, the terrible lesson of the collapse of the Soviet economy and the aftermath of the devastation of the Russian economy over most of the nineties also altered fundamentally the directed evolution of the Chinese system of innovation towards a new variety of capitalism with an accelerating integration into the post-industrial mode of innovation. The political collapse and disintegration of the Soviet Union, and the virtually overnight swing from a centrally planned to a privatised economy effectively meant the destruction of an NSI. The birth of the new NSI of the Russian Federation came about under conditions of hyperinflation, rocketing poverty, and the dismantlement and private appropriation of state assets (Zaichenko, 2014). The continued eruption of political tensions and conflict among former Soviet states has also marked the evolution of the Russian NSI with troubling implications for its regional interactions.

The modes of innovation preceding the socialist modes of the Soviet Union and the People’s Republic of China had both been predominantly feudal modes in two imperial powers. By contrast, the other three members of the BRICS group are all ex-colonies, formed and defined at their origin by imperial powers. These countries in their respective spheres came to be nodal points in postcolonial history. Brazil along with other Latin American countries has provided one of the strongest theoretical bases for development economics, broadly branching into the two Marxian based, structuralist-reformist and Marxist-revolutionary, schools (Kay, 1991). India, the largest multi-party democracy in the world, also provided an alternative of a largely state-directed inward industrialisation development programme for almost the first forty years after independence. The formation of the Union of South Africa in 1910 saw the start of a white-dominated postcolonial era during which state-driven industrialisation started the shift of the base of the NSI away from a virtually total dependence on resource extraction. The installation of apartheid after the Second World War came at the dawn of the postcolonial era in most of the rest of the world and spanned over the emergence of the post-industrial mode of innovation. While the country’s system of science and technology flourished, driven by military R&D, the evolution of its broad system of innovation was crippled by the blocks set by apartheid legislation and practice on the development of broad-based human capabilities (Scerri, 2009). The neoliberal macroeconomic planning framework which marked the start of democracy in South Africa did little to correct for systemic fault lines in the NSI which had developed over four decades of apartheid. The end of apartheid in South Africa held significant implications which ranged across Southern and sub-Saharan Africa. The transition from the Organisation of African Unity (OAU) to the African Union (AU), and the constitution and implementation of the New Partnership for Africa’s Development (NEPAD) as the technical planning and coordinating body of the AU emerged with the end of apartheid and the corresponding re-orientation of continental organisations. The end of apartheid also led to the formation of the Southern African Development Community (SADC) with the prominent initiative of former frontline states in collaboration with South Africa. South Africa, the smallest NSI in the BRICS should therefore implicitly represent the

presence of sub-Saharan Africa in the group.

The extent to which these five NSIs have shifted to the post-industrial mode of innovation may partially be reflected in the trends of their research allocations, as reflected in the ratio of gross expenditure on research and development (GERD) to their GDP. This may provide a rough indication of a move towards a stronger national base for the control of the means of innovation. These trends are shown in Table 2.

Table 2. GERD/GDP (%) for the BRICS Economies and the EU

Country	YEAR							
	2003	2004	2005	2006	2007	2008	2009	2010
Brazil	0.96	0.90	0.97	1.01	1.10	1.11	1.17	1.16
China	1.13	1.23	1.32	1.39	1.40	1.47	1.70	1.76
India	0.71	0.74	0.78	0.77	0.76	na	na	na
Russia	1.29	1.15	1.07	1.07	1.12	1.04	1.25	1.16
South Africa	0.79	0.85	0.90	0.93	0.92	0.93	0.87	0.76*
EU**	na	na	na	1.77	1.77	1.84	1.92	1.91

Sources: World Bank data at <http://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS/countries?display=default>, accessed 15 April 2014.

\* NACI (2014).

\*\* OECD data base at [http://www.keepeek.com/Digital-Asset-Management/oced/science-and-technology/main-science-and-technology-indicators-volume-2012-issue-1/gross-domestic-expenditure-on-r-amp-d-gerd-as-a-percentage-of-gdp\\_msti-v2012-1-table2-en#page1](http://www.keepeek.com/Digital-Asset-Management/oced/science-and-technology/main-science-and-technology-indicators-volume-2012-issue-1/gross-domestic-expenditure-on-r-amp-d-gerd-as-a-percentage-of-gdp_msti-v2012-1-table2-en#page1), accessed 15 April 2014.

The two countries which show the strongest upward trend are China and Brazil. The indicator for India remains relatively constant over the five years for which data are available, while the one for Russia shows a fluctuating performance. In the case of South Africa we see a rapid deterioration over the last two years, caused by a sharp drop in private sector R&D. This measure is of course too aggregate to provide anything more than a crude indicator of the shifting knowledge base of the various economies but it is interesting to note that the measure for most of the BRICS still lies considerably below the indicator for the EU as a whole. The rates of growth of this indicator for China and Brazil over the eight year period are impressive, especially in the case of China where the gap between its indicator value and that of the EU fell by more than half over 2006 to 2010.

Other science and technology indicators which may be used as rough proxies for the deepening of the technological base of the different NSIs in the BRICS are provided in the appendices. Patent data filing rates have increased consistently in all of the BRICS over the period 1998-2012 (except for South Africa), with China showing the fastest rate of growth (Appendix 1). Patent grant data (Appendix 2) show that in the case of Russia by far the greater portion of patents which were granted had been consistently filed by residents throughout the fifteen-year period. This is probably due to the historical development of a strong research base and the training of scientists and engineers prior to the formation of the Russian Federation. The case of China, the only other BRICS member where patent grants to residents outweighs those granted to foreigners, is altogether different. It is not just the sheer magnitude of patents which is remarkable by the BRICS standards. The data also show an exponential rise in patents over the period with a reversal of the resident/non-resident ratio of patents granted since 2009 and an accelerating increment in the proportion of local origin in the approved patents figures.

Table 3. Knowledge Economy Index (KEI) and Knowledge Index (KI) – 2012

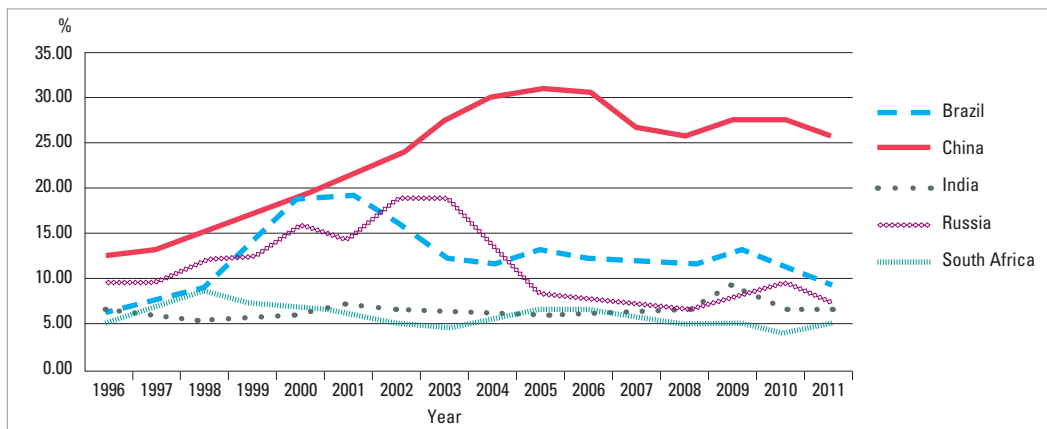
Rank (out of 145 countries)	Change in KEI rank since 2000	Country	KEI	KI	Economic Incentive Regime	Innovation	Education	ICT
55	+9	Russia	5.78	6.96	2.23	6.93	6.79	7.16
60	-1	Brazil	5.58	6.05	4.17	6.31	5.61	6.24
67	-15	South Africa	5.21	5.11	5.49	6.89	4.87	3.58
84	+7	China	4.37	4.57	3.79	5.99	3.93	3.79
109	-6	India	3.06	2.89	3.57	4.5	2.26	1.9

Source: derived from World Bank data at [http://info.worldbank.org/etools/kam2/KAM\\_page5.asp](http://info.worldbank.org/etools/kam2/KAM_page5.asp)

Table 3 depicts the Knowledge Economy Index (KEI) and Knowledge Index (KI) values for the BRICS economies. The KEI is a composite of sets of indicators reflecting (a) indicators of the incentives offered by the economic and institutional regime for the efficient use of existing and new knowledge and the flourishing of entrepreneurship; (b) the education and skills levels of the population; (c) an efficient innovation system of firms, research centres, universities, consultants and other organisations; (d) information and communication technology. The KI is a composite of indicators sets (b), (c) and (d) while the “knowledge economy index” adds on the market grounding of the knowledge system. It is interesting to note the high placing of South Africa in these two indices, especially given its ranking in terms of other S&T indicators. The reason for this apparent discrepancy is indicated by the value of the “economic incentive regime” for South Africa which is significantly higher than for the rest of the BRICS, indicating an unusually market friendly political economy. South Africa also ranks high in terms of its institutional innovation structure. The changes in world ranking for these five countries clearly indicate a strong improvement for Russia and China and a sharp drop for South Africa.

A final indicator of the narrowly defined NSI for the BRICS is provided in Figure 1 which shows high technology exports (high R&D intensity) as a proportion of manufacturing exports.

Figure 1. High Technology Exports as a Percentage of Manufacturing Exports

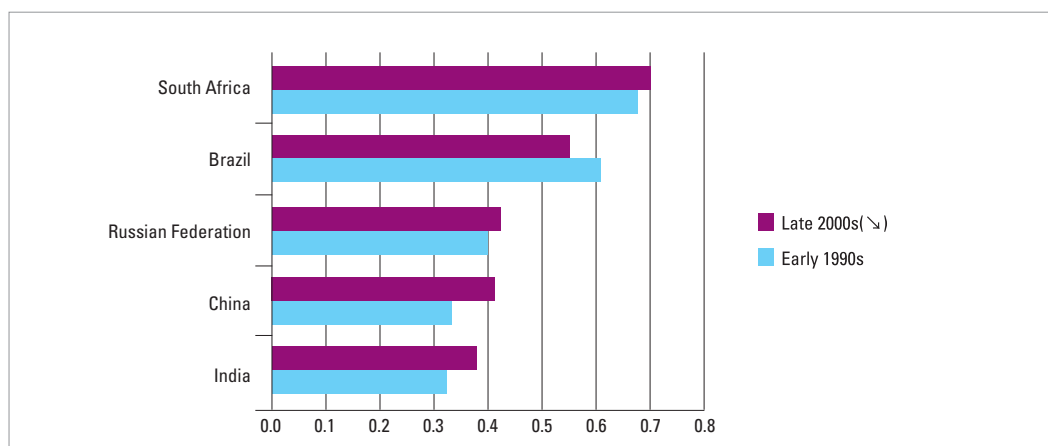


Source: derived from World bank data at <http://data.worldbank.org/indicator/TX.VAL.TECH.MF.ZS>

Figure 1 clearly shows the ascendance of the Chinese NSI, not only in terms of size or of its export led growth but in the high knowledge intensity of its export base.

However, the indicators discussed above refer to the narrow science and technology version of the NSI and can be seriously misleading as indications of the capacity of the broader NSI to adapt to the post-industrial mode of innovation. The contradictions inherent in the general capitalist mode of innovation, especially between growth and human development, are inescapable throughout the BRICS economies.

Figure 2. Change in Inequality Levels, Early 1990s versus Late 2000s\*: Gini Coefficient of Household Income\*\* (Soares, Scerri & Maharajh, 2014)



Note: \* Figures for the early 1990s generally refer to 1993, whereas figures for the late 2000s generally refer to 2008.

\*\* Gini coefficients are based on equivalised incomes for OECD countries and per capita incomes for all EEs except India and Indonesia for which per capita consumption was used.

Source: OECD-EU Database on Emerging Economies and World Bank Development Indicators Database (2011)

Measures of inequality, depicted in Figure 2, provide one indicator of the tensions which could accompany the rapid growth of the BRICS. The one notable exception to the trends portrayed in Figure 2 is Brazil where the Gini coefficient has declined over an approximate ten period. The case of South Africa is surprising not only because of its high levels of inequality but also by the fact that inequality has increased over time. One would have expected a downward trend in the Gini coefficient given that the country emerged from a system of legislated racial inequality. This is a testimony of the effects of the neoliberal macroeconomic policy course after South Africa's liberation from apartheid, whose basic tenets, in the absence of an explicitly articulated alternative paradigmatic base, still permeate policy formulation. The results of this policy are manifest in growth rates which, while low by the average standards of the other BRICS economies, have still been considerably higher than those of industrialised economies but which are accompanied by increasing income inequalities and the failure to shift the base of the economy away from the minerals-energy-complex developed through its pre-democratic history.

This is not to say that individual BRICS economies have not introduced alternative paths to growth as options to the global economy. Table 4 shows the behaviour of the Human Development Index

(HDI) for the BRICS which shows an improvement for all member countries since 2000. In the case of Brazil, the *Bolsa Família* and other welfare measures in the neo-structuralist approach to economic policy, which have resulted in an enviable combination of falling inequality and a rising quality of life, are reminiscent of the “embedded capitalism” (see Harvey, 2005) which had virtually disappeared from the centre of capitalist economies by the mid-nineties. With a strong dependence of its economic growth on a growing domestic market, Brazil’s programme of “growth with development” has good prospects of being sustainable. China is similarly striving to address the rising inequalities generated by its rapidly transforming economy, while its HDI has shown the most dramatic increase over the past couple of decades. However, the contradictions posed by a growth path which is overwhelmingly reliant on export markets (with domestic consumption at under 35 percent of GDP) create serious problems of instability. China’s future growth prospects in the time of an endemic global recession may increasingly rely on its success in slowing rising inequality or even reversing it, while continuing to raise internal purchasing power, so as to expand the domestic market for its huge industrial output.

Table 4. Human Development Index Trends for the BRICS Economies

Country	HDI				1990-2000 Average Annual HDI Growth	2000-2012 Average Annual HDI Growth
	1990	2000	2007	2012		
Brazil	0.59	0.669	0.71	0.73	1.26	0.73
China	0.495	0.59	0.662	0.699	1.78	1.42
India	0.41	0.463	0.525	0.554	1.23	1.5
Russian Federation	0.73	0.713	0.77	0.788	-0.23	0.84
South Africa	0.621	0.622	0.609	0.629	0.01	0.11
World	0.6	0.639	0.678	0.694	0.64	0.68

Source: derived from UNDP data base, at <https://data.undp.org/dataset/Table-2-Human-Development-Index-trends/efc4-gjvq>, accessed 25 April 2014.

The HDI values for the BRICS, as well as their rates of growth, compare well with the global average, except for India whose HDI is well below this benchmark and South Africa whose rate of growth of its HDI, as well as its value, is also below that of the world average. The HDI is not only an indicator of the quality of life of the population but, from a mode of innovation perspective, it also serves as an indicator of a country’s stock of human capabilities. In this regard, the poor performances of South Africa and India hold particularly worrying implications as to the capacity of these countries to develop their economies up the global value chain. India has become a typical case of economic growth which has failed to address broad-based human development on a number of fronts, such as infant malnutrition and mortality rates, female literacy, sanitation, schooling and other human development indicators; in most of these indicators India compares badly with other countries in South Asia which have shown far lower economic growth rates (Drèze & Sen, 2013).

Table 5. Failed States Index

Country	Rank (of 178 countries)		Change in rank 2010–2013
	2013	2010	
Brazil	126	119	+7
Russia	80	80	0
India	79	79	0
China	66	62	+4
South Africa	113	115	-2

Source: Fund for Peace, at <http://ffp.statesindex.org/rankings-2013-sortable>, accessed 15<sup>th</sup> January 2014

Table 5 shows the world ranking of the BRICS economies in terms of the Failed States Index which is a composite of a wide range of social, economic and political stability indicators. Brazil and South Africa show the best ranking in this index among the BRICS economies but South Africa is the only member whose ranking deteriorated since 2010, while that of Brazil and China improved considerably.

#### 4. CONCLUDING REMARKS

The emergence of the BRICS economies as a distinct group is typically a product of the geopolitical order associated with the post-industrial mode of innovation. All five of them exhibit a mix, to varying degrees, of the mature industrial and the post-industrial modes of innovation. In this sense the rising global prominence of these five NSIs, in terms of the orthodox measures of economic performance, is a final ratification of the global dominance of the capitalist post-industrial mode of innovation. The question which strikes to the core of the issue of the role of the BRICS in the evolution of the global economy is whether the BRICS as a group will form a strong countervailing economic power base within the broad framework of global neoliberalism or whether it can constitute a base for the emergence of an alternative economic coordination paradigm. It is of course much too early to assess the BRICS group on this issue but we may speculate on possible eventualities.

The BRICS group could stay on as a loose association forming a notable global economic bloc. Here the size of the BRICS matters as is evident in the recently established BRICS development bank. This bank poses a historic challenge to the monopoly power of the World Bank and the IMF as the dominant global financial institutions. This is in itself a major countervailing geopolitical/economic positioning but still lies within the broad framework of global capitalism. A further development would be for a learning process to develop wherein the individual BRICS economies may, within the limits imposed by their structural differences, learn from policy and practice in each other's economies. Here Brazil and China may provide valuable lessons, specifically with respect of the management of economic growth within the framework of the human development requirements for a transforming NSI. Brazil's policy programme has yielded evident progress on this front with strong indications that its structural inequality and poverty are being systemically addressed, while maintaining the pace of the transformation of its NSI. China's deepening concern with the dangers of its overly export-based growth has stimulated an intense exploration of remedial policies

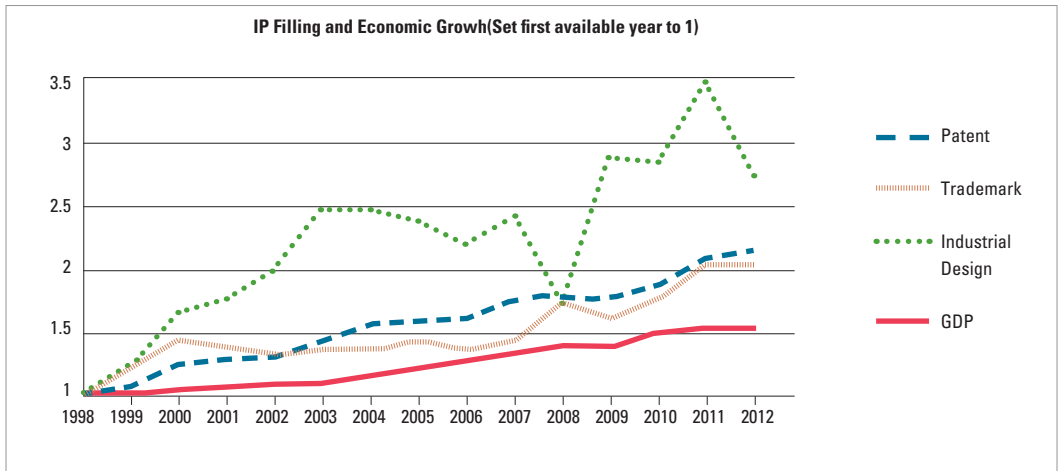


aimed at addressing inequality and poverty in order to dampen rising social and political tensions and provide a more stable base for its economic expansion. A successful policy learning process could eventually provide an alternative development model to the extreme form of a neoliberal economic global regime which is currently dominant. This could create the conditions, through a global demonstration effect especially in the developing world, for a new mild bifurcation within the post-industrial mode of innovation.

Beyond this, it is hard to imagine a deeper rupture in the current evolutionary path of global capitalism which could emanate from the BRICS. The relative success of the individual BRICS economies is now apparently written as the result of an engagement with the new globalised economy, with China as the main case in point in this regard, having emerged from a closed system to the world's second largest economy over a mere three decades. Regardless of its various travails, the high growth rates of the Indian economy and its increasingly visible presence in the world economy are seen as the result of its liberalisation policies since the mid-eighties, forgetting the innovation capacity which was built over the decades of protection before that. The terrible economic devastation of the nineties in Russia has now been superseded by the growth of its economy since the turn of the century. Like Russia, the democratic South Africa was born at the apex of the global neoliberal hegemony and, while there are clear indications that systemic human capability constraints are not being addressed, the country can still report positive GDP growth rates. The success of Brazil in systemically addressing the material conditions of life of its population along a development trajectory which can, and has, also been interpreted as another variation of the "third way" policy repertoire. It is therefore difficult to imagine a credible geopolitical alternative to a capitalist mode of innovation arising from the members of the BRICS group, whether individually or in unison. The recent slowdown in the rates of growth of the BRICS economies, with contractions in Brazil and South Africa, is in a way a further indication of the normalisation of the BRICS phenomenon within the prevalent global mode of innovation.

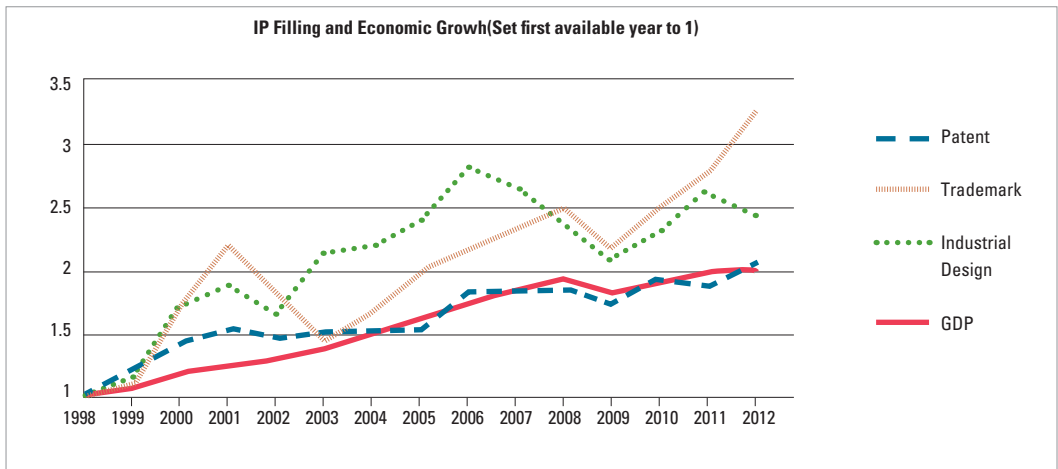
Appendix 1. Intellectual Property Filings and Economic Growth Rates for the BRICS Economies

Brazil



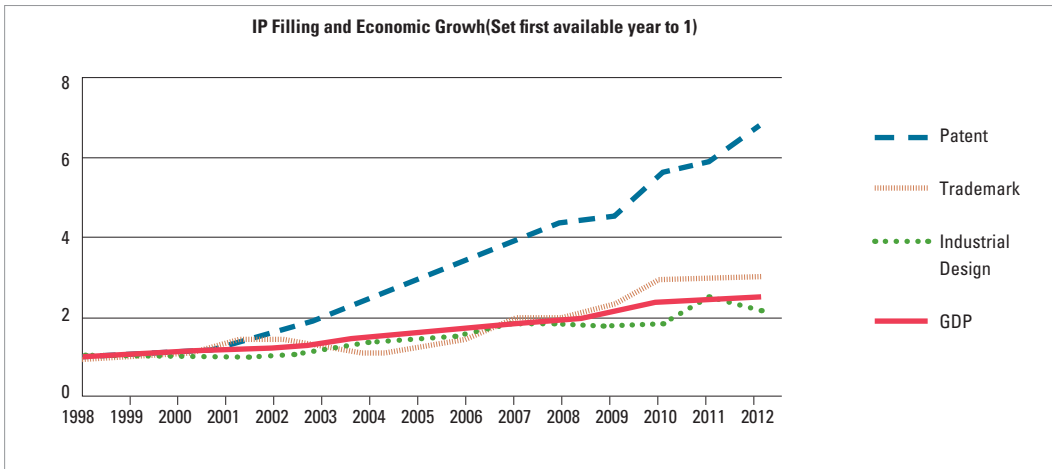
Source: WIPO Statistical Services at [http://www.wipo.int/directory/en/details.jsp?country\\_code=BR](http://www.wipo.int/directory/en/details.jsp?country_code=BR)

Russia



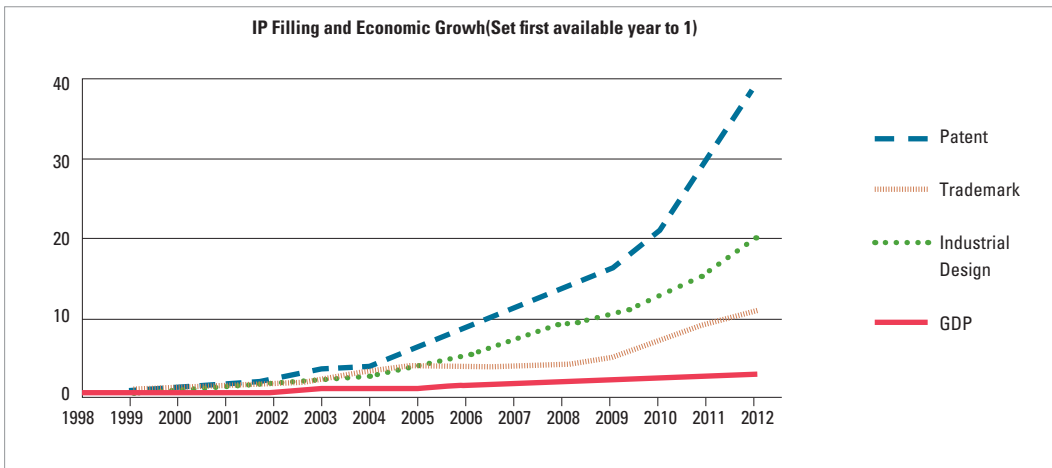
Source: WIPO Statistical Services at [http://www.wipo.int/ipstats/en/statistics/country\\_profile/countries/ru.html](http://www.wipo.int/ipstats/en/statistics/country_profile/countries/ru.html)

## India



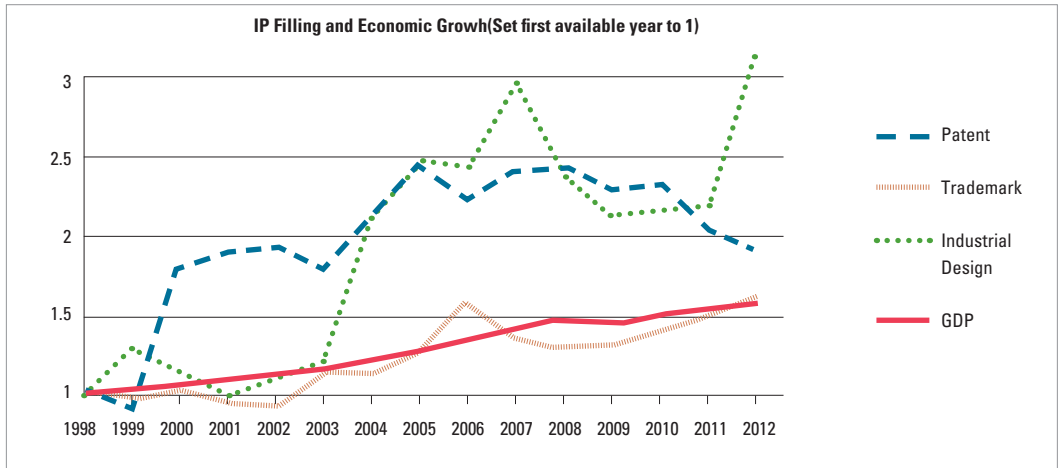
Source: WIPO Statistical Services at [http://www.wipo.int/ipstats/en/statistics/country\\_profile/countries/in.html](http://www.wipo.int/ipstats/en/statistics/country_profile/countries/in.html)

## China



Source: WIPO Statistical Services at [http://www.wipo.int/ipstats/en/statistics/country\\_profile/countries/cn.html](http://www.wipo.int/ipstats/en/statistics/country_profile/countries/cn.html)

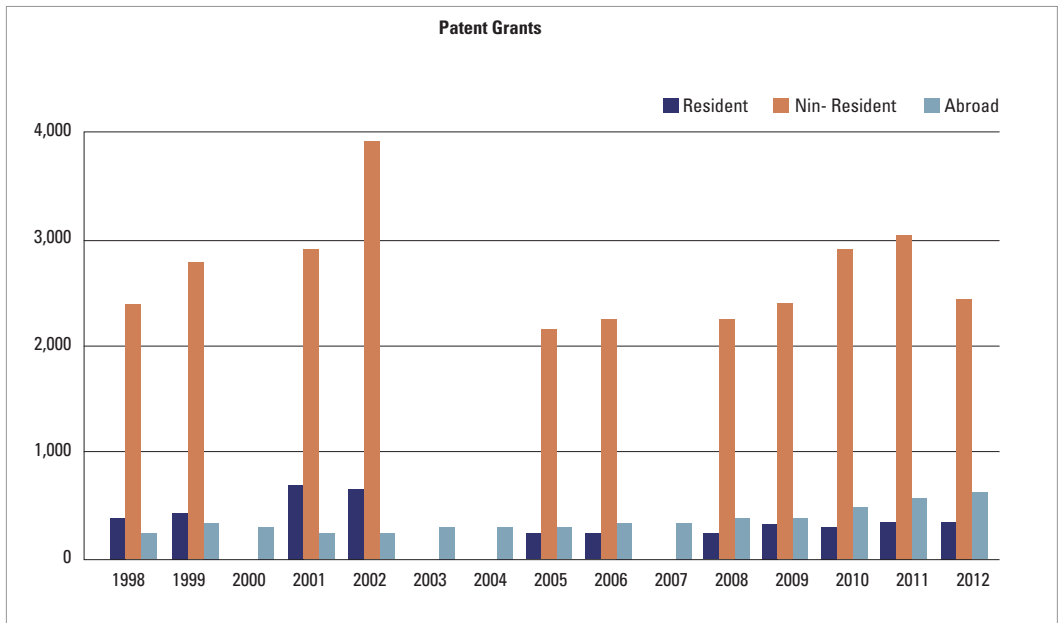
South Africa



Source: WIPO Statistical Services at [http://www.wipo.int/ipstats/en/statistics/country\\_profile/countries/za.html](http://www.wipo.int/ipstats/en/statistics/country_profile/countries/za.html)

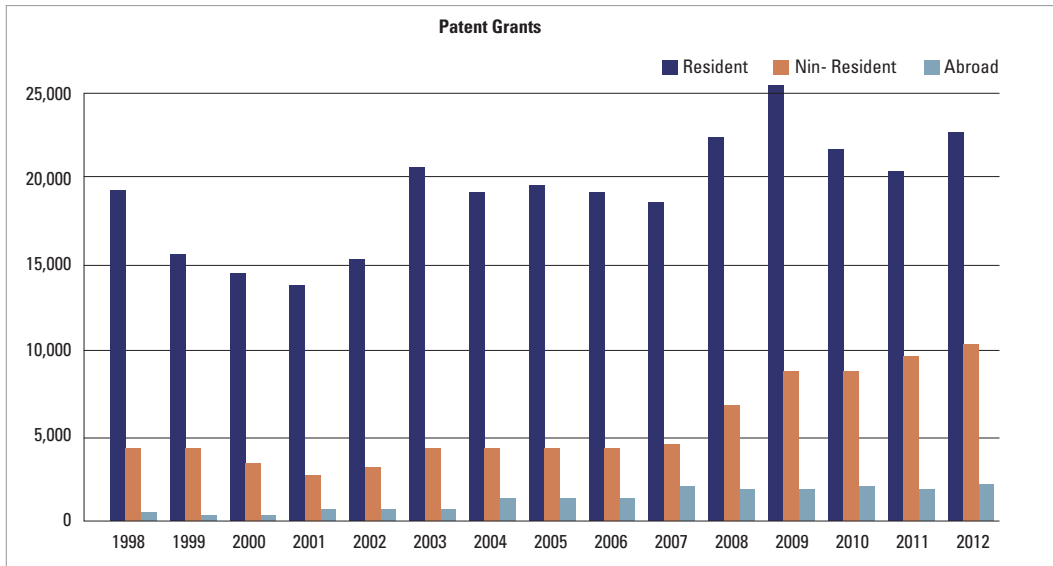
Appendix 2. Patent Grants by Source for the BRICS Economies

Brazil



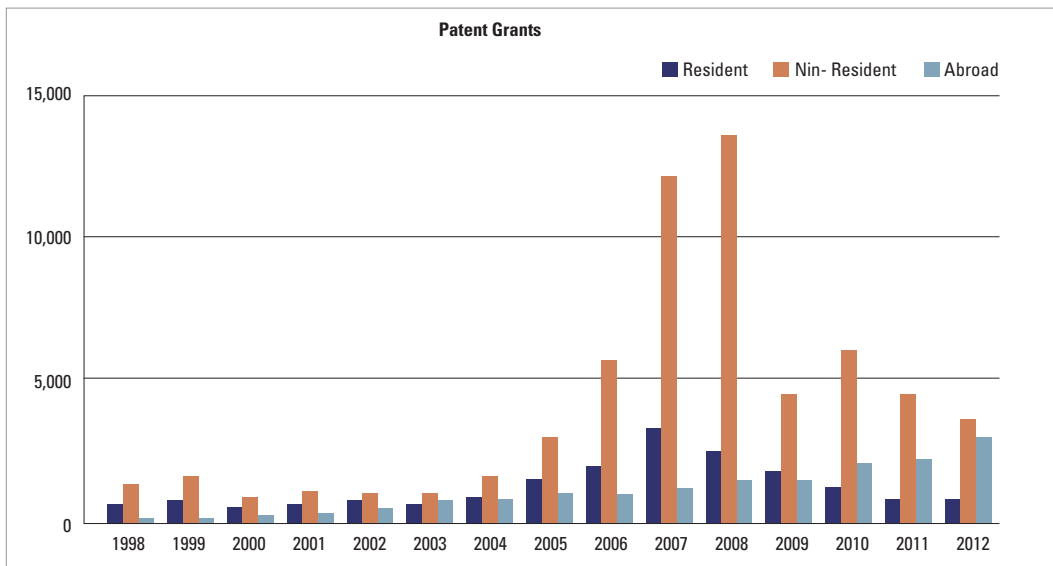
Source: WIPO Statistical Services at [http://www.wipo.int/directory/en/details.jsp?country\\_code=BR](http://www.wipo.int/directory/en/details.jsp?country_code=BR)

## Russia



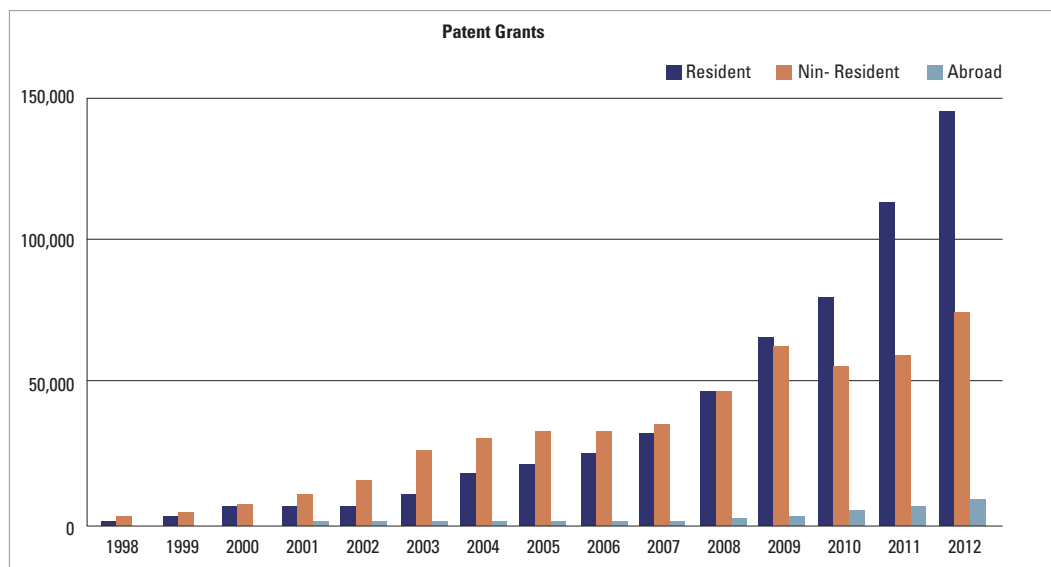
Source: WIPO Statistical Services at [http://www.wipo.int/ipstats/en/statistics/country\\_profile/countries/ru.html](http://www.wipo.int/ipstats/en/statistics/country_profile/countries/ru.html)

## India



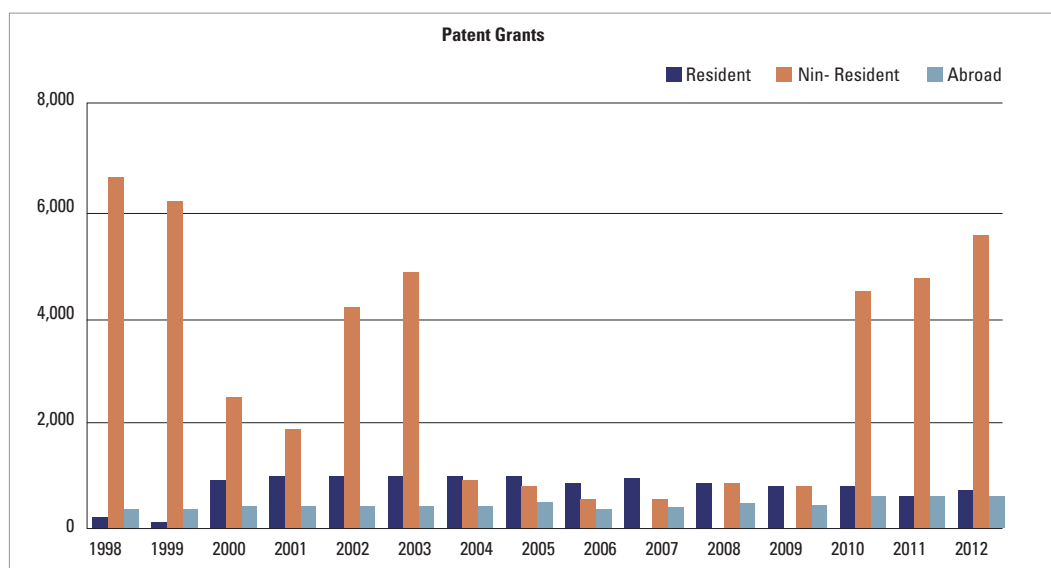
Source: WIPO Statistical Services at [http://www.wipo.int/ipstats/en/statistics/country\\_profile/countries/in.html](http://www.wipo.int/ipstats/en/statistics/country_profile/countries/in.html)

## China



Source: WIPO Statistical Services at [http://www.wipo.int/ipstats/en/statistics/country\\_profile/countries/cn.html](http://www.wipo.int/ipstats/en/statistics/country_profile/countries/cn.html)

## South Africa



Source: WIPO Statistical Services at [http://www.wipo.int/ipstats/en/statistics/country\\_profile/countries/za.html](http://www.wipo.int/ipstats/en/statistics/country_profile/countries/za.html)

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