

## **BRICS International Competitiveness on Innovation Capacity ----Evidence from Cross Countries Comparison**

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### **Abstract**

As innovation become one of the important aspects of international competitiveness, instrument for measuring innovation: synthetic indicators at the country level are developing at the same pace. On the way towards the innovation country, the most important thing for China is that we should catch up with the innovation system of developed country and challenge with their innovation capacity. At the same time, we should found our own innovation mode in the competition with the BRICS. Therefore, we design our own innovation capacity index base on comparable country level data to give a continuous comparison of national innovation capacity. Especially we focus on the BRICS country not only their innovation capacity but also the economic benefit from innovation.

Keywords: countries comparison, economic performance, innovation capacity index

### **1. Introduction**

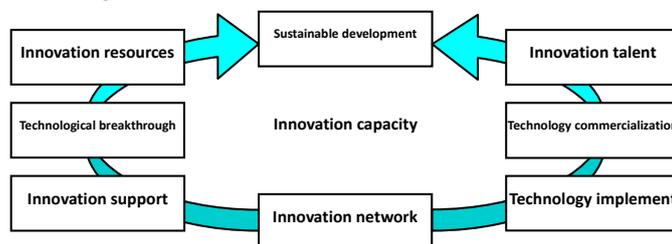
The notion of innovation country is point out by the academia of the world aimed at emphasizing on the innovation as the driving force of the world's development. The innovation country refers to the country which places the science and technology innovation as the basic strategy and improves the innovation capacity rapidly, forming strong superiors in the international competitiveness. On 9th January 2006, Chairman Hu Jintao declared the aims of the development of the Chinese science and technology for the coming 15 years that China will be the innovation country in the year 2020 with the strong support of science and technology to the development of the whole economy and society. On the way towards the innovation country, the most important thing for China is that we should catch up with the innovation system of developed country and challenge with their innovation capacity. At the same time, we should found our own innovation mode in the competition with the BRICS. Therefore, we make use of the World Competitiveness Yearbook from 1994-2010 by the IMD to analyze the innovation capacity and competitiveness of the 57 main counties and regions dynamically. Base on the theory of economics of innovation and innovation index, we take the average level of the 57 county as the standard and try to find out the factors that determine the innovation capacity of the BRICS and the trend of their development. To extend our study, we also try to explore the relationship between innovation and economic development by quantile regression to find out whether different level of economic benefit differently from the innovation enhancement to economic.

### **2. International innovation index**

Composite synthetic indicators of the technological capabilities of nations have

been used more frequently over the last years becoming a sort of Olympic medal table of the innovation race. Among these indicators systems, the most successful attempt to rank countries' position on the ground of economic and technological indicators comes from the World Economic Forum (WEF). The Technology Index (Tech) has been calculated for the first time in 2001/2002 for 75 countries from 1997 to 2000. In the 2006/2007 GCR edition, Tech considered 125 countries, divided in two groups: core economies and non-core economies, according to the number of granted patents. The Technology Achievement Index, developed by UNDP and reported in the Human Development Report 2001 with a comparison of 84 countries. Another one is ArCo, a composite indicator which takes in consideration variables relative to three different dimensions of technological change for 162 countries and two years, 1990 and 2000 (Castellacci and Archibugi, 2008). Since 2000 the European Commission has published every year the European Innovation Scoreboard (EIS) aiming at assessing the progress of the objectives concerning innovation set by the Lisbon Strategy as of March 2000. The EIS 2007 includes innovation indicators and trend analyses for the EU27 Member States as well as for Croatia, Turkey, Iceland, Norway, Switzerland, Japan, the US, Australia, Canada and Israel. All these indicator systems have their own angle in analyzing innovation capacity, but none of them have a time series long enough to see the trend of innovation capacity in the world.

To get a general view of the innovation situation of China, it is inevitable to introduce international comparison. Based on the theory of innovation index, we design the analysis system in Fig.1 and make use of the World Competitiveness Yearbooks from 1994 to 2010 to measure and compare the innovation capacity of the main 57 countries and regions in the world.



**Fig.1 The international innovation index system**

### **3. The analysis of international innovation index from 1994-2010**

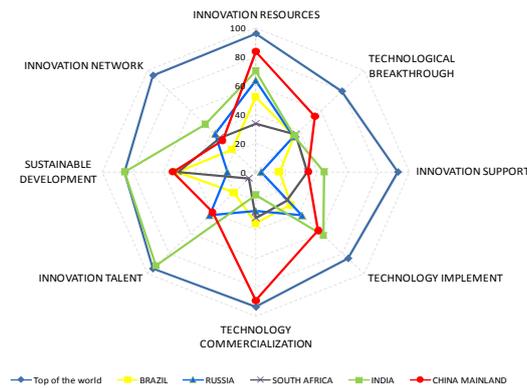
#### **3.1 The international innovation index of 2010 and its trend**

In the synthesized comparison of the international innovation index in 2010, China ranks at the 22th, which decrease by 5 positions compared to the result of 2008. Since the 57 countries included in our comparison are all countries with stable economy and society, the ranking result of China may be considered that the innovation capacity of China is above the average. And notice after it suffered from the financial crisis, the ranking of the USA came back to number one, followed by Singapore. Rely on the great emphasize on the science and technology education and the cultivation and support of the high-tech human resources, Singapore ranks the first in 2008 and now second in 2010 considering the recovery of the USA. Of course, the USA is indubitably the pioneer of the innovation activities around the world. Since the new technology based on the computer and internet is mostly stem from the USA, the

innovation superior of the USA will continue. As for Singapore, a typical innovation country, with higher management and innovation efficiency attributed to the small size of the country, the national innovation system developed well, which make it the first one in the innovation ranking of our study.

When it comes to the BRICS, the India has a little bit advanced but equivalent level to China. But Russia, Brazil and South Africa have relatively low innovation index value. As a whole, the innovation level of the BRICS is not match with their economic development speed, which is a problem that might cause anxiety. And the effects of the financial crisis greatly challenge the national system of many countries.

**3.2 The innovation superiors and inferiors of countries in the world**



**Fig.2 Comparison of innovation factors of the BRICS in 2010**

From Fig.2 we can see that the innovation modes are quite different between the BRICS. Although China has the second highest innovation index values, it is not excellent in all aspects. The superiors of China are in the innovation resources, the capability to conduct breakthroughs and also the technology implement and commercialization. All these superiors are needed in the primary stage of innovation mode. In the hope of bring high quality innovation, the increase of innovation input and quality of research are inevitable, and results in new product and innovation value added. But the innovation developing mode of India is totally different, of which the large superior is the innovation talent cultivation. And the advantage of this aspect also helps make the innovation sustainable, in company with extraordinary innovation support and network. The mode of India is a more advanced innovation, which commence from the innovation support and duration to enhance the innovation. With the help of the government, the talented persons can better service for the innovation activities, in order to make it sustainable. That is more or less the weak point of China innovation system. Of course, the innovation capacity of India is affected by the relatively low level of innovation resources, the achievement on core technology and the commercialization of the innovation result, which leads to an unbalanced innovation. The innovation mode of Russia is similar to that of China, the main motivation of which is the resources input and the capability to make breakthrough. Russia also achieves good technology development, but since the lack of support from all aspects, the innovation vitality is quite weak. As for Brazil and South Africa, there is a certain gap between them and the three countries mention above. Basically, the innovation of Brazil is developed by the promotion of innovation resource and

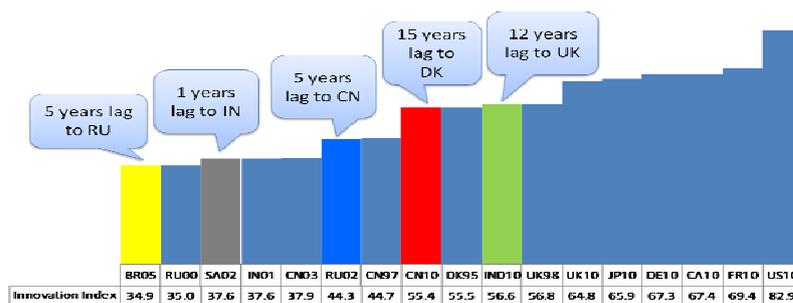
technology. And South Africa mainly relies on the innovation support and new product trade.

To summarize, the higher level innovation countries in the BRICS, India and China both have a unique develop mode. The mode for China is more typical with obvious short term effects, suitable for the country in the starting stage to realize the high speed of innovation growth, but it is not that favorable for the long term development. And the education driven mode of India is relatively prospective and makes the innovation activities a civil activity, which will offer the opportunity for the sustainable development of innovation. And the Indian mode is more suitable for the country in the mature stage to gain a long run development.

### 3.3 The innovation stage of innovation great power and the BRICS

In our study of the dynamic innovation capacity, we put together the data of all the indicators from 1995-2010 to the same analysis dimension to detective the development of each country during the decades. During the 15 years, China maintained an average of 6.6% speed, keeping the fast moving steps with a top ranking in terms of innovation development growth. And most of the top 10 countries are Asia countries and some European countries. The innovation centre of the world is transferring, and the innovation capacity of the western countries have entered the mature and saturation stage, so it is hard for them to achieve large amount of increase, while the rising Asian countries with perfect innovation systems are replacing the western countries to be the innovation main bodies.

The BRICS besides South Africa all have relatively high speed in this comparison board. Russia remains a speed of 4.42%, while Brazil and India remains around 3.5%. And the growth rate of South Africa is negative. Therefore, China is still the pioneer of the BRICS in the aspect of innovation. But the problem facing China is how to break the inherent mode, improve the quality of innovation and get into the next step of innovation.



**Fig.3 The innovation capacity of BRICS compared with developed countries**

Let us have a look at the innovation development stage of the BRICS as shown in Fig.3. There are great gaps between different countries. India is indubitably the top of the BRICS and the development trend of China indicates that it is catching up. Russia is following up and located in the third place. The highest level of Russia in 2002 is equivalent to that of China in 1997. That is to say, the innovation capacity of Russia is five years falling behind China. Notice that in the mid 1990s, there wasn't great gap between the level of China and other BRICS countries, but China grew rapidly during the recent years. The top level of South Africa emerged at the year 2002,

approximately equivalent to the level of India in 1999. It appears that the innovation capacity of South Africa fluctuates during the years, implying the instability of it is innovation development. The level of Brazil is relatively low, with a top level in the year 2005, only equals to the Russia level at the beginning of the 21 century.

In short, on the initial stage of innovation, the BRICS are almost standing on the same starting line, but gradually the division emerged. China and India begin to reveal the strong stamina to promote innovation, while Russia is trying to follow up. But the South Africa suffers a fluctuated development. And Brazil is apparently lack of staying power. Compared to the innovation mode of the developed countries, the common problems for the BRICS is the lack of capacity to realize the innovation and turn it to productivity. There is no lack of great amount of innovation input, talent personal and strong power to make breakthrough in the BRICS. But the low innovation capacity is caused by lacking a fine innovation resources management and allocation system, so that all kinds of resource cannot get a decent distribution, leading to the waste of resources. The urgent problem for the BRICS to tackle is learning the experience from the innovation great power, building up a suitable national innovation system and making good use of the government support and innovation network to keep the sustainable innovation development.

#### 4. From innovation capacity to economic development

Traditional growth theory emphasizes the incentives for capital accumulation rather than technological progress. With the acceleration of globalization process, innovation is more and more seen as the appropriate tool to create business value. And it's function in economy in terms of productivity growth in firms and the technology comparative advantage in international trade. But we are still wondering in what aspect the countries innovation capacity influence the economic development. And since we have countries with different economic performance which provide diversity to our sample, we can have an exploration of the innovation index and economy. To explore this problem in a precise way considering the difference in our sample, we do the quantile regression on innovation with economic performance and growth. The result is shown in Table 1.

**Table 1 Quantile Regression Result**

tau=	0.05	0.1	0.25	0.5	0.75	0.9	0.95
<b>Model 1 : GDP per capita</b>							
(Intercept)	1.314	1.104	1.330	1.471	1.540	1.673	1.744
innovation cap	-0.004	0.006	0.004	0.004	0.007	0.006	0.006
<b>Model 2 : GDP growth</b>							
(Intercept)	-3.312	-0.611	1.219	3.114	5.159	7.300	8.530
innovation growth	0.088	0.037	0.014	-0.003	0.008	0.009	0.010

Base on the model result we can see that innovation capacity do have the positive effect on economy performance especially in the highly developed countries such as the US and some great powers in the world. But the relation of innovation growth to economic growth is not that strong. Only in those countries with a relatively low level of growth, let's say they have already entered the mature level of development, the innovation of them shows a positive growth along with their economic growth.

## 5. Conclusion

To summarize, the innovation capacities of all the countries around the world are on different developing stage and level. As fresh troops, the innovation of the BRICS is growing rapidly. As for the innovation mode, the five countries differ from one another and also have different targets to obtain. Considering the unique situation of each country, we draw up the target or route for each country as follow.

For China, the main objective is to learn from German and the USA. First put the concentration on the interpenetration of innovation spirit. At the same time, the policy and laws must offer enough supports to innovation activities, in order to improve the cultivation of innovation human resource, innovation ideas and the status of innovation in the whole economy. And after the innovation is on the track, the great amount of innovation input was needed. With an optimized innovation environment, the innovation will extensively implement in all production procedures and enable a long lasting development. And the financial support also needs to be emphasized, building a more flexible financial market to encourage firms to take part in the innovation.

As for India and Russia, both are talents driven innovation countries, the target of them must be the mode of Japan to achieve a widely use of innovation technology. The new technology and cultivation of innovation personal are the best result of innovation. So what India and Russia should pay attention to is how to turn these technology achievements to real profit for firms and countries. The characteristic of Brazil is its technology realization capacity, so France and the UK might be the good example of Brazil. The urgent aspect for Brazil to improve is the science and technology research quality. A high quality innovation will achieve maximum results with little effort. The whole innovation of South Africa is relatively weak, and the weakest point is the talent cultivation. So South Africa should learn the experience from India and reform the education system in order to train more talent person for the future innovation.

All the BRICS country will share a considerate growth in economic growth if they keep their innovation capacity growing. But the urgent thing for them is to develop their financial system and make it more compatible and supporting to the innovation system of the countries.

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