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Russian innovation system in international comparison – the BRIC countries in focus

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1 Introduction

For the beginning of the 21st century, the emerging economies are challenging the more developed economies. One of the last indications of the increasing power of Brazil, Russia, India and China (the BRIC-countries) was evident in Yekaterinburg, Russia in June 2009. The leaders of the BRIC countries gathered there to discuss the new global order.

The Emerging Giants have already started to enter the global markets in full steam. In 2005, there were only 3 companies from Brazil, 3 from Russia, 5 from India and 16 from China which made it to the *Fortune Global 500*. Currently, there are 6 from Brazil, 8 from Russia, 7 from India and a massive 37 from China (Fortune 2009). A tremendous hike in just 4 years! Companies from BRIC-countries have also increasingly engaged in R&D activities. Consequently, 21 companies originating from BRIC countries are already among top 1,000 R&D investors in the world. The R&D spending of these BRIC companies has grown rapidly. Over last four years, the top R&D spenders have increased their R&D expenditure on average by 132% in Brazil, 95% in Russia, 43% in India and 59% in China. The growth rate of respective companies in the USA has been 24%, and only 15% in Europe.

Table 1 Countries of origin for top companies in terms of turnover and R&D spending

	Companies in Fortune Global 500		Companies in top 1,000 R&D investors	
	2005	2009	2005	2009
Brazil	3	6	3	3
Russia	3	8	2	1
India	5	7	1	12
China	16	37	3	5
Europe*	175	180	294	333
USA	176	140	423	378

* Europe excluding Russia

Source: DIUS (2009); Fortune (2009)

A part of this development may be explained by the investments of BRIC economies in innovation-based activities. Particularly, China and Brazil have improved their knowledge economy since 1995 (Table 2).

Table 2 Development of Knowledge Economy Indicators in selected countries

Country	Year	Position in the ranking	KEI*	Economic incentive regime	Innovation*	Education	ICT
Brazil	1995	69	5.23	4.81	5.98	3.95	6.17
	2009	54	5.66	4.31	6.19	6.02	6.13
Russia	1995	58	5.73	2.55	5.64	8.12	6.60
	2009	60	5.55	1.76	6.88	7.19	6.38
India	1995	108	3.56	3.47	3.70	2.56	4.50
	2009	109	3.09	3.50	4.15	2.21	2.49
China	1995	100	3.93	3.24	4.07	3.62	4.77
	2009	81	4.47	3.90	5.44	4.20	4.33
Western Europe	1995	16**	8.95	8.69	9.21	8.66	9.25
	2009	17**	8.76	8.71	9.27	8.29	8.78
United States	1995	2	9.53	9.29	9.55	9.44	9.84
	2009	9	9.02	9.04	9.47	8.74	8.83

* Innovation variables are weighted by population

** The ranking for Western Europe is calculated based on its KEI points

Source: World Bank (2009)

Earlier the BRIC countries were able to maintain economic growth by relying on vast pool of labour and natural resources. Now they have entered into a situation when these resources are not solely enough at least for long. Despite the recent progress, it must be remembered that the innovation systems remain underdeveloped in the BRIC countries. Therefore, it is not fair to compare these directly against more developed economies. Although they may learn from the past experience of more developed countries (Dezhina & Peltola 2008), in my opinion the position of Russian innovation system benefits from the comparison against its peers among the BRIC countries[1].

Although it is often analysed as a group, the BRIC-countries differ remarkably in their innovation potential. In this report, the innovation potential and challenges of each four countries are analysed separately. Each country is first analysed in terms of their internal resources. However, international cooperation is important in technology transfer and international learning so the countries external relations are also briefly discussed from the viewpoint of innovations. The usage of internal and external resources is dependent on economic incentives. Therefore, incentive regimes are also discussed in the report. The concluding discussion focuses on summarising the purpose of this report – **analysing Russia's position in the global innovation system with a special focus on its role among the BRIC countries.**

[1] Peltola (2008) has earlier compared the opportunities and challenges of Russian innovation development against more developed countries.

2 Brazil

2.1 Internal resources

The world may recognise Embraer, Havaianas and some Cachaça brands but honestly said – Brazilian companies have not performed well in the world markets. This may stem from the challenges of the Brazilian innovation system, which are manifold. The problems accumulate in the statistics: Brazil is not spending in R&D (1% of GDP), the little R&D investments are mostly undertaken by the public sector (approximately 60%), the private R&D investments are concentrated in few major companies, and the supply of venture capital is relatively scarce. (OECD 2006.)

In many terms these problems reflect the general view which Brazilian companies have towards innovations. In general, Brazilian companies do not show interest in long-term profit and are more focused in short-run gains which encourages using mediocre resources. The local experts have recognised that it is often more popular to hire a tax lawyer than R&D people, as lawyers are able to cash in faster. This cultural feature hinders the development of innovation system in Brazil and leaves innovative activities mainly to more globally oriented MNCs. There is also evident mistrust in public institutions such as politics and economy. Bureaucracy, corruption and complex taxation system discourage entrepreneurship, too. Rodríquez et al. (2008) have pointed the key messages in shifting Brazil into a knowledge economy: consolidating the macro economic environment – ensuring public investments, boosting innovation, and improving skills across the labour force.

Brazil's innovation system remains focused on academic research, and the coordination of the Brazilian innovation system between science and technology and industry and commerce is not very strong. (Rodríquez et al. 2008) The innovation issues are dispersed around various ministries and to different councils in these ministries. Consequently, it is difficult to identify a clear innovation policy in Brazil.

Innovation policy has recently been refocused on collaboration between the science and technology, R&D programmes and trade competitiveness (OECD 2006), which shows that the government has understood that innovation policy is much more than purely a scientific task, and has to be in line with the country's long-term strategy. Collaboration between universities and companies is encouraged by government

financing R&D via universities (covering almost two-thirds of overall governmental spending on R&D). There have also been interesting new projects, like Inova, an innovation agency created by the University of Campinas (OECD 2006). Otherwise the results may remain nominal. There was a new innovation law set in 2005 in order to strengthen the interaction between university and industry; promote the shared use of S&T infrastructure by firms and S&T institutions; stimulate the creation of new technology based firms by researchers; create new financial mechanisms for grants to R&D and innovation in firms. While it is considered to be a step in the right direction, administrative rules to implement the law have not yet been issued. Consequently, it has had virtually no impact since firms are reluctant to act, leery of how its provisions will be interpreted by tax authorities. (Finpro Brazil 2008.)

On the other hand there are success stories such as Embraer. In addition to airplane industry, Brazilian companies have world-class knowledge in agriculture, forestry, and deep sea oil (Finpro Brazil 2008). Brazil has number of “strategic areas” but there are clear differences between the industries in which they have established their position decades ago, and the industries which they seem to be interested in because they are expected to grow enormously in the future. Scientific progress is above average in the fields of photonics, materials science, biotechnology, agronomy and veterinary medicine, physics, astronomy and space sciences, microbiology and plant and animal sciences. For instance agricultural success is not solely based on preferable location but science base which has remarkably increased productivity. Particularly, sugarcane production is heavily researched, and there are numerous projects on bio ethanol. With few exceptions such as health, agriculture, petroleum, and aeronautics, there have been few explicit instructions to the R&D infrastructure to develop practical knowledge. There have also been encouraging scientific collaborative projects which have engaged Brazilian companies into commercially-oriented research projects. (OECD 2006.) As Brazil hosts 5% of the world’s arable land, it is well-positioned for the future. Although it is difficult to estimate the future markets, it is evident that the world needs food and the growing population puts even more pressure on the supply of foodstuff.

Focus on life sciences and sustainable development also positions Brazil well in the projected boom of environmental friendly solutions. In fact, Brazil is already the only industrialized country which generates close to half of its energy from renewable sources (Grützmann et al. 2009).

Brazil has been able to increase coverage but quality in basic education still remains low. The percentage of individuals with very low literacy skills exerts a strong negative effect on growth, as basic skills for the entire population appear as important to growth as the development of sophisticated, high-level skills within a country (Finpro Brazil 2008.) Therefore, remarkable growth in Master and Doctoral degrees during the past 20 years may not be sufficient to widen the innovation base of the country.

As the country is short of skills, the reasoning of innovation policy is on a vague basis. Of course the country can still develop a lot but the profitability of changes in taxation may come short as the skills of labour hinder the innovative activities. It may also be waste of money to coordinate the government's R&D funding via universities as their capacity to undertake innovative activities is relatively low even compared with countries on the same income-level.

There is a wide political consensus on the need for innovation and various programmes are launched to improve the situation. National Plan for S&T&I is targeting the innovation policy, and US$ 20 billion has been allocated in its development (Finpro Brazil 2008). R&D&I investments have been expected to increase to 1.5% of GDP by 2010, and eventually to 2% of GDP (OECD 2006). It remains to be seen whether this helps the country's economy. As R&D intensity is a measure of costs and GDP, it does not necessarily measure positive development of the economy. Therefore, more telling would be to have more companies in the Fortune Global 500 list among the largest companies in the world. Perhaps, apart from natural resource-dependent companies, this tells that R&D money is well spent. The economic crisis has, however, discouraged investments and it remains to be seen whether these expectations are realistic. The government has announced that the economic crisis would not have negative impact on the Brazilian innovation system but in reality budget cuts seem to be evident.

It is difficult to say what kind of innovation producer Brazil can be in the near future. Brazil's new S&T&I Action Plan does not define the explicit goals for innovation development but defines the resources which will be allocated until 2010. However, Brazil's new industrial policy sets several ambitious medium term goals, and it is expected that at least the priority programmes will advance. (Finpro Brazil 2008.) Most of the recent plans have been put into action which is good news but the results of

these actions remains to be seen. Although these measures are considered to have positive impact on the Brazilian innovation system, it takes a lot of time to make visible changes in an economy with a size of Brazil.

2.2 External resources

The Brazilian concept of a national innovation system devotes little explicit attention to acquiring foreign knowledge or to disseminating knowledge (Finpro Brazil 2008). However, a new Council for International Co-operation has just been formed at the Ministry of Science and Technology.

Although Brazilian companies seldom have formal collaborative ventures for innovations, they are still co-operating with their suppliers and customers and even imitating their competitors (OECD 2006). Brazilian Coteminas has also international R&D centres in the United States and Asia (Accenture 2008).

The refocused innovation policy has also resulted in changes on the foreign trade and industrial policy which has been more integrated to the target of innovation policy (OECD 2006). As companies are faced by foreign competitors, they must increase their innovative effort to stay on the business. And this competition should not only be considered to be against the Western companies but also other BRIC companies hungry for market share in the global economy.

Despite the cuts in tariffs during the past decade, importing foreign resources remains expensive (OECD 2006). It is positive that there have been no hikes in customs and taxes during the economic crisis but they still add up 60–70% to the FOB prices. This encourages looking for domestic alternatives, which may result in the usage of worse quality resources and thus hinders the development of Brazilian competitiveness.

As a result of openness towards international markets, foreign companies have invested massively in the country. Despite the increased interest of foreign companies to invest in Brazil, they have not really undertaken innovative projects there. According to statistics, foreign companies use less money for R&D than domestic companies in Brazil (OECD 2006).

2.3 Economic incentives

Brazil started to develop an innovation system earlier than most other then-developing and developed countries. Yet, Brazil is underperforming in innovation, and it is not getting as much for its R&D efforts as it should. In fact, Brazilian firms have been found to innovate less than those of other countries.

One major reason for the underperformance in innovation development is the trade policy which protected domestic producers from foreign competition and cut the need for the private sector to invest in R&D or its commercial applications. These weaknesses still lie at the heart of Brazil's lacklustre economic growth (Finpro Brazil 2008).

There is relatively little demand for innovation in the unsophisticated internal market. Protection continues to undercut the need for innovation and creative risk taking. The lack of competitive pressure on the home market has most probably also affected the eagerness of Brazilian companies to apply for international patents and to pay license fees for foreign companies (OECD 2006).

To some extent the lack of interest in investing in R&D may also be explained by macroeconomic volatility and high interest rates, which does not encourage companies to take risky actions (OECD 2006). Traditionally, money has been expensive but recently Brazilian central bank has been able to lower interest rates – even during the financial crisis. Real interest rates still remain closer to 30%, which discourages investments. Although Brazilian Development Bank offers loans with lower rates, investments are seldom targeted in innovations.

There have also been tax incentives established in order to lower the costs on foreign machinery and royalties (OECD 2006). The tax incentives have mostly been directed to ICT industry but the level of the ICT industry is further away from international breakthrough than other strategic areas which have better basis in the scientific competence of the country.

3 Russia

3.1 Internal resources

Russia seems to be the worst positioned among the BRIC countries on the innovation front. There is a clear distinction between the innovation inputs and outputs, as the private sector is not interested in getting involved in R&D and interaction with public sector researchers (Kaartemo et al. 2009). The current problems are further emphasised by negative demographics which leads to ageing R&D personnel.

Good news is that the Russian innovation environment is developing. A number of factors, such as developing legislation system, governmental support to regional innovation development agencies, increasing availability of financial resources (such as public funds, private venture companies, business angels, and growing interest of global venture capital towards Russia) is turning Russian economy to more innovative direction. The Government is promoting the innovation policy on all levels of education and economy. Particularly, President Medvedev has repeatedly emphasised the importance of innovations to the economic development of the country. However, it is quite telling that innovations were not in reality seen as the way out from the economic crisis, as public R&D expenditure was cut by up to 30% for 2009. Also otherwise the government's reaction to the economic crisis has had features of anti-innovativeness (Dezhina & Kaartemo 2009; Simachev et al. 2009).

The commission on Modernization and Technological Development of the Economy has decided to focus on five priority areas in order to get rid of energy dependency: nuclear technology; space and communications technology; energy efficiency; medical technology; and information technology, including supercomputers. In addition, the presidential support of nanotechnology is providing it a special status. In fact, nanotechnology is one of the most advanced and prospective area of sciences in Russia (Koponen 2009).

These priority sectors of the economy are quite far away from low- and medium-technologies where Russia might have better chances to diversify the economy. Currently, Russia lies far beyond the leading nano-countries like the USA and China but nanotechnology is also such a new field of study that Russia may not be late from its development. The market for nano-products also remains marginal but it is expected

that during the following two decades, it will be embedded in all kinds of product categories. The basis for nano business is also realistic in Russia, as the level of basic research is high in nuclear, space and civilian nanotechnologies.

Rusnano is probably the largest profiled venture investment fund in the world and it is aiming to invest only into products based on nanotechnologies in Russia (Koponen 2009). Even with Rusnano there are major shortcomings. The number one problem is that they have too many rules on where they can and can't invest, which does not encourage the effective allocation of resources. Innovations are borderless but the rules hinder Rusnano's international investments. This is quite opposite from the Chinese anti-crisis approach, as the Chinese have eagerly set for the after-crisis party by buying assets abroad. The financial crisis might have given interesting global opportunities to Rusnano, too. This again proves that nationalist-oriented approaches of Russia are more important than economic facts. Secondly, the scientific community seems not to trust Rusnano, as they are working differently from what the researchers have used to. This makes Rusnano's work in Russia very challenging. Thirdly, the Russian nanotechnology research remains far from market demand and the solutions are more targeted to the state-run defence sector than to end consumers. Although some of the most valuable innovations have their basis in defence sector, such as internet and GPS devices, it is a long and bumpy path to diversify the economy.

In certain other sectors such as ship building, and agricultural machinery, there may be interesting possibilities for Russia to find its innovative edge, too. In fact, Russian decision-makers should forget the misconception that innovation equals with high-tech. Of course also these sectors consist of high-tech parts but most of all the need for innovative solutions is the key. The customers do not base their buying decisions on the share of R&D used but the ability to solve their needs.

3.2 External resources

Dezhina and Peltola (2008) have found out that "the international learning has become an important component in government innovation policy making" in Russia. However, there are major problems in the attitude of Russians and Russian companies towards international cooperation. Conservative investors are not willing to have cooperation in Russia, although the innovators would be internationally oriented. It is also a problem that patents are often applied solely in Russia, as innovative products are not aimed at global markets. Large home market, at least in certain product categories, does not

push the companies to foreign markets. The culture also holds Russians back as they are not encouraged to go abroad. Thus, there is a clear demand for understanding the international dimension of innovation system in Russia and improving its functionality via networking. The new generation of modern and internationally-oriented young Russians may anyway provide stable movement of Russia towards innovative society.

Despite the challenges mentioned above, some Russian companies have entered into partnerships with foreign companies in various ways (such as joint ventures, research contracts, and cooperative research projects) in order to get access to the latest technology as well as managerial and marketing experience. At the same time, Russian research organisations have been very active in mobilising foreign support and research contracts. In addition to American and European governmental and non-governmental programs supporting non-commercial R&D activities in Russia, there is also a growing number of Western companies that contract out research of a commercial nature to Russian research institutes. Foreign funding makes up for nearly 10% of all R&D expenditures in the Russian Federation. Primary sources of foreign funding are: the EU and the USA, but also some Asian countries such as China, Japan, and South Korea. (European Commission 2007.) The Rusnano has also understood the need for international collaboration, as they are seeking collaboration particularly with US venture funds (Moscow Times 2009b).

The institutional development does not support collaboration with international partners. For instance, the patenting system is not related to those of Western, and the Russian companies have not been willing to apply for international patents. Russian companies might, however, start collaboration with foreign companies and let the foreigners help to succeed internationally. Partnerships with foreign companies might also provide them with the capital for product development from national and supranational funds. The funding is also available in Russia after the recently established state funds, business angels and venture funds but the lack of collaboration and trust makes their functions challenging.

For instance, in agricultural machinery foreign collaboration is evident. John Deere, the largest farm machinery company in the world, announced in July that it will invest $500 million in new joint projects and innovation technologies during the time span of 2009–2015 (Moscow Times 2009c).

3.3 Economic incentives

There is a clear lack of economic incentives which results underinvestment in the economy. As no one invests in Russia, there are no investments in innovations either. This is partly due to lack of competition in the Russian market, as domestic enterprises are protected by the Russian government. Rusnano is basically the only instance which is investing in new business. To some extent there are investments in traditional sectors of the economy like dairy business but this may not help the country to diversify the country in a larger scale.

During the past few years, the state-owned enterprises have gained more power in the economy, and there have been features of renationalisation in the Russian economy. The increasing role of SOEs is problematic, as the state financing often crowds out private investments. The available public funding should be boosting private money but in Russia it seems not to be the case. This is problematic as the public sources dominate R&D investments in the country. During the crisis the share of Federal funding in innovation investments has even increased (NAIR-IT 2009). It is also a well-known fact that state-owned enterprises do not innovate, and Russia is no exception there.

As the market forces are pushing Russia towards resource dependence and low international competitiveness, the government intervention becomes important to remedy the problem (Dezhina & Peltola 2008). The problem in Russia is that the development of innovation environment is seen merely as a bureaucratic task. Also general distrust, corruption and bureaucracy are hindering the innovation development.

Special economic zones are good examples of innovative-technological policies as bureaucratic task. The companies are attracted to enter the zone as a result of conditions in state funding instead of value-added which these zones might in best case provide to companies. In innovative-technological SEZs the benefits are mostly targeted for production-related activities. The benefits of lower energy and customs costs, and profit taxation are not a real treatment for a typical technology-oriented SME. Obscurely, mass production within these zones is even prohibited and it has to take place in another location.

Also technology parks with business services are needed but the problem is that these parks with modern services become often too expensive to the companies. The answer here is not to support the business service providers directly – and increase public involvement – but to support the small companies to buy expert services.

As a result of lacking incentives, Russians are losing interest in entrepreneurship. The corruption and bureaucracy makes entrepreneurship very challenging. Young people know that even with your good idea, some one will eventually steal it, and you do not benefit from it at all, or in the best case, only marginally. Together with earlier mentioned problems of renationalisation of the Russian economy, we end up with the question: “How innovative private sector will Russia have after the crisis?”

4 India

4.1 Internal resources

There has been insufficient emphasis on innovation culture in India. Most Indian companies have not yet realised the importance of deploying resources in innovation development. There is no sufficient collaboration between private and public sectors, and in practice there are neither innovation hubs nor industry clusters developed in the economy.

India's expenditure on R&D was about 5.7 billion euros in 2005. It has increased rapidly during the early 21st century. As a result, India's R&D investments are above those of Brazil and Russia, but behind China (Halme & Grützmann 2009). A majority of R&D (70–80%) originates from public sources. Of this, the bulk of money is allocated to defence, space and energy. In fact, in these sectors India has been able to develop some innovations which may also be brought to civilian applications at some point.

The problem with the public R&D funding can be found in fragmentation, bureaucracy, lack of coordination, focus on inputs rather than impact, focus on frontier technologies, insufficient focus on commercial and applied areas of public goods, and insufficient interaction among public institutions.

Despite these problems, there are some large private firms with significant innovative and managerial strength. For instance, Tata Group and Reliance Group have been ranked among the top 25 most innovative companies in the world by BusinessWeek (2008). In addition to these conglomerates, there are strong Indian companies in pharmaceuticals, software and auto components, which are the major R&D investor sectors. In addition to these industries, nano- and biotechnology, agriculture and engineering industries have recently increased collaboration with universities. Innovation in manufacturing has also made progress. It has provided high-technology and skill-based products available to consumers at low cost.

Given the declining productivity levels in agriculture and forecasted rise in demand, the government has started to promote rural-based industrial clusters and intermediary technological solutions, which connect the rural agro-industrial sector with the skill and knowledge base in the formal science and technology system (Halme & Grützmann

2009). Stronger focus on innovations in services is also positioning India favourably into the future.

The demographics are also very suitable to India. The young labour force is expected to provide basis for the future growth of India. By 2050, it is expected that the age group of 20–59-year-olds will increase by 263 million in India. On the other hand this gives pressure to the development of the education system in the country.

According to one estimate, India has more than 12 million science and engineering graduates, of which 100,000 hold PhD degrees. India has educated university graduates for long and there is no news about it. Therefore, no one should be threatened by the figures of Indian S&T personnel with higher education degree. India's stock of scientists and engineers is among the largest in the world, and availability of S&E personnel is also recognised in international competitiveness reports. There are also some world-class institutions of higher education located in India, such as IIT and IIM.

There are also world-class challenges in the Indian education system. The enrolment ratio is low, and the level of primary and secondary education has become a bottleneck for innovativeness. There is a lack of qualified teachers, and the system encourages memorisation and taking orders from above instead of independent thinking. The development of the universities has been slow, too. It is evident in slower progress in academic publications than in China, for instance.

The universities are also only limitedly engaged in R&D activities which hinders the innovation development in India. A significant amount of basic research is conducted at public research institutions but they have been found to suffer from complex policy and decision-making. As a result of bureaucratic resource allocation combined with the lack of risk taking, these institutions have not been using the public R&D funding effectively.

The low level of education system also shows the huge potential which may shake the world. The education has become the core of the current 11th five year plan of India. During the 11th five year plan, India aims at increasing the R&D intensity from 1.1% to 2.0% – close to OECD average. In the plan there is an increase of 400% for science, technology and education. It indicates the serious actions taken by the Indian

government. As a result of new budget allocations, the share of education would increase to 6% of GDP.

4.2 External resources

In 1970s and 1980s India was mostly counting on self-reliance and import substitution in innovation development. This all changed in early 1990s when economic reforms were targeted in liberalisation of the Indian economy. The policy shifted from self-reliance to outward-orientation. The economy opened space for private businesses and welcomed FDI inflows. Software, pharmaceuticals and biotechnology industries benefited from the S&T policy of 1970s and 1980s, and they were further strengthened during the economic reforms. Ultimately, these industries proved to be true success stories in India.

Since then, the global R&D and innovation strategies have changed dramatically. India has been well positioned in attracting outsourced R&D operations of MNCs, particularly for services outsourcing and software development. Nobody knows exactly how many R&D centres foreign companies have established in India but estimates vary somewhere around 300. The country also remains one of the top locations for foreign R&D, as a result of its provision of low cost labour with technical and language skills, and further creamed by supportive government policies. As a result, India is considered to provide the best human capital per USD, which has encouraged outsourcing R&D activities to the country. Majority of R&D investments have originated from the USA but there have also been investments from Europe and China.

As a result of opening up, some Indian companies have also internationalised. Companies like Tata, Infosys, Mittal and Wipro are already key players in their respective industries. In the past couple of years Indian firms have made some 150 acquisitions in the Atlantic Community.

Like China, also India has benefited from overseas natives. There is about 20 million Indians living abroad. Non-resident Indians have acted as mentors, investors, policy advisors and returning talent.

4.3 Economic incentives

As other BRIC countries, India suffers from its heritage of being earlier closed and planned economy which did not encourage innovativeness. Still today the importance of collaboration and creativeness is unclear among Indian companies. Particularly governmental research institutions work in isolation. Partly, this is due to lack of trust between industry and academia. On the other hand, there is low risk taking capacity in India which leads to the lack of applied research. The researchers are also discouraged to focus out-of-the-box research.

5 China

5.1 Internal resources

Chinese economy has been a true economic miracle during the past decades. This has also had influence on its innovation capacity. Despite the remarkable development, it must be remembered that innovation capability remains low in China compared to the more developed countries in the world. Level of higher education remains low in average, the education system is oriented towards passive learning, and there is also little basic research in high-tech sectors which has led to shortage of human capital in domestic private firms. China also lacks institutional framework for a venture capital system. Domestic venture capital firms have been set up by the government, and are run by government officials who do not always have adequate skills.

On the other hand, Chinese private sector has expanded massively, which is good news as they are also remarkably more productive than companies under direct state control (OECD 2008). In addition to changes in privatisation and opening up of the economy, also the governance of S&T and innovation policy have improved.

China benefits also from large market size which provides companies a good test bed for innovations on a large scale. As a result of huge labour reserves in rural China, labour costs have remained low in urban China even during the period of economic expansion. The lower income level of local customers has also directed Chinese companies to be cost-efficient and they have been able to provide high-tech products in low prices also to global customers.

In part of global market orientation, R&D investment is increasing in the Chinese business sector. Consequently, R&D intensity is no longer lagging far behind OECD average. In the OECD countries R&D intensity has remained nearly steady since early 1990s. However, it has been found out that China's R&D expenditure has not been efficient (Lee & Park 2005), and therefore the R&D intensity growth is not only good news to China.

China has recently started to educate more PhDs. By 2010 it is expected that there will be for the first time more S&E doctorates from China than from the USA. The number of students has increased by 21% per year during the past decade. In addition to these

home-made graduates, 250,000 overseas Chinese have returned from abroad with education. Simultaneously, China has built its expertise in nanotechnology, and is already the second most important (~20%) publisher of nanoscience papers in the world behind the USA.

Innovation development however lags due to low institutional development. There are major problems in IPR, corporate governance, social capital and trust. There is insufficient interaction among private and public actors, and even between various parts and layers of government. There is also a constant shortage of complementary assets as a result of underdeveloped service sector. These challenges can also be seen in the problems of commercialisation and innovation management.

Recent policy initiatives show the government's commitment to develop a competitive innovation system. The S&T Strategic Plan 2006-2020 sets out the key objectives and priorities in science and technology. The overarching goal is to make China an "innovation-oriented" society by the year 2020 and – over the longer term – one of the world's leading "innovation economies". The Strategic Plan, for instance, proposes several initiatives to increase access to funding for high-tech SMEs and start-ups. China is taking the need for innovations seriously and aims to increase R&D expenditure to 2.5 % of GDP by 2020 (Accenture 2008), which requires annual growth of 10–15%. Since 1999, R&D has grown 24% annually. Additionally, the investments in education prove the commitment of the Chinese government to innovation development. They have also very much emphasised needs-driven research (Schwaag Serger 2009) which is fruitful for innovation development.

5.2 External resources

Economic reforms, including the launch of the "open door" policy in late 1970s, led the Chinese economy to nearly three decades of remarkable development. As a result of the changes, China has become the most open of the large developing economies, and the world leader in high-tech and ICT exports. As a result, there are more than 1,000 foreign-owned R&D centres in China which all have been established during the past two decades. Currently, the number is growing by 150–200 new units each year. In 2004, foreign companies covered for nearly 30% of R&D expenditure in China, 48% of technology imports and 76% of exports. Even during the economic crisis, the Chinese economy has showed strong resistance to external shocks.

To some extent, China is already more open than a number of significantly more developed market-based economies. In ten years the number of private enterprises has mushroomed, outnumbering SOEs by the factor of ten in only 10 years. Consequently, about 65% of its GDP and 75% of its employment originates today from private enterprises.

To date, China has largely relied on the supply of foreign technology, and the development of its scientific and technological capability has until recently lagged behind its economic growth. In fact, China's export growth has been largely based on the expansion of low-wage manufacturing utilising imported components, equipment and technology. However, it is now boosting investment in science and technology and has taken steps towards building a high-performing innovation system. Since the end of the last decade significant progress has been made towards developing the country's innovation potential.

China's dependence on external resources remains visible. Need for foreign investments remains significant and the foreign-owned companies account for more than half of China's exports (OECD 2008). In fact, China itself remains specialised in low-tech. High-technology industries, notably ICT-related manufacturing, are primarily under foreign control, while traditional industries such as textiles and garments are largely domestically owned. High-tech industries are considerably less R&D-intensive in China than in advanced OECD countries. Industries in this category typically produce high-volume goods, often by assembling imported components with low share of value added.

It is shocking that foreign firms are less R&D-oriented in China than indigenous companies (OECD 2008). The question is whether the R&D activities in China can be considered as "innovation activity". Foreign R&D in China is generally considered to be market-seeking, involving tactical, short-run adaptations to the market. The overall perception is that the R&D activities of most foreign firms are development-focused (rather than research-focused) and aim to support their local business and customers. Current patterns of specialisation, a lack of absorptive capacities in Chinese firms and shortcomings in institutional development may have limited the amount of spillovers. Improvements in these areas would allow China to better benefit from international technology flows.

FDI projects and the operations of foreign-invested firms have also helped to improve China's access to advanced technologies, to management practices and to a wide range of skills. Foreign MNEs diversify their R&D activities through science-industry partnerships with Chinese research institutes and universities. Public-public R&D partnerships between Chinese and foreign research institutes, universities and government agencies are beginning to complement R&D cooperation in the private/business sector. Moreover, there is a high level of mobility of skilled people in science and engineering between China and OECD countries as well as between different parts of the Chinese economy.

Chinese firms' outward R&D investment to OECD member countries and developing countries has been booming. In addition to inward flow of FDI, Chinese companies have established themselves internationally. Companies like Huawei and ZTE even run R&D centres abroad (Kaartemo 2007). Huawei has also established R&D centres in Russia and India. It is interesting to see that the BRIC countries are collaborating on the innovation front which resembles the new global order.

5.3 Economic incentives

As stated in the previous chapters: competition is an important incentive for innovation. In China, administrative interventions and protectionism still distort competition. Also the economic policy is not the most efficient for innovations, and corruption often damages the incentives for innovation. Moreover, a top-down approach, by which authorities instruct SOEs to invest in R&D and innovation, is unlikely to produce the desired outcome. Instead, this may result in investment in R&D activities that are inefficient and only weakly related to demand. There is some evidence that SOEs are not very efficient producers and users of knowledge, and government policies focused on SOEs may have crowded out support to private companies.

Corporate governance, which shapes the incentives of managers has a significant impact on innovation performance. The corporate governance, especially of SOEs, may give management insufficient incentive to undertake long-term, risky investment in R&D. A severe lack of competent professionals with experience in managing R&D projects creates an added disincentive.

As new enterprises have emerged alongside SOEs and the latter are restructured with a view to making them more market-oriented, incentives to invest in R&D and innovation will become more closely attuned to market signals. However, most Chinese firms remain unfamiliar with innovation activity.

6 CONCLUDING DISCUSSION

Russia invests less than other BRIC countries in R&D. The underdevelopment of the Russian innovation system is often explained to stem from its historical heritage and current resources, which has resulted in the dominance of large state-owned companies in raw materials. However, Russia is not unique in terms of its socialist past, legacy of planned-economy or availability of natural resources. Interestingly, these features may all be found among other BRIC countries, too. In this regard, **Russia is not unique in its challenges for the future of innovation development**.

It seems like Russia lags in innovation development as a result of lack of economic incentives. Therefore, the research findings on the Russian reaction to the economic crisis are worrying. Dezhina and Kaartemo (2009) found out that the economic crisis has only further worsened the competitive environment of the economy. "The situation with innovation at enterprises … is not only failing to change but is worsening because of the crisis," President Dmitry Medvedev has said. (Moscow Times 2009b.)

All in all, the problem in Russia seems to be that decision-makers are aiming at innovations instead of providing good soil for innovations. The development of innovation environment is seen merely as a bureaucratic task. Also general distrust, corruption and bureaucracy are hindering the innovation development. These problems are well-acknowledged but the continuation of top-down approaches is not really helping the situation without incentives for private businesses. Private investors are not investing only if the bureaucrats tell them to do so. Instead, the decision-makers should be listening to the entrepreneurs and do whatever it takes to support their innovative activities based on their needs. It must be stated that the availability of innovation inputs is not a problem as such. Particularly, the level of education is very good in Russia. Also President Medvedev has agreed that the problem is instead how to use it (Moscow Times 2009a).

This report indicates that there are similar problems also in other BRIC countries. Russia could learn from their mistakes and success stories in innovation development – in order to improve its international position among its peer countries, in particular.

Internal resources

As a result of the heritage of closed economies, the BRIC countries have not been successful in developing innovation culture. These countries are characterised by low risk-taking capacity. This can also be seen in R&D data. The countries are not spending in R&D and the R&D money originates mostly from public sources. On the other hand this also indicates the general consensus among policy-makers on the need for innovation among the BRIC countries.

However, BRIC companies are not providing the best soil for innovation with high bureaucracy, complex taxation and problems related to innovation system in general. Particularly, lack of coordination is visible in all BRIC countries, and it is not clear-cut if these countries even have innovation systems as traditionally defined in more advanced contexts. Consequently, R&D expenditure is not efficient, and the figures on increased R&D intensity should not be praised too much.

The BRIC countries are also similar in terms of significant pool of scientists. They already host some world-class institutes of higher education. In general, the level of education yet remains low and this affects negatively the absorptive capacity of local companies. Here again same applies to number of PhDs than to the amount of R&D – the quantity does not cover the quality gaps.

The quality of education varies, and the problems in basic education are remarkable. The underdeveloped education system encourages memorisation and passive learning. The challenge of large size has not been able to encourage independent thinking which would improve the innovation potential of these countries. Investments in education are remarkable but it remains to be seen whether these are enough in the vast countries.

Brazil, in particular, has emphasised the role of the academia in the development of the innovation system by channelling most of the government R&D funding via universities. It is questionable whether they have capacity to undertake innovative projects. Particularly, the mistrust on institutions, among them mistrust between industry and academia, makes the setting challenging. The problems in institutional development in IPR, corporate governance, and trust seem to be shared by all BRIC countries.

The government's misinterpretation of innovations is evident in the ideology of strategic sectors and frontier technologies, which pop up in discussions in all BRIC countries. These sectors are often without clear reference to earlier success stories. Although a computer consists of high-technology, and high-technology is often related innovative projects, computers do not equal to innovations – as well as high-tech does not equal to innovation. It seems weird how practically all BRIC countries are repeating the ICT-mantra of more advanced economies, as if it provided them prosperity and increased living standards. In the case of Russia, it might be better positioned as a manufacturer of agricultural machinery[2] or furniture[3], instead. And innovation policy should be directed accordingly.

For instance, Brazil has been successful in airplane industry, agriculture and forestry, which all have been systematically developed for decades. India has been able to have huge innovation-based companies which have made it to the global markets. In part, India's success salutes to the understanding of the importance of innovations in services. And China has also developed its manufacturing base since late-1970s. Thus, **other BRIC countries can be seen as good learning points for Russia how to systematically develop its strategic industries**. Foreign collaboration has often had a decisive role in the development process of these sectors.

External resources

The greatest difference between Russia and its peers in systematic industrial development seems to be in the attitude towards foreign collaboration. Particularly, India and China have benefited from their open door policies remarkably. Private businesses and foreign investments have changed these two economies rapidly. As a result of supply of foreign technology and know-how, they have become important sources of high-tech products and services in the global market.

Indian and Chinese companies have also invested in the knowledge-intensive sectors abroad. Whereas Russian investments still focus mostly on raw materials and energy (Vahtra 2009), knowledge-exploring investments have improved competitiveness of Chinese and Indian companies on global market.

[2] Farm machinery company John Deere announced in summer 2009 to invest more than $US 500 million in new joint projects and innovation technologies in Russia (Moscow Times 2009c).
[3] Avdasheva (2007) has written on potential role of industrial policy in furniture industry.

But there are problems elsewhere, too. In Brazil, foreign resources are quite irrelevant in the national innovation policymaking. Despite systematic tariff cuts, foreign imports remain expensive, and foreign companies are not willing to undertake innovative projects there. This indicates the close linkage between foreign competition and economic incentives.

Economic incentives

The report emphasises the need for competition – both domestic and international. As local companies are protected against foreign competition, they have no incentives for innovations. This accumulates the problems, as then there is no demand in the home markets for innovative products or services.

This has distorted investments together with high interest rates in all BRIC countries. Particularly, Russia has failed in providing a context in which companies have economic incentives to undertake innovative projects.

This again indicates **the need for understanding innovation policy as providing the context for companies to undertake innovative projects**. Top-down approaches do not create innovations. Although government intervention may be needed to provide funding, infrastructure and institutions, these all should be develop bearing in mind the needs of innovative companies – just like innovations are developed based on customer needs.

Suggestion for future studies:

1. We need more comparative studies on innovation potential of BRIC countries

There is need for a practice-oriented comparative study on BRIC-countries as a location for innovative activities. So far, there have not been comparative studies contributing to the location decision-making of internationalising companies. It is a challenging task to make a comprehensive analysis of one innovation system. Thus, it must be understood that the comparative study of BRIC innovation systems with global dimensions requires a grand project. This requires resources but it is a necessity for the repositioning of innovation policies in the global context.

2. We need more foresight research on the global innovation development

In order to exploit the opportunities and to avoid the facilitation of the threats, we need a long-term oriented cross-border foresight programme (Kaartemo & Kaivo-oja 2009). The foresight programme should focus on the global challenges and the potential solutions to them. We need knowledge how to counteract the trends of global warming and population growth which potentially lead into a worldwide crisis.

3. We need a new definition of R&D intensity and high-tech

Similarly, we need a new definition for high-tech exports as it does not anymore indicate the innovation outputs of countries. Since the 1980s when the concept was invented, R&D and production facilities have scattered all around the world. Actually, we might ask to whom is high-tech, actually high technology? Is it high-tech for the assembling country? Is a product high-tech for a consumer who has no idea about the R&D inputs but is more interested in how it matches his needs? More focus should be put on data on the value creation of products, which would better resemble the innovative characteristics of exports.

It also remains unclear whether the industrialised countries are able to compete against the BRIC-countries with R&D investments. As the figures are set to increase, the focus should be on the quality instead of quantity. Therefore, the aim of the Lisbon Strategy should not be measured in R&D intensity. As the cost level for R&D activities is lower in BRIC-economies, they also may get equal amount of work with smaller investments. However, if the use of money is uncoordinated, this all may result in unproductive measures in practice.

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