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Abstract

This paper deals with comparative analysis of the patent systems of the BRICS countries. A close comparative look at the patent systems of these countries will give us some idea of the technological capabilities of these countries and hints at their future role in technology generation. The five BRICS countries vz., Brazil, Russia, India, China and South Africa have differing patent histories, patent laws and domestic patent application numbers. Their patent systems were a reflection of their political and social histories; and the stage of their economic development. A close look at the patent systems of these countries shows that they are not reached a mature state. These patent systems are not yet of robust health. From this one can say that they will take a much longer time to start generating technology in any meaningful way.

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1 Introduction

Brazil, Russia, India, China and South Africa form the BRICS countries. It was formed in 2006 by Brazil, Russia, India and China, as BRIC. South Africa joined the group in 2010 to make it BRICS. BRICS is not a conventional economic grouping. It is neither a customs union nor a trade block. Its economic shape is yet to take shape. The most important characteristic of the countries in this grouping are the size of the country, they are large countries area wise as also population wise. BRICS account for 26.94 percent of world land area and 41.79 percent of world population. These five countries account for 20.14 percent of the world GDP. What is the economic role this grouping known as BRICS perform? One is not yet sure.

While developed countries have withdrawn from agriculture long ago (as shown by the negligible share of agriculture in GDP); they have started withdrawing from industry in the past two decades (again shown by the declining share of industry in GDP). Their economies are becoming more service oriented. One question which arises in this context is whether the withdrawal of developed countries from industry and manufacturing will have larger implications for technology generation from these countries. Put it another way do those countries which gained by the relocation of industry start generating technology too. Is there a relation between manufacturing and technological capability? It used to be so in the past, but will the developed countries continue to generate technology with only a small manufacturing capacity. If so, for how far into the future? Will BRICS start generating technology?

This paper deals with comparative analysis of the patent systems of the BRICS countries. A close comparative look at the patent systems of these countries will give us some idea of the technological capabilities of these countries and hints at their future role in technology generation. The next section will deal with brief recent economic histories as well as the histories of the patent systems of BRICS countries. Section 3 will deal with the latest pre-TRIPS patent law in these countries. Section 4 will deal with the post-TRIPS patent law in BRICS countries. Section 5 will analyze the available patent data from BRICS countries. Section 6 will offer some concluding remarks.

2 History

This section will take a brief look at the recent economic histories of the BRICS countries and also the histories of patent systems of these countries. All the BRICS countries except China had their earliest patent laws in place by the 19th century.

Recent economic histories: It is important that we keep in mind the recent economic histories of the BRICS countries when we are discussing their patent systems.

Brazil: Brazil was under a military dictatorship between 1964 and 1985. The economic policies followed during this period resulted in both growth for some time and hyper inflation later. Return to democracy and gradual liberalization policies followed from the early to mid 1990s started to recover the economy. The liberalization program of the 1990s coincided with the adoption of the TRIPS agreement at the WTO in 1994. The unstable economy had a profound impact on a long term instrument such as the patent system. There is long term stagnation in the domestic patent applications. The Brazilian patent office takes about 10 years to grant a patent which is a very long time given that earlier the patent term was 15 years and after 1996 it was 20 years.

Russia: The collapse of the Soviet Union in 1991 has had a devastating impact on the invention system of Russia. It virtually collapsed. But Russia put together a working patent system very quickly, in fact by 1993 a new patent system was in place. After declining for about 10 years the domestic patent application have stabilized and are growing slowly, its well on its way to recovery.

India: In 1991 India started its liberalization process. It chose to fully utilize the transition period provided in the TRIPS agreement. Its domestic patent applications are growing slowly.

China: China's economic liberalization started in 1978. Its reliance on export led growth strategy worked. It never had a patent system. It adopted a patent system only in 1984 with technical help from Germany. The performance of domestic patent applications especially since 2000 is remarkable.

South Africa: The end of apartheid in 1994 had an impact on the patent system in South Africa. Its economy as well as its patent system is slowly adapting to the new economic and social systems and it may take a long time.

Histories of patent systems

Brazil: Brazil's earliest patent law dates back to 1809. It was a founder member of the Paris convention which came into force in 1884. Till November 1992 Brazil adhered to

The Hague Act, 1925 of the Paris convention as far as the substantive provisions were concerned. Hence it used the flexibilities provided by the Paris convention to adhere to a 'lesser' level of patent protection. Brazil abolished product patents for pharmaceuticals in 1945 and process patents pharmaceuticals in 1969.

Russia: Russia's first patent law dates to 1812. After the Russian Revolution in 1917, it replaced its patent law with an 'inventor's certificate' law in 1931. 'Inventor's Certificate' system while recognizing the inventor did not entitle monopoly over the invention. If the invention was used then the inventor got some remuneration. It started giving patent protection to foreign inventions in 1955. It joined the Paris convention (as Soviet Union) in 1965. It adhered to the Stockholm Act, 1966 of the Paris convention in April 1970.

India: The first patent law in India dates to 1856. A relatively modern patent law was adopted in 1911, which was in force when India became independent in 1947. The government of independent India started the process of enacting an independent patent law right in 1947 but they succeeded only in 1970, a process which took 23 years. The Patents Act, 1970 came into force in April 1972.

China: China did not have a patent law till 1984. In 1984 it enacted a patent law with technical help from Germany.

South Africa: The first patent law of a unified South Africa was passed in 1916. It joined the Paris convention in 1947, adopting the Stockholm Act, 1966 of the Paris convention in 1975. The South African patent system is a deposit or a non-examining system, which effectively means that it is not a 'real' patent system. Surprisingly it is one of the major countries still with a registration patent system.

Comments:

The five BRICS economies had completely differing histories in the past about 50 years. Russia and China are transiting from socialist to capitalist economies, through China in a much more orderly fashion. Brazil and India are undergoing liberalization of their economies since the 1990s. South Africa is yet to recover from its apartheid history.

On patent front too BRICS countries have differing histories with some similarities. Brazil and Russia had their earliest patent laws in place by early 19th century, while India adapted a patent law in the second half of the same century. China never had a patent law in its history till 1984. South Africa adapted a patent system only in 1916; it

is still a registration and not an examining country. Only Brazil joined the Paris convention in the 19th century, all the other BRICS countries joined it only in the 20h century.

3 Pre TRIPS Patent Law

In this section we will discuss the last substantive patent law that the BRICS countries had before the WTO TRIPS Agreement came into force in 1995. We will discuss the substantive patent law under three important provisions viz., coverage, duration and compulsory licensing.

Brazil: The Code of Industrial Property No. 5772/71 of 1971 was the law governing patent protection in Brazil when the TRIPS came into effect in 1995. The important provisions of the patent law were as follows.

Coverage: Chemical products, pharmaceutical products and processes, food products, and micro organisms were not patentable (Article 9).

Duration: The patent term was 15 years from date of application (Article 24).

Compulsory licensing: A compulsory license can be granted in case of non-use or not meeting the market demand (Article 33). Imports are not to be considered as working of the patent.

Russia (as Soviet Union): Between 1931 and 1991 all the domestic inventions in the then the Soviet Union were protected with essentially an 'inventor's certificate', under 'Regulations on inventions and technological improvements' first issued in 1931, modified in 1939, 1941, and 1959. Under the 'inventor's certificate' system the inventor had the right to be identified as an inventor and granted a certificate he has no monopoly rights over the invention. When the invention is used the inventor receives a royalty payment. While the 'inventor's certificate' system is not the same as a patent system it was an alternative used by the socialist countries. While 'patents' existed in theory they were actively discouraged for domestic inventions. Foreigners applied for patent protection.

Coverage: Chemical substances were not protected. New and improved species of plant and animal life were protected.

Duration: There was no fixed duration of protection for 'inventor certificate' protection. Patents were granted for the duration of 15 years.

Compulsory licensing: Inventor certificate system does not require compulsory licensing provisions. There was no compulsory licensing provision governing foreign patents.

Hence the system of 'inventor's certificate' for domestic inventions was in place for about 60 years in the then Soviet Union from 1931 to 1991. A proper and unprejudiced historical evaluation of this system has not yet taken place. The following table gives data on domestic inventor certificate applications in the then Soviet Union between 1980 and 1991.

Table 1 Domestic inventor certificate applications in the then Soviet Union 1980-91

Year	Applications
1980	164852
1981	146228
1982	156972
1983	149447
1984	145910
1985	165625
1986	169450
1987	178047
1988	172057
1989	145266
1990	113362
1991	21875

On average there were 144000 inventor certificate applications in the then Soviet Union between the year 1980 and 1991. The highest was in the year 1987 when it reached 178047 and the lowest was in the year 1991 at 21875 inventor certificate applications the year in which the Soviet Union collapsed. The inventor certificate applications declined by as much as 7.96 per cent per annum during this period.

India: In 1970 the Indian Parliament passed the Indian Patents Act, 1970 replacing the colonial the Patents and Designs Act, 1911. This act came into force in 1972. The main provisions of this law were as follows.

Coverage: Chemicals, pharmaceuticals, food and agricultural chemical inventions were granted only process inventions. Biotechnological inventions were not explicitly prohibited but by convention were not granted patents.

Duration: The duration of patent protection was 14 years from the date of application. But for pharmaceutical and agricultural chemical inventions the duration was seven

years from the date of application or five years from the date of grant which ever was shorter.

Compulsory licensing: India had stringent compulsory licensing provisions. Three years of grant if certain criteria are fulfilled the Patent Office could grant a compulsory license. The criteria were: the market demand not being fulfilled; the patented product not being available at reasonable prices in the market and an export market not being fulfilled. The prospective licensee had to approach the patentee for a voluntary license and if it is refused then the prospective licensee had to approach the Patent Office for a compulsory license. Apart from this food, pharmaceutical and agricultural patents came under 'licenses of right' where the prospective licensee had a right to a license by right; the only area of dispute could be the license fee which the Patent Office had the right to adjudicate.

China: China adopted its patent law only in 1984; just ten years before the TRIPS agreement was adopted in 1994. The main provisions of this law were as follows.

Coverage: The 1984 Patent law of China excluded product patents for chemical and pharmaceutical inventions from patentability; and food, beverages and seasonings from patentability (Article 25).

Duration: The patent term was 15 years from the date of application (Article 45).

Compulsory licensing: The 1984 law provided that the patentee use the patented invention by himself or by permitting others, within three years after the grant of the patent. If the patent was still not used after three years without a reasonable justification then a compulsory license could be issued by the Patent Office (Article 51).

South Africa: South Africa has a registration/non-examining patent system which makes it very weak. The current law in South Africa was also the last pre TRIPS patent law. It was enacted in 1978. It was amended four times before the adoption of TRIPS Agreement in 1994 (viz., in 1979, 1983, 1986 and 1988); and four more times after the TRIPS Agreement in 1994 (viz., 1996, 1997, 2001 and 2002). Let us see what its main provisions provide.

Coverage: All fields of technology are patentable. This South African patent law of 1978 was based on the United Kingdom Patent Act of 1977. Hence its Section 25(4)(b) reflects and anticipates the confusion created by Article 27(3)(b) of the TRIPS Agreement which was borrowed from the Strasbourg Convention of Council of Europe dating to 1973 (Rao [2002a]). Such an early and providential adherence to the TRIPS agreement is remarkable.

Duration: The patent duration was 20 years from the date of application (Article 46).

Compulsory licensing: The Patents Act of 1978 (as amended up to 1988) provided for a strong compulsory licensing system. Section 56 of the Act stated that the grounds for granting of compulsory licenses were: the patent not being worked in South Africa, importation of the patented article is hindering working of the patent in South Africa, the demand is not being met, and price of such imported patented article is excessive (Article 56).

The following table gives the data on domestic patent applications in South Africa during the apartheid period which lasted till 1994.

Table 2 Domestic patent applications in South Africa 1980-94

Year	Applications	Year	Applications
1980	3092	1988	4829
1981	3340	1989	5134
1982	3017	1990	1093
1983	4240	1991	1023
1984	3874	1992	888
1985	4051	1993	904
1986	4730	1994	935
1987	4922		

During this 15 year period the average number of domestic patent applications was 3070 and the annual growth rate was 10.58 per cent.

Pharmaceutical industry in the BRICS countries and the pre TRIPS patent law:
All said and done it is a fact that patent system is important for the pharmaceutical industry. Taylor and Silberston [1973] first pointed out this phenomenon. Various countries at various points of time in history tried to reduce patent protection to pharmaceutical inventions. The trade off here was the possible generation of pharmaceutical inventions with a high level of patent protection on the one hand; and the higher prices for pharmaceutical products which this high level of patent protection entails, leaving many people not being able to afford those pharmaceutical products. This contradiction of giving 'lesser' level of patent protection was commented upon by Kahn [1962], "The denial of patents in most countries on medicines, articles of food, or chemical compounds are more intriguing, since they to appear to involve a serious contradiction. The rationale must be that the dangers of monopolistic retardation are intolerable in areas so closely affecting the public interest. But by the same scheme of values, technological progress in these areas ought to be exceptionally desirable. If the

patent system is conducive to such progress it makes little sense for society to refuse to pay the price when the public benefits are greatest; if it is not, there would seem to be little point in having a patent system anywhere. The only possible reconciliation, which does in fact find some support in practice, is that in areas of such general social interest society prefers to pay the price in other ways - for example, by taxpayer-financed research, public awards, or very indirectly by protective tariffs." This paradox has never been properly resolved and it may not be possible to resolve it.

Almost all the BRICS countries have given lesser level of patent protection for pharmaceutical inventions at some point in their history. It was done mainly to either reduce the prices of pharmaceutical products or to develop an indigenous pharmaceutical industry or both. Ballance, Pogany and Forstner [1992] give a typology of the world's pharmaceutical industry according to research and manufacturing capacities. One may feel that a 1992 typology may not be relevant now, but technological capabilities in any industry and especially pharmaceutical industry do not change frequently, they take several decades to build and stay that way for quite a long time. Ballance, Pogany and Forstner put Russia, India and China in category B which is defined as 'countries with innovative capacities'. They say 'each country in this group discovered and marketed at least one NME between 1961 and 1990'. This is quite a lax standard of one NME in 29 years. While Russia and China have not been really important inventors in the pharmaceutical sector, India also did not really achieve much in inventing and innovating new pharmaceutical products. India developed capabilities of reverse engineering the processes and developing new processes (Dhar and Rao [2003]). Brazil is categorized as a country in C1 category with 'those producing both therapeutic ingredients and finished products'. They categorize South Africa as C2, 'those producing only finished products'.

Similar policies with regard to pharmaceutical patens led to different outcomes in Brazil and India. One of the reasons for this could be that supplementary policies viz., foreign direct investment, technology policies, price control policies etc. were not the same. Exploring this issue Guennif and Ramani [2012] say that even with a lot of capacity building in this sector, while Brazil has dominance of MNCs, in India the dominance of MNCs in this sector is re-emerging. Schuren [2012] points out that while India chose export led strategy in pharmaceuticals, Brazil's emphasis was catering to the domestic market and this led to differences in technological capability in this sector in these countries.

Comments:
Among the five BRICS countries there were considerable differences in the provisions relating to coverage, duration and compulsory licensing. Russia had mostly a system of

'inventor's cerificates'. Apart from that pharmaceutical product patents were not granted in Brazil, China and India and pharmaceutical process patents were not granted in Brazil. While Brazil protected micro organisms all the patent systems did not mention biotechnology patents reflecting the times when biotechnology did not have any presence. As far as duration was concerned it was 15 years in Brazil, China and South Africa. It was a more complicated system in India where while for everything else it was 14 years, it was only 7 years for pharmaceutical inventions from the date of application.

Compulsory licensing provisions in the patent laws of BRICS countries were very comprehensive. The grounds on which compulsory licensing were issues covered: non use (Brazil, India, China and South Africa); not meeting market demand (Brazil, India and South Africa) and excessive price of the patented article (India and South Africa).

In summary it can be said that BRICS countries used the flexibilities offered by the Paris Convention in having different provisions to cover the important parts of the patent protection such as, coverage, duration compulsory licensing.

4 Post TRIPS Patent Law

In this section we will discuss the post-TRIPS patent law in the BRICS countries. We will use the same format as the pre-TRIPS patent law discussed in the last section. We will discuss coverage, duration and compulsory licensing. As such the TRIPS agreement did not leave much leeway for the member countries to shape their patent laws suited to their particular requirements, but let's see whether the so-called 'flexibilities' of the TRIPS agreement did get expressed in the patent laws of the BRICS countries.

Brazil: Brazil was a founder member of the General Agreement on Tariffs and Trade (GATT), and so of the World Trade Organization (WTO). It was an active participant at the Uruguay Round of Multi-lateral Trade Negotiations. In the Negotiating Group on Trade Related Aspects of Intellectual Property Rights (TRIPS) it opposed the inclusion of TRIPS under GATT, but later agreed to discuss it. At the later stages developing countries were unable to reduce the high norms and standards put in the TRIPS Agreement by the developed countries.

It signed the TRIPS agreement in 1994. Brazil had three options to make its patent law TRIPS consistent: 1) Implement TRIPS agreement by January 1, 1996 with no need to institute 'pipeline' protection for pharmaceutical inventions); 2) as a developing country it could implement the TRIPS agreement by January 1, 2000 (with no need to institute 'pipeline' protection for pharmaceutical inventions?); 3) as a country with no process or product patents for pharmaceutical inventions, bringing about product patent protection for pharmaceutical inventions after a transition period of 10 years (January 1, 2005)

but with a provision for providing 'pipeline' protection for pharmaceutical inventions. This pipeline protection meant accepting product patent applications for pharmaceutical inventions from January 1, 1995 itself, but actual examination and grant only from January 1, 2005.

Brazil chose the first option to make its patent law TRIPS consistent by January 1, 1996, a time frame fixed for developed countries. It also chose not to opt for the 10 year transition period for introducing product patents for pharmaceutical inventions. So there was no need to constitute provisions for pipeline protection for pharmaceutical inventions from January 1, 1995. This path was probably chosen as the country was in the midst of carrying out economic reforms and changes in its patent law were seen as a part of the larger process.

On May 14, 1996 Brazil promulgated the Patent Law No.9279. It came into effect on May 15, 1997. Let us see the main provisions of this law.

Coverage: Agricultural chemicals, chemicals, food and pharmaceutical inventions are granted product patents. The coverage of biotechnology is discussed in Chapter II Section I Article 10 (IX) and Chapter II Section III Article 18 (III). What is clear from these articles is that genetically modified micro organisms seem to be patentable. What about other biotechnology inventions covered under Article 27 (3) (b) of the TRIPS agreement?

Duration: Patent term is 20 years from the date of application (Chapter IV Section II Article 40).

Compulsory licensing: Chapter VIII deals with compulsory licensing provisions. The grounds on which a compulsory license could be issued are: abuse of patent rights, abuse of economic power conferred by patents, non-working of the patent in Brazil (except in the case of un-viability) Section III Article 68. Article 71 provides that a 'temporary ex officio non-exclusive' compulsory license in the case of national emergency or public interest can be granted. The inclusion of 'public interest' in this provision is interesting; it can have a broad interpretation.

Public health crisis in Brazil: During 2000 Brazil facing a public health crisis in the form of HIV/AIDS started a program called 'Free Distribution of Aids Drugs for All Programme'. Under this program 12 drugs under combination therapy were distributed. Seven of these drugs were not under patents in Brazil (but were under patents elsewhere) and were manufactured in Brazil. Five of the drugs were imported, two of which (Efivirenz of Roche and Nelfivanir of Merck) were under patents in Brazil. These two

drugs constituted 36 percent of total cost of providing the combination therapy. The Brazilian government while conducting R&D in its public laboratories for the possible production of these two drugs, negotiated with these drug companies for reduction of prices for importing these drugs. The Brazilian government was successful in reducing the import prices of these drugs. The Brazilian government is cautious of increased prices of combination therapy in the future once new drugs under patents become part of it. Interesting in this case no compulsory licence was issued.

The US had taken Brazil to the Dispute Settlement Panel in 2001 for the provision of 'local working' being a ground for the issuance of compulsory licensing. This dispute was later with drawn on the understanding between these two countries that the Brazilian government will notify the US - Brazil Consultative Mechanism if the Brazilian government is contemplating using Article 68 involving US firms. This amounts to back tracking by the Brazilian government. It would have been interesting to see how the WTO Dispute Settlement Mechanism would have interpreted Article 68 of Brazilian patent law.

Russia: Russia was not a member of the GATT/WTO when the TRIPS Agreement was adopted in 1994. So it was not under any immediate obligation to make its patent law TRIPS consistent. Russia became a member of WTO only in 2012. Soon after the collapse of the then Soviet Union in 1991 Russia adopted Patent Law No. 3517-1 on September 23, 1992. This law was amended 2000, 2001 and 2003. Later in 2006 a new 'Civil Code of the Russian Federation' was passed. Chapter 72 of Part IV of this code deals with the Patent Law. This was amended in 2008 and 2009. We will discuss only the first version and the latest version of the patent law in Russia regarding coverage, duration and compulsory licensing.

Coverage: Article 4 of the original 1992 law and Article 1350 of the 2006 law deal with coverage of patent protection. Chemical and pharmaceutical inventions are granted product patents. As far as biotechnology is concerned strains of micro-organisms and cultures of vegetal or animal cells are granted patents. Plant varieties and animal breeds are not granted patents. But the 2006 law narrows this provision and provides: "Legal protection as inventions shall not be granted to: 1) varieties of plants, breeds of animals and biological methods of obtaining thereof with the exception of microbiological methods and products obtained by the use of such methods". This seems to have been done to comply with Article 27 (3) (b) of the TRIPS Agreement. Interestingly while the 1992 law included 'use of a known …. strain for a new purpose', the 2006 law excludes this provision. In an extravagant gesture Article 1349 (4) provides that: '1) methods of cloning of a human being; 2) methods of modification of the genetic integrity

of cells of embryonic line of a human being; 3) use of human embryos for industrial and commercial purposes;" shall not be granted patents.

Duration: Article 3 (3) of the 1992 law provides for a patent duration of 20 years from the date of application. Article 1363 (1) of the 2006 also provides for a patent term of 20 years from the date of application at the patent office. It also provides for extension of patent term of those products which require marketing approval viz., agricultural chemicals or pharmaceuticals by a maximum term of five years.

Compulsory licensing: The 1992 law did not contain any provisions relating to compulsory licensing. Article 1362 of the 2006 law provides for compulsory licenses. This provision provides that in the case of non-use or insufficient use of a patent which results in not meeting the demand of the market, a non-exclusive compulsory license can be issued. There is a mention in this provision of: 'The effect of a compulsory simple (non-exclusive) license may be terminated by judicial procedure on a suit initiated by the patent holder if the circumstances that resulted in granting such a license cease to exist and their appearance is unlikely', is a verbatim reproduction of a sentence in Article 31 of the TRIPS Agreement. Such a provision makes a compulsory license unattractive to a prospective licensee who has to invest in using a patent through compulsory license but cannot know whether the circumstances which were present at the time of grant of a compulsory license will prevail in the future or not. Russia does not have provisions relating to emergency compulsory licenses.

India: India chose to carry out several amendments to its Patents Act, 1970 rather than have a new patent law. Right from the beginning this meant a patch work on some incompatible elements. First the 1994 amendments: India chose to utilize the transition period of 10 years for the introduction of product patents for pharmaceuticals. Because of severe opposition in the country this ran into problems right from the beginning. The so-called transition period entailed putting in place a mechanism at the Patent Office to receive product patents for pharmaceutical inventions overnight from January 1, 1995. This India could not do because the Ordinance which they promulgated on December 31, 1994 lapsed as it was not passed by the Indian parliament within 3 months. After several ordinances and laws and a dispute at the WTO with the US a retrospective law finally passed in March 1999. Second the 1999 amendments: Most of the substantive provisions had to be amended by January 2000 when the 5 year period to enact TRIPS consistent legislation was supposed to be put in place. India did this only in May 2003. Finally the 20004 amendments supposed to bring the product patent regime for pharmaceuticals into operation and also start examining and granting product patents for pharmaceutical patent applications done from January 1, 1995 to

December 31, 2004. This amendment was passed by the parliament in March 2005. Finally a TRIPS consistent patent law was in place. The provisions were as follows.

Coverage: Product patents for chemical and food inventions were introduced from January 1, 2000. Product patens for pharmaceutical (including agricultural chemicals) were introduced from January 1, 2005. As far as biotechnology inventions are concerned, micro organisms have been made patentable. India chose the path of explicit exclusion rather than explicit inclusion as its way of listing biotechnology inventions which are patentable. This leaves a lot of areas included in patentable biotechnological inventions. From a reading of the sections concerning biotechnology inventions given in section 3 (j) non-biological and micro-biological processes for the production of plans and animals are patentable, which makes it complete TRIPS consistent.

Duration: The patent term is 20 years from date of application from 2000.

Compulsory licensing: As mentioned earlier India had comprehensive compulsory licensing provisions in its 1970 law. Apart from that it had 'licenses of right' provisions covering pharmaceutical patents. The first casualty was 'licenses of right' provisions which were done away in 2000. But India chose to retain almost the entire compulsory licensing provisions in Section 84 and some subsequent sections, but with one change. The change was that a provision concerning non-fulfillment of export markets as a ground for compulsory licensing was removed. But all the other provisions providing the grounds on which a compulsory license can be issued such as, non-use, not meeting market demand and excessive price of the patented article were retained.

China: China was not a member of WTO when the TRIPS Agreement was adopted in 1994. It became a member of the WTO only in 2001. While China enacted a Patent Law only in 1984 with technical help from Germany, and it did not need to adhere to the TRIPS agreement till it became a member of the WTO in 2001, the United States through its bilateral measure put pressure on China to amend its patent law in accordance with the TRIPS Agreement. It amended its patent law in 1999 and 2000 before it became a member of WTO and again in 2008.

In 1992 China amended its Patent Law in accordance with the 'Memorandum of Understanding between the Government of the United States and the Government of the People's Republic of China on the Protection of Intellectual Property'. The amended provisions were as follows.

Coverage: The exceptions to patentability under the 1984 law were removed. Hence chemical, food, beverage, seasoning and pharmaceutical invention came under patentable subject matter.

Duration: The duration was increased from 15 years to 20 years from the date of grant; this made it TRIPS consistent much before TRIPS Agreement took a shape in 1994.

Compulsory licensing: The three years wait period for grant of compulsory licensing was replaced with the vague 'reasonable duration of time'.

The provisions relating to coverage, duration and compulsory licensing as per the latest version of the Chinese patent law are as follows:

Coverage: All technological fields are patentable. Article 25 permits for the production methods of animal and plant varieties to be granted patents.

Duration: Patent term is 20 years from date of application.

Compulsory licensing: The 2008 amendment made extensive changes to the provision on compulsory licenses. A compulsory license can be granted: if a patent is not exploited or fully exploited; or if the patent right has been used as a monopoly with a negative impact (Article 48). Interestingly article 49 provides for grant of compulsory licenses in the case of 'national emergency or extraordinary state of affairs'. Article 50 provides for compulsory licenses to meet the obligations of Para 6 of the Doha Declaration.

South Africa: South Africa which has a registration system has enacted a patent law in 1978 and amending it periodically to make it TRIPS consistent. The main provisions of the latest version of the act are as follows.

Coverage: All technological fields are patentable.

Duration: The patent term is 20 years from the date of application.

Compulsory licenses: The Patents Act of 1978 (as amended up to 2002) provided for a strong compulsory licensing system. Section 56 of the Act stated that the grounds for granting of compulsory licenses were: the patent not being worked in South Africa, importation of the patented article is hindering working of the patent in South Africa, the demand is not being met, and price of such imported patented article is excessive. This seems to cover the non-emergency compulsory licensing provisions. There is no provision for any emergency compulsory licensing provisions in its patents law.

Public Health Crisis in South Africa: South Africa faced a public health crisis in 2000. Instead of using the patent law it used 'Medicines and Related Substances Act, 1965 to institute parallel imports. 'Medicines and Related Substances Act, 1965' (as amended in 1997) covers parallel imports. Sec. 15C of this act authorizes the Minister of Health

to prescribe conditions for the supply of more affordable medicines in conditions of need to protect the health of the public. According to the then Foreign Minister of South Africa this measure is not only to respond to emergencies relating to public health but to make all medicines affordable (South Bulletin, March 20, 2001). In fact South Africa refused to declare national emergency regarding AIDS epidemic and use the emergency compulsory licensing provisions.

The relevant section is as follows: "Measures to ensure supply of more affordable medicines

Sec. 15C The Minister may prescribe conditions for the supply of more affordable medicines in certain circumstances so as to protect the health of the public, and in particular may -

(a) notwithstanding anything to the contrary contained in the Patents Act 1978 (Act No. 57 of 1978) determine that the rights with regard to any medicine under a patent granted in the Republic shall not extend to acts in respect of such medicines which has been put onto the market by the owner of the medicine or with his or her consent;

(b) prescribe the conditions on which any medicine which is identical in composition, meets the same quality standard and is intended to have the same proprietary name as that of another medicine already registered in the Republic, but which is imported by a person other than the person who is the holder of the registration certificate of the medicine already and which originates from any site of manufacture of the original manufacturer as approved by the council in the prescribed manner, may be imported; …".

Sec. 15C (a) allows international exhaustion, which will enable South Africa to permit parallel imports.

Sec. 15C (b) allows parallel imports to protect public health.

The Pharmaceutical Manufacturers Association of South Africa (which is an association of MNC drug manufacturers in South Africa) and thirty-nine pharmaceutical companies challenged this law in the Pretoria High Court in 1998. After a lot of negative publicity the pharmaceutical firms withdrew the case in April 2001. Hence an opportunity was lost on judicial pronouncement on the TRIPS compliance of the South African law.

In both the cases developed countries withdrew the cases at the last minute to deny any substantial victory for developing country viewpoint. But these two developments led to a 'clarification' of the compulsory licensing provisions of the TRIPS Agreement through the Doha Declaration on the TRIPS Agreement and Public Health of 2001.

Biotechnology industry in the BRICS countries and the post TRIPS patent law:
Even though it generated a lot of controversy traditional chemical based pharmaceuticals was not the main issue, it was the patenting of biotechnology inventions that will have far reaching impact on the technology development of the future. Unfortunately the biotechnology provision of TRIPS was not properly discussed in the Negotiating Group during the Uruguay Round, and a legacy of the European Patent Convention with its confusing wording slipped into the TRIPS agreement. The whole idea of the TRIPS agreement may be to appropriate benefits from future biotechnology inventions mainly in agricultural and medical, with a strong worldwide patent system through the TRIPS agreement itself.

Biotechnology could be conveniently divided into: plant, animal and chemical (including medical) biotechnologies. Agricultural and medical biotechnologies will be very useful for developing countries. Even though its potential is being discussed in the past three decades it has fallen short of its promise. It may take longer than expected. But developing countries have not shown any indication that biotechnology is any easier to develop than conventional technologies. In agriculture where it is still important developing countries have not shown any inclination to develop technologies on their own. It seems a mastery of generation of industrial technology is a pre-requisite for being able to generate agricultural technologies. If developing countries could develop agricultural biotechnologies they could be more 'appropriate' to their needs.

What about medical biotechnology? Henderson; Orsenigo and Pisano [1999] point out the paradigm shift in pharmaceutical inventions from 'random drug discovery' to 'targeted drug discovery'. They say those countries which shifted from 'random drug discovery' to 'targeted drug discovery are better placed to take advantage of the technological possibilities of medical biotechnology. None of the BRICS countries have been identified as those countries with a possible role in developing future medical biotechnologies. Neither the private sector nor the public sector in these countries is putting in enough effort and R&D to get any break through.

Comments:
While the TRIPS Agreement has been successful in standardizing the patent term to 20 years, it was not that successful in standardizing norms and standards concerning coverage of biotechnology inventions and compulsory licensing.

Coverage: There is standardization also in the area of product patents for chemical, pharmaceutical, food, and agricultural chemicals. The confusion on biotechnology inventions is mainly because of the not well worded provision of Article 27 (3) (b). While plant and animal biotechnologies are being focused upon the chemical (including

medical) biotechnologies are well within the ambit of patenting in all the BRICS countries. Micro organisms have been explicitly mentioned in the patent laws of Brazil and India, but while Brazilian law says genetically modified, Indian law just says micro organisms. Methods of producing plants and animals are mentioned in the patent laws of Russia, China and South Africa, but while Chinese law says just methods, Russian and South African law says micro biological methods. In addition in Russia products obtained from such micro biological methods are patentable. India chose to explicitly mention that essentially biological methods of producing plants and animals are not patentable. This may mean a lot of technologies may be patentable.

Compulsory licenses: Article 31 of the TRIPS Agreement and the Doha Declaration on TRIPS and Public Health had been interpreted in the following way (Rao [2009]). There are three types of compulsory licenses possible, 1) classic compulsory licenses; 2) emergency compulsory licenses; and 3) anti-trust compulsory licenses. As far as classic compulsory licenses are concerned all the BRICS countries have non-use as a ground for compulsory licenses; not meeting market demand is a ground for compulsory licenses in India and South Africa. Excessive price is a ground for compulsory licenses in India and South Africa. Emergency compulsory licensing provisions are included in the laws of Brazil, India and China. South Africa deals with public health issues of patent protection (including emergency situations) through its 'Medicines and Related Substances Act, 1965'. Interestingly none of the BRICS countries have experimented with anti-trust compulsory licensing provisions. These countries come from the tradition of dealing with patent abuses within the patent laws rather than through anti-trust laws.

5 Patent Data

Annual Reports of patent offices report on the working of the patent office. This will in turn shed light on the working of the patent system in that country. The Annual Reports give data on patents, which could be brought together in a time series. We assumed that the Annual Reports of the patent offices of the BRICS countries will have useful, consistent and comparable data so that one can attempt a comparative analysis of the working of the patent systems in these countries. But that was not the case. The annual reports of the patent offices of the BRICS countries did not have any comparable data on patents except patent applications data.

Availability of data on the following variables would have led to useful economic analysis of the patent systems of the BRICS countries: 1) grant data by date of application of the patent; 2) average time taken to grant a patent from the date of application; 3) ownership pattern of the patents granted viz., individuals, firms and not-for profit institutions; 4) classification of the patents granted by sector of use

Standard Industrial Classification (SIC); and 5) expiry pattern of patents. But unfortunately we have to make do with the data on patent applications year wise. But patent applications data is very interesting over a period of time.

Patents as an indicator of inventive activity

There are at least two problems that need to be taken into account while using patents as indicators of inventive activity. The first is the fact that not all patentable inventions are patented. Mansfield [1986] estimates that while in the pharmaceutical, oil and machinery industries, more than 80% of patentable inventions are patented, it is only 60% in case of primary metals and automobile industries. This not only shows that some patentable inventions are not patented but also points out to inter-industry differences in patenting. The inter-industry differences in propensity to patent arise from the fact that while some industries such as pharmaceuticals depend on patent protection as an appropriation mechanism the others do not. Taylor and Silberston [1973] showed that fine chemical industry in general and pharmaceutical industry in particular depend on the patent system. The reasons for this are that, inventions in pharmaceutical industry are easier to imitate and there are low entry barriers to this industry. Industries such as aircraft industry depend much less on the patent system; while they spend heavily on R&D, their patent output is very small.

The second is that there are considerable differences in quality among patents. While some patents are important, most of the others are not. There have been attempts to quantify differences in quality of patents through the use of number of claims, renewal information and citations. The most successful of these attempts was the patent renewal models. Many countries have a requirement that for the patent to be effective it has to be renewed periodically. The main reason for this is to weed out economically useless patents from being in force. Hence, we can assume that a patent, which has been renewed through its lifetime, is more valuable than the one, which was allowed to lapse. Using the patent renewal information and patent fee schedules Schankerman and Pakes [1986] have shown that the distribution of private value of patents is highly skewed, while a few patents are very valuable, a large majority of patents do not have any value.

Use of patent applications data

The major flaw with using applications data is that only some of the patent applications are granted patents. The other problem is that the grant ratio is not constant over time. Patent grant data is a more direct measure of inventions than patent applications, because patent applications go through an examination at the patent offices and only those applications, which fulfill the patentability criteria, are granted patents. But even patents granted by a patent office may not be a good indicator on inventive activity. A significant proportion of patents whose validity is challenged are held to be invalid by courts. One

reason given is that the patent offices, do not have the resources to do a thorough examination of each and every patent, whereas a court is obliged to conduct a thorough examination of a patent in order to determine its validity (Engel [1985]).

While applications have a time dimension to it, grant data does not have. This can be explained by the fact that while the patent applicants decide the date of application, the practices of the patent office decide the date of grant. Griliches [1989] discusses how the resources available to the patent office determine the grants. Some time these grants do not follow the trends in applications.

While applications for a year belong to that particular year, grants for a particular year contain applications made in different years. We regard the time dimension as contained in the applications data to be important hence we use applications data. The ideal data set will be grant data arranged according to date of application, but such data are not available. In India we also do not have a breakup of patent application data ownership wise viz., individuals, firms and not-for profit entities which could lead to further analysis of applications data.

While this discussion is relevant for both developed and developing countries, there are some additional problems concerning the situation in developing countries. In these countries patent applications are of low quality. The quality of patent examination by patent offices tends also to be of low quality. Most of the patent applicants are individuals or not-for-profit institutions, while the patent applications by private firms are comparatively low (Rao [2002a]). Despite all the problems patent applications data will tell us something about the technological capability of a country.

Let us have a close look at the characteristics and long term trends in patent applications data of the BRICS countries covering 31 years from 1980 to 2010. The source of data is the WIPO patent database available at http://ipstatsdb.wipo.org/ipstats/searchresultsTable. We have filled up some missing observations by taking an average of the two adjacent observations.

Brazil: The following table gives data on domestic patent applications in Brazil for the years 1980 to 2010. The average number of domestic patent applications for the entire 31 year period was about 2800 per annum with a compound growth rate of 2.38 percent per annum. The lowest was in the year 1986 at 1855 and highest at 4084 in the year 2008.

Table 3 Domestic patent applications in Brazil 1980-10

Year	Applications	Year	Applications	Year	Applications
1980	2149	1991	2319	2002	3365
1981	2171	1992	2100	2003	3689
1982	2116	1993	2429	2004	3958
1983	2302	1994	2269	2005	3905
1984	2062	1995	2707	2006	3810
1985	1954	1996	2611	2007	4023
1986	1855	1997	2756	2008	4084
1987	2451	1998	2491	2009	3921
1988	2338	1999	2816	2010	2705
1989	2323	2000	3080		
1990	2389	2001	3323		

According to trends this 31 year period can be divided into two periods. The first period covers 1980 to 1997 and the second period covers 1998 to 2010. During the period 1980 to 1997 domestic patent applications were on average about 2300 per annum and grew at 1.35 percent per annum. During the period 1998 to 2010 the average domestic patent applications was 3474 per annum and the growth rate was 2.31 per cent per annum. If we exclude the year 2010 which saw a low number of domestic patent applications the average goes up to 3538 per annum and the growth rate was 4.68 per cent per annum. Long term trends in domestic patent applications show that there is long term stagnation in Brazil.

Albuquerque [2000] reports that of the domestic patents granted by INPI during 1980-95, 34.4 percent belonged to individuals; 52.5 percent belonged to firms and 13.1 per cent belonged to not-for-profit institutions. It is interesting to note that more that 50 per cent of patent grants belong to firms, which is a very healthy trend.

Russia: The following table gives data on domestic patent applications in Russia for the years 1992 to 2010. The average number of domestic patent applications for the entire 19 year period was about 24000 per annum with a compound growth rate of only 1.10 percent per annum. The lowest was in the year 1997 at 15106 and highest at 39494 n the year 1992.

Table 4 Domestic patent applications in Russia 1992-10

Year	Applications	Year	Applications
1992	39494	2002	23712
1993	28503	2003	24969
1994	21250	2004	22985
1995	17551	2005	23644
1996	18014	2006	27884
1997	15106	2007	27505
1998	16454	2008	27712
1999	19900	2009	25598
2000	23377	2010	28722
2001	24777		

According to trends this 19 year period can be divided into two periods. The first period covers the years 1992 to 1997 and the second period covers the period 1998 to 2010. During 1992 to 1997 domestic patent applications declined by 16.64 per cent per annum with the average number of domestic patent applications being 23319. The second period covering 1998 to 2010 saw a growth rate of 3.27 per cent per annum with the average number of domestic applications being 24403. The collapse of the Soviet Union had a drastic impact on the patent systems of Russia and it took only a relatively short time of about 6 six years for its patent system to recover and start growing. Since then it has been growing steadily.

India: The following table gives data on domestic patent applications in India for the years 1980 to 2010. The average number of domestic patent applications for the entire 31 year period was about 2580 per annum with a compound growth rate of 7.39 percent per annum. The lowest was in the year 1985 at 982 and highest at 8312 in the year 2010.

Table 5 Domestic patent applications in India 1980-10

Year	Applications	Year	Applications	Year	Applications
1980	1207	1991	1267	2002	2693
1981	1067	1992	1248	2003	3425
1982	1128	1993	1209	2004	4014
1983	1065	1994	1588	2005	4721
1984	1003	1995	1545	2006	5686
1985	982	1996	1661	2007	6296
1986	999	1997	1926	2008	6425
1987	988	1998	2247	2009	7262
1988	1033	1999	2206	2010	7500
1989	1048	2000	2206		
1990	1147	2001	2379		

According to trends this 31 year period can be divided into two periods. The first period covers 1980 to 1987 and the second period covers 1988 to 2010. During the period 1980 to 1987 domestic patent applications were on average about 1055 per annum and declined by 2.55 percent per annum. During the period 1988 to 2010 the average domestic patent applications was 3110 per annum and the growth rate was 10.16 per cent per annum. Long term trends in domestic patent applications show that the domestic patent applications are growing since 1988.

Rao [2002a] reports that of the domestic patents granted by the Indian patent office for those patent applications done during the years 1972-96 30.42 percent belonged to individuals; 28.50 percent belonged to firms and as many as 41.08 per cent belonged to not-for-profit institutions. It is interesting to note the very low percentage of patents belonging to firms and also the large percentage owned by the not-for-profit institutions. Coupled with the considerable percentage of patents belonging to individuals this is a clearly a developing country patent system.

China: The following table gives data on domestic patent applications in China for the years 1985 to 2010. The average number of domestic patent applications for the entire 26 year period was about 55160 per annum with a compound growth rate of an impressive 19.46 percent per annum. The lowest was in the year 1987 at 3975 and highest at 293066 in the year 2010.

Table 6 Domestic patent applications in China 1985-10

Year	Applications	Year	Applications
1985	4065	1998	13751
1986	3494	1999	15626
1987	3975	2000	25346
1988	4362	2001	30038
1989	4749	2002	39806
1990	5832	2003	56769
1991	7372	2004	65786
1992	10022	2005	93485
1993	12084	2006	122318
1994	11191	2007	153060
1995	10011	2008	194579
1996	11628	2009	229096
1997	12672	2010	293066

According to trends this 26 year period can be divided into two periods. The first period covers the years 1985 to 1999 and the second period covers the years 2000 to 2010. During the period 1985 to 1999, covering 15 years, the average number of domestic patent applications was 8722 and they grew by 11.87 per annum. The year 2000 saw a breakthrough in the Chinese patent system and it grew at an astonishing pace in the second period. During the period 2000 to 2010 the average number of domestic applications grew to 118486 and the growth rate of domestic patent applications was an astounding 28.67 per cent per annum. This level of performance is unprecedented in the patent world. What are the reasons for such an outstanding performance of China?

Hu and Jefferson [2009] give a partial explanation for the dramatic increase in domestic patent applications in China; increase in R&D activity, increase in FDI and amendment to its patent law n 2000 giving stronger patent protection. But this reasoning is not sufficient to explain the phenomenal growth in domestic patent applications in China since 2000. In fact Hu and Jefferson's paper covers China's domestic patent applications till 2007, and China's domestic patent applications continued to increase more dramatically (if possible) over the next three years.

South Africa: The following table gives data on domestic patent applications in South Africa for the period 1995 to 2010.

Table 7 Domestic patent applications in South Africa 1995-10

Year	Applications	Year	Applications
1995	883	2003	922
1996	757	2004	956
1997	355	2005	1003
1998	200	2006	866
1999	138	2007	915
2000	895	2008	860
2001	966	2009	822
2002	983	2010	821

The 16 year period from 1995 to 2010 saw an average of domestic patent applications of 770 per year. The growth rate of domestic patent applications during this period was 5.55 per cent per annum. The end of the apartheid has had a profound impact on the patent system of South Africa. There was a drastic decline in the number of patent applications. The average number of applications which was 3070 during 1980-94 fell to 770 during 1995-10. The growth rate of applications also fell from 10.58 per cent to

5.55 per cent. The South African patent system is still to recover from the shock. The reasons for such a drastic impact are unknown and have not yet been studied.

Comments:

Domestic patent application data is a robust indicator of technological capability of a country. According to the aggregate domestic patent application data for the period 1995 to 2010, the ranking of the five BRICS countries was: China, Russia, India, Brazil and South Africa. While patenting activity in South Africa is very low; Brazil and India belong to the middle group. While Russian domestic patent applications are growing steadily in recent years, China's growth performance has been outstanding.

6 Concluding Remarks

The five BRICS countries vz., Brazil, Russia, India, China and South Africa have differing patent histories, patent laws and domestic patent application numbers. Their patent systems were a reflection of their political and social histories; and the stage of their economic development.

A close look at the patent systems of these countries shows that they are not reached a mature state. These patent systems are not yet of robust health. From this one can say that they will take a much longer time to start generating technology in any meaningful way.

But BRICS should start coordination of policy relating to patents at the international level to begin with and then may be at the national level. One immediate issue on which they can start acting upon and one in which can have short term results will be to cooperation in the field of public R&D in medical biotechnology.

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