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Comparative Analysis for Science, Technology and Innovation Policy; Lessons Learned from Some Selected Countries (Brazil, India, China, South Korea and South Africa) for Other LDCs Like Iran

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Abstract

Having recognized the importance of designing Science, Technology and Innovation policies (STIP), many Less Developed Countries (LDCs) such as Iran have nowadays attempt to reshape their STI policies. The policy makers of LDCs like Iran can adopt and design suitable strategies learning from the successful experiences of prosperous nations. This paper performs a comparative analysis of STI policies of some successful countries in managing their technological change. This is mostly due to the fact that the other LDCs can draw valuable lessons from these success stories which in turn can also contribute to success in their own short and long term development. Firstly, the empirical experiences of some successful nations namely (Brazil, India, China, South Africa and South Korea) will be studied. The empirical experience in STI policymaking will be surveyed. The most critical success factors contributed mostly to their management of STI policies will also be compared. Finally, a general framework of STI policymaking drawing from the experiences of these countries will be proposed for other LDCs like Iran.

Keywords: Iran; science; technology and innovation policy; ldcs; comparative analysis.

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1. Introduction

The successful implementation of Science, Technology and Innovation policy has a very important role in the prosperity of any nation in the global market. Recent years have seen a flourish of interest in the comparative benchmarking of some emerging economies such as Brazil, India, China, South Korea and South Africa (BICSS). Their growing role as producers and intermediate powers in the global economy is now outstanding. Their particular experiences of implementing successful STI policies indicated that the acquisition, adaptation and absorption of technical know-how along with strengthening of their local technological capabilities have contributed mostly to their rapid economic and industrial growth. These countries are able to increase their productivity level as well as managerial and technological expertise very rapidly. They can also manage successfully to decrease their technological gap with the more technologically advanced countries through a catching-up process.

Policy making is the act or process of setting and directing the course of action to be pursued by a government, business, etc… high-level development of policy, especially official government policy(OECD, 2006; Metcalfe, 2005; Lundvall and Borrás, 2004). Policymaking has its advantages like improving decision making in all macro level; explaining why things need to change; helping us to focus on what is important; informing judgments and guide actions; managing risks and entitlements; Strengthening relationships and build capacity(Lall S. , 1995; Fagerberg and Srholec, 2008; Fagerberg et al., 2007; Nelson and Rosenborg, 1993).

Science policy is a concept that belongs to the post-war era. Before the war, regional and federal governments were funding university research and the training of scientists. But they did so primarily for historical and cultural reasons and, before the Second World War, the idea of science as a productive force was taken up mainly in the planned economies (Fagerberg & Srholec, 2008; Thrope, 2007). As Metcalf pointed out the main objective of science policy is "to manage and fund the accumulation of knowledge in relation to natural phenomenon by creation and support of appropriate organizations – research laboratories and universities" (Lundvall and Borrás, 2004).

According to Christopher Freeman science policy was recognized as a policy area through the pioneering work by Bernal (1939). Bernal was a pioneer in measuring the R&D effort at the national level in England and he strongly recommended a dramatic increase in the effort since he was convinced that it would stimulate economic growth and welfare. In the US, the Vannevar Bush report from 1945 "Science: The endless frontier has a specific status in defining an agenda for the US post-war science (and technology) policy". It defined the task for science policy as contributing to national security, health and economic growth. Like Bernal, the Bush report gave strong emphasis to the potential economic impact of investments in science.

Technology policy refers to policies that focus on technologies and sectors. The era of technology policy is one where especially science-based technologies such as nuclear power, space technology, computers, drugs and genetic engineering are seen as being at the very core of economic growth. These technologies get into focus for several reasons. On the one hand they stimulate imagination because they make it possible to do surprising things - they combine science with fiction. On the other hand they open up new commercial opportunities. They are characterized by a high rate of innovation and they address rapidly growing markets (Thrope, 2007).

The objectives of technology policy are not very different from those of science policy but – at least to begin with – it represented a shift from broader philosophical considerations to a more instrumental focus on national prestige and economic objectives. Technology policies were developed in an era of technology optimism. But later on – in the wake of the 1968 student revolt – more critical and broader concerns relating to technology assessment and citizen participation came onto the agenda (Lundvall and Borrás, 2004).

Innovation policy appears in two different versions: First It comes out of the concepts of laissez fair and non-interventionism approach of neo-liberal school of thought. The second version is more focused on structuralist approach which is in continuing of the concepts of national innovation system (Fagerberg et al., 2007). Considering these two different approaches, what they have in common in terms of innovation policy, consist of diffusion, using and marketing of the new technology. Both approaches look at innovation policy as an infrastructure to assist those organizations and institutions which are involving in S&T policy making. Therefore we may look at innovation policy to achieve economic development and finding solutions for eliminating problems related to lack of renewable energies and pollutions (Fagerberg and Srholec, 2008; Fagerberg et al., 2007).

Having defined such concepts as, science, technology and innovation policy-making, one may ask, what is the fundamental role of government in this process? Why government usually is responsible for policy-making in this area? The answer can be viewed from two different aspects: First, the government in developing countries is responsible for designing appropriate policies for the development of their countries and their people. Second is the nature of technology which is the public good (Lall S. , 2003). After World War II, governments have reached to an agreement and consensus regarding different definitions of development. The policy makers have designed some related policies in accordance with the general goals and objectives of their nations. In 1950s, the economic growth was among the main goals and objectives of less developed countries. The policy- makers believed that economic growth and the modernization are two sides of the same coin that may increase their revenue and reduce social inequality.

The results of this policy in 1950s led to the immigration of people from rural areas to urban areas, so in 1960s policy-makers did have particular attentions to the agriculture and industry sector at the same time. In 1970s, policy-makers made their efforts to reduce unemployment and have more emphasis on the spiritual aspects of human being. This has led to adding sociologists aims to the other goals of the policy-makers (Thorbecke, 2006).

In 1980s, regarding the past experiences, the policy-makers found out that they needed to bring the concepts of science, technology and innovation policy in designing the general policies for the development of their countries (Gore, 2000). Most recently, in 1990s and the past 10 years of 21 century, the policy-makers have reemphasized the role of science, technology and innovation policies in the overall development process of their nations.

There are essentially two approaches theoretically to the issue of science, technology and innovation policy: Neoliberal and Structuralist school of thought (Lundvall and Borrás, 2004). The neoliberal approach is that the best strategy for all countries and in all situations is to liberalize – and not do much else. Integration into the international economy, with resource allocation driven by free markets, will let them realize their 'natural' comparative advantage. The neoliberal approach has strong theoretical premises: markets are 'efficient', the institutions needed to make markets work exist and are effective, and if there are deviations from optimality they cannot be remedied effectively by governments. The premises are a mixture of theoretical, empirical and political assumptions. Their theoretical core relies, among other things, on a restrictive view of the technological basis of competitiveness(Ga´spa´r et al., 2003).The empirical one relies on a particular interpretation of the experience of the most successful industrializing economies, the 'Tigers' of East Asia (Lall, 2003; Etzkowitz & Sandra 1999).

The structuralist view puts less importance in free markets as the driver of dynamic competitiveness and more in the ability of governments to mount interventions effectively. Structuralists also accept that some industrialization policies have not worked well in the past. They believed that past policy failures may assist policy-makers for improving government capabilities to intervene where the market forces are not working efficiently (Lall S. , 2003; Lall and Teubal, 1998).

2. Research Methodology

This study has selected countries namely Brazil, India, China, South Korea and South Africa, and Iran to do benchmarking in the Science, Technology and Innovation policy-making process. It can be found out that each country has implemented its own STI policies with various policy measures. Having considered a vast data resources involved in the benchmarking of these cases one may find out that the finalized results may become more complicated. So this study has taken "comparative analysis" as a research methodology. It tries to reach to a conceptual model based on the successful experiences of selected countries. Having developed this model one can state three main factors influencing it; namely, institutional structure, the role of the industrialized countries in the development process and the comparative advantage. The institutional structure has been derived from the National Innovation System (NIS) perspective. Since each country has its own NIS based on its institutional infrastructure, the studies of these institutions have shown different ways of STI policymaking that have been introduced by these countries.

The next factor mentioned that is "the role of the industrialized countries in the development process" can also be derived from the concept of the "catch-up" theory. Catching up refers to the principle that countries with relatively low technological levels are able to exploit a backlog of existing knowledge and therefore attain high productivity growth rates, while countries that operate at (or near to) the technological frontier have less opportunities for high productivity growth (Verspagen, 1991). According to the above mentioned concept, one can realize the importance of the technological frontier countries in the development process. So it is very important to analyze the relations between developing countries and frontier countries. The comparative advantage factor can be derived from the concepts given by Lall, S. (1995). Lall (1995) provided evidence to support his idea that the science, technology and industry policies of a particular country can be led to the success when these policies are based on its comparative advantage.

3. Comparative Benchmarking of Some Selected Countries (Brazil, India, China, South Korea and South Africa)

Having reviewed the past trends of science, technology and innovation policy, policy makers in each country decide to choose the policy tools and the areas that they want to apply for their own purpose in order to achieve the overall development of their nations. Selecting some emerging countries like (BICSS) in order to study their science, technology and innovation policy and its contribution to their overall development have two reasons: First, these countries (BICSS) have emerged to become as newly industrialized countries (NICs) mostly because of policy makers of these countries have begun their policymaking with more emphasis on designing science, technology and innovation policy. Second, policy-makers of other developing countries are very interested in replicating the pattern of development of these countries. The data collected and presented is mostly based on the international databases such as OECD, the World Bank, UNCTAD, and some other well-reputed organizations.

3.1. Brazil

Brazil's population of approximately 180 million people constitutes about one-third of the Latin America and Caribbean total, and it's GDP at US$498 billion for 2003 accounted for about 29 percent of Latin America's GDP (World Bank, 2010). Brazil is the fifth-largest source of FDI from among the emerging markets, after Hong Kong (China), Singapore, the Russian Federation and Taiwan Province of China. Inward FDI in Brazil, having dropped from its peak in 2000, increased again from 2003, reaching US$ 19 billion in 2006. (Grosse, 2005). In the late 1960s and throughout the 70´s, a strong military influence took command of the country. The military coup of 1964 was followed by a strong commitment from the government towards scientific and technological development. In order to achieve this target it was necessary to promote technological improvements of the military and at the same time search for autonomy in the development of strategic technologies. Brazil had to overcome more than 50 years of military intervention in the governance of the country until 1985 when the military regime was replaced by civilian rule (Etzkowitz et al., 2005; Bartzokas, 2008).
The policy-makers in Brazil pursued Import-Substitution Industrialization policies for a long period of time. In 1990, Brazil started the process of opening its market to foreign products and the country gained access to the international technology scene. The end of the Market Reserve for many products and the increasing competition with foreign producers took the local industry to an imposed process of modernization (Campos, 2005). The Brazilian government created various incentives for companies that exported non-traditional products as well as provided incentives for firms for technological innovations (Amman and Baer, 2002).

The guidelines on "industrial, technological and foreign trade policy", coordinated by Brazilian Ministry of Development, Industry and Foreign Trade (MDIC, 2004), comprising 57 measures, some in force as of 2003, is intended to define a new model of industrial and foreign trade policy for Brazil (Pereira, Jose Matias et al.. 2006) The government in Brazil attempted to stimulate domestic technological innovations through three programs: the Technology Capacity Program which aimed to improve technological capability through new incentives for R&D; the Quality and Productivity Program aimed at improving efficiency in manufacturing; and Law 8661 which decentralized control over the creation and diffusion of technological capabilities (Ryan, 2010). It aimed to develop linkages between R&D institutions, universities and the private sector through financial incentives for technological development. The results of these policies and other Science, Technology and Innovation policies have generally been positive for Brazil. Total exports increased from $27 billion in 1984 to $81 billion in 2004, with the share of manufactured exports increasing from 50 percent in 1984 to 65 percent in 2004 (OECD, 2005; Branscomb, 1993).

Having compared some Science, Technology and Innovation policies as well as indicators of Brazil, India, China, and S. Korea, it can be noted that Brazil and India have followed relatively similar pattern of industrialization and technological development (Viotti, 2002; Rongping & Wan, 2008). The Brazil government like that of India has determined that their past efforts to protect their domestic economies and constrain FDI are inadequate for growth. In Brazil, more recently Lula's government has turned from socialism and populism and is seeking to attract more FDI with an offer of public–private partnerships. Currently, Brazil's gross national product (GNP) (US$605bn) is of the same order of magnitude as that of Korea (US$696bn) and India (US$686bn). Populations differ in these three countries however, and Korea's GNP per capita is three times higher than that of Brazil which, in turn, is four times larger than India's. China's GNP is currently twice the size of these three economies (US$1,460bn) and GNP per capita is somewhere between that of Brazil and India (OECD, 2005, 2006, 2008; Viotti, 2002).

3.2. India

One of the fastest economic growths, India has achieved an average growth rate of 8.2 percent since 2003(Chakraborty and Nunnenkamp, 2008). It is also one of the world-class excellences in a number of science-intensive sectors such as nuclear power, satellite communications and defense as well as software (Ratchford and Blanpied, 2008). India generally has great strengths in R&D, scientists and engineers, and technical publications, but weaknesses in patents that can be spun off into commercialization; therefore, despite a strong R&D infrastructure, India is weak on turning its research into profitable applications (Rongping and Wan, 2008). India is becoming a center for innovation for multinational companies, which have already established around 400 R&D centers in India to draw on its scientists and engineers (Daryl and Pearson Jr, 2002).

India undertook sweeping reforms as a way of speeding economic growth and achieving faster integration into the world economy (Rongping and Wan, 2008). Part of these reforms has been the re-enactment of a science, technology and innovation policy more suited to the achievement of the goals of building a prosperous nation. The Industrial Policy Statement of 1991 had, among its objectives, the aim of "injecting the desired level of technological dynamism into Indian Industry" and "the development of indigenous competence for the efficient absorption of foreign technology" (Krishnan, 2003). It also expressed the hope "that greater competitive pressure will induce our industry to invest much more in research and development than they have been doing in the past". The intention was to create a national innovation system (NIS) that was in sharp contrast to that prevailing prior to the July 1991 (Dayasindhu and Chandrashekar, 2005). The national innovation system of a country is the set of institutions, policies and organizations and the interactions between them that determine the level of innovation arising from that country. While the increase in globalization has resulted in some dilution of the importance of the boundaries of the nation-state from an economic perspective, the NIS continues to be an important determinant of a nation's economic performance (Reddy, 1997). In effect, India plans to integrate science and technology into all spheres of national activity and gear the generation of scientific and technological developments to poverty alleviation and the improvement of the quality of life of its nationals (Mohan and Aggarwal, 1990).

Having compared several S&T as well as Innovation indicators between China and India, China has more than seven times India's foreign direct investment as a percentage of GDP—5 percent vs. 0.7 percent—and a like margin, 810,525 to 111,528, in number of researchers engaged in R&D in 2002. Additionally, China is acquiring $2.75 worth of technology through formal transfer for each member of its population versus India's 40 cents per person. India accounts for 1.5% of world trade which is well behind China. It is also well behind China in attracting FDI, accounting for about.0.4% of global FDI stock by 2006. China spends 1.4 percent of GDP on research and development, whereas India's share remains at around 0.8 percent. Finally, China is producing twice the number of scientific and technological journal articles as India, 16.5 vs. 10.73 per million populations in 2001, and it was granted 597 U.S. patents in 2004 to India's

374 (OECD, 2005, 2008). There are many challenges that policy-makers in India are facing: among them is the fact that India's economy is overregulated, that it has very poor physical infrastructure, and that it's nearly 1.1 billion populations at present, needs to be "skilled up." (Narasimha, 2008).

3.3. China

China's GDP is now become $ 4.97 trillion with the growth rate of 8.9% in 2009 (World Bank, 2009). China set to become second largest economy after US. China has excelled at mobilizing resources for S&T on an unprecedented scale and at exceptional speed: R&D spending has increased at a stunning annual rate of nearly 19% since 1995 and reached USD 30 billion (at current exchange rates) in 2005, the sixth largest worldwide. (OECD, 2008) In terms of total number of researchers, it has ranked second in the world since 2000 after the United States and ahead of Japan (Fan and Watanabe, 2006). R&D output has also grown very rapidly. For example, China's share in the world scientific publications rose from 2% to 6.5% over the decade ending in 2004, and China already ranks second, behind the United States, in world publications on nanotechnology (Michelson, 2008). Chinese patent applications account for 3% of applications filed under the Patent Cooperation Treaty (PCT) of the World Intellectual Property Organization (WIPO) and are doubling every two years (WEF, 2010).

China has established fundamental changes in its system since 1980s (Song, 2008). The policy-makers in China have realized the importance of the role of science, technology and innovation policy in their overall development policy since then (Ratchford and Blanpied, 2008). They began the implementation of STI policy with the establishment of the Ministry of Science& Technology (MOST) and enacting some related laws such as "the Law for Promoting Commercialization of Science & Technology", "Technology Contract Law", "The law for Agricultural Technology Diffusion" and "the Patent law"(Rongping, 2004a; Kostoff et al., 2007).

The Chinese government was eager to build infrastructure, including highways, ports, telecommunications system, etc… This required foreign capital and modern technology that can be supplied by Foreign Direct Investment (FDI) (Tuan et al., 2009). China has become a major destination for foreign direct investment (FDI) and a trading nation of global rank, with an increasing share of high-technology products in its export structure. China has climbed up the world rankings for trade and FDI with lightening speed. It has displaced Japan as the world' third largest trading nation, with 7% of world trade by 2006. China has a 2.4% share of global inward FDI stock, ahead of many countries. It has been the second largest FDI recipient in the world since 2000 (OECD, 2008). Globalization and emerging economies, Chinese state-owned enterprises were also looking for partners to upgrade their technology, management, labour, and marketing abilities (Chow, 2002). It is more recently that Chinese government has directed its policies toward interventions for maximizing national advantage from innovation system (Xiwei and Xiangdong, 2007). China's National Innovation System is not fully developed and is still imperfectly integrated, with many linkages between actors and sub-systems (e.g. regional versus national) remaining weak.

China's race to raise the level of its industrial output and join the world economic system as a key player has advanced through some stages (Liang and Teng, 2006). The country initially relied on transfer of knowledge and capital from foreign firms in the first stage; grouping them together in industrial parks sought to promote local supplier relationships and subsidiary formation in the second stage. The effectiveness of the Chinese science and high-technology park model lies in its mix of local and foreign forms of investment and in the role of universities in nurturing native companies through information networks and entrepreneurship training, in the "bridge high technology" companies forming based on domestic efforts, as predicted in the fourth stage (Walcott, 2002). Despite of the great success of Chinese government in implementation of science, technology and innovation policies and the significant contribution of this in China's becoming second economic superpower after US, the policy-makers in the country are facing numerous challenges among them keeping the country's technological advantage and also equal income distribution of the western part of the country (Hak Eun et al., 2006).

3.4. S. Korea

From 1962 to 1997 South Korea achieved remarkable economic growth, an average of nearly 8 percent per year (Kim and Dahlman, 1992). Such phenomenal growth is largely attributed to a strong national innovation system, which functioned effectively from the 1960s through the 1990s and in the first decade of 21 century. The role of Science, Technology and innovation policy has not received as much attention as that of industrial policy in the study of Korea's industrial development. Nevertheless STI policies played an important role from the initial stage of Korea's industrialization and its role continued to expand (Oh and Kim, 2004).

The government in Korea has been the key player in coordinating all the actors and factors for efficient national innovation system (Lee and Park, 2006). The national government intervened extensively in resource allocation, targeting industries to be promoted and providing incentives to promote the selected industries it invested heavily in promotion of technological infrastructure and also created the bridging system between different actors that dynamically interacting each other and regarded as the country's elements of a collective system of knowledge Parka and Leydesdorff, 2010). Moreover the innovation behavior of Korean large conglomerates named as "Chaebols" considered being a crucial factor affecting the innovative performance of the Korea's NIS (Sakakibara and Cho, 2002). The most important factors contributing to Korea's success are a package of policies undertaken by national government including policies on trade, human-resource development and science and technology. Korea's successful industrialization and its relevance for other developing countries cannot be assessed accurately unless we appreciate the essential contribution of these related policies (Chung, 2003; Kim & Dahlman, 1992).

Having compared some of S&T indicators of Korea and Brazil, it can be seen that Korea is well ahead of Brazil in many S&T indicators in particular in terms of human capital. For example, the number of tertiary students per 100 thousand inhabitants in Brazil (1.079) is approximately a fourth of that of Korea (4.253). Brazil, however, had a very low percentage of its total first university degrees in engineering in 1992, only 7 percent, whereas such a percentage in Korea was 18 percent. While the most important source of foreign technology in Korea has been imports of capital goods, Foreign Direct Investment (FDI) plays a major role in the Brazilian acquisition of foreign technology.☐ Korean and Brazilian expenditures on R&D present very different patterns. In the beginnings of the 1990's the Brazilian share of its GNP devoted to R&D was just 0.4%, whereas Korea expenditure was more than 5 times larger, 2.1% (Viotti, 2002).

3.5. S. Africa

South Africa is not only the largest economy in Africa with GDP annual growth rate of 5.4% since 2006 but also the most technologically advanced (OECD, 2006). South Africa is like two nations, where the historically privileged side can boast rightfully of having innovation of world frontier vintage and performance in certain technologies related to aerospace, arms, mining, IT and medicine (Mani, 2002). In South Africa like many other post-colonial African states, an integrated and coherent national framework for innovation and technological learning exist. This means that South Africa's National System of Innovation is not so radically different that it cannot be integrated with the NSI from other parts of Africa. The innovation system in South Africa has evolved extensively, especially since the mid 1990s. In a relatively short period of time, South Africa has managed to frame numerous policies and institutions to accelerate domestic innovation and technology development as well as improve the absorption of imported technologies (Muchie, 2004). The development of South African industry before 1990s has occurred largely independently of international competition due to its isolation from international arena (Hipkin and Bennett, 2003). Primary products such as gold, minerals and key agricultural products were the main source of foreign exchange. Manufacturing industry was almost wholly inwardly oriented and domestic firms were insulated from new trends in management techniques and production processes (Christie, 2006). The end of apartheid has returned South Africa to the international fold (Barnes et al, 2001). Much of the flow of FDI to Africa has gone to South Africa—about 37 percent of FDI in 1997 and 90 percent of portfolio investment. This is one of the main sources of country's technological expertise as well as managerial and marketing skills. In 2002 the new Department of Science and Technology came forward with a National Research and Development Strategy that identified five thrusts; Biotechnology, ICT, exploitation of natural resources and advanced manufacturing. The fifth thrust refers specifically to the country's development dilemma namely 'technology for poverty reduction (Muchie, 2004).

In 2004, Ministry for Science & Technology established that designed the country's 10 Year Innovation Plan in 2007 aiming at transition of South Africa from resource based economy into knowledge-based economy. South Africa has begun to move towards a knowledge-based economy, with a greater focus on technology, e-commerce and ICT services. There are already many Transnational Corporations (TNCs) operating in South Africa. Notable success stories of South African TNCs include AngloGold Ashanti (gold production), Illovo Sugar (sugar production in South Africa and in neighboring countries), Mondi (paper production) Steinhoff (furniture manufacturing) and the MTN group (cellular phone services). There are also small- and medium-sized South African enterprises investing abroad such as Spanjaard Ltd., Metorex, DPI Plastics (UNCTAD, 2005).

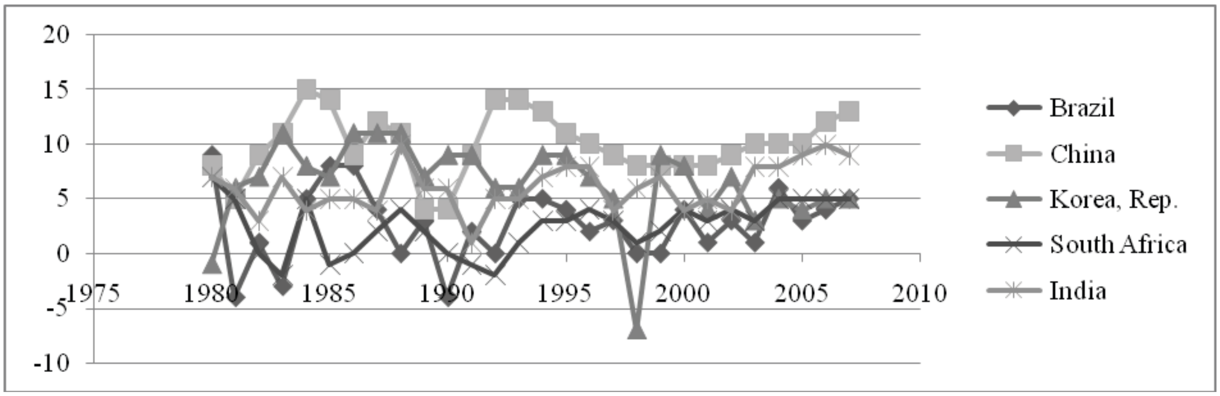

Figure 1. The trend of changing growth rate of GNP for BICSS countries in 1980-2008/ Source: World Bank WDI 1980-2008

As is shown in Figure 1, Brazil, India, China, and South Africa have a relatively similar growth rate of GNP in early 1980s. It can be generally noted that there is an increasing trend in the growth rate of all countries most recently. This is the fact that the policy-makers of these countries have placed more emphasis on Science & Technology and innovation in their countries' overall national development. The high GNP growth rate of these countries also indicates that these countries have moved toward knowledge-based economy with effective implementation and diffusion of Science, Technology and Innovation policies as well as strengthening their national technological innovation capabilities.

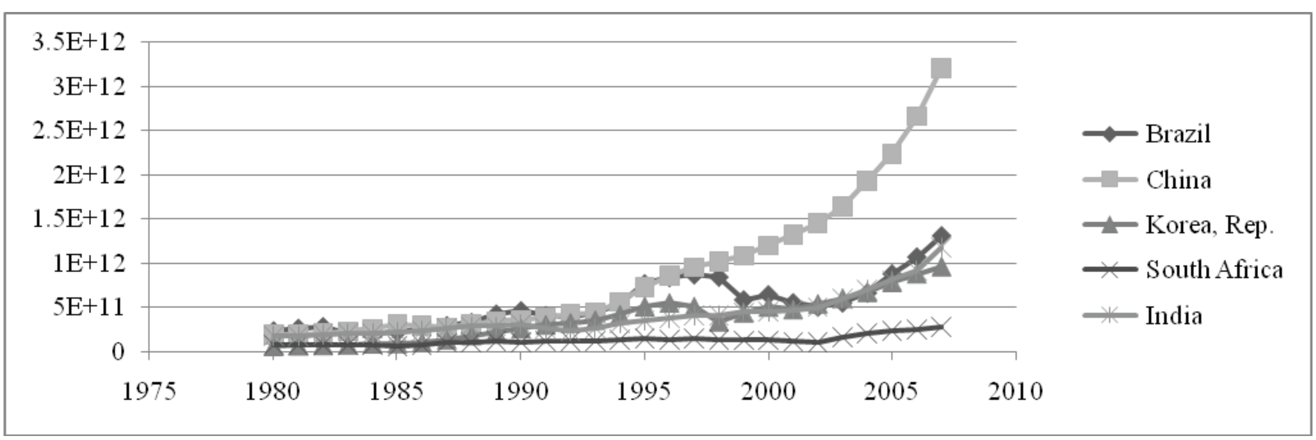

Figure 2. The trend of changing GNP for BICSS countries in 1980-2008 (The GNP per US $)/ Source: World Bank WDI 1980-2008

The differences in the rate of GNP between period 1980-2008 in these selected countries have also shawn that there are some differences in S&T as well as innovation policies of each nations. As can be seen China's growth rate of GNP is significant. This is mostly because of this country's very dynamic national innovation system and its capability to comercialize the results of research and development activities. As it is shawn, India's economic boom has started since mid-1980s that has also been as a result of a series of its government STI policies aimed at strengthening country's technological capability in such specific area as ICT and software industries.

4. Iranian experience of STI policy

Iran's development programmes have started in 1948 with a first seven year plan (1948-1955). The period between 1960s and 1970s, Iran's economic programs have paid little attention on the fundamental development of Science & Technology in the country. The success of these programs was based more on building appropriate infrastructure. The S&T policy in this period also focus more on the creation of heavy and chemical industrialization drive. In the first period of its implementation (1960s & 1970s), Iran's Science & Technology programmes focused more on enforcing foreign direct investment, patents laws, and activating more research institutes such as the Pasteur institute (Paya & Baradaran-Shoraka, 2006; Sarkisian, 2008). In the period of implementing the First economic, social and cultural development plan of Iran[1] (1990-1995), the Science &Technology policy was mostly focused on import-substitution industrialization policy. The policy-makers' attitude towards technology transfer also more depended on technoware (the physical part of technology) (Salami, 2008). The policy-makers have also considered more value added created in contracts between domestic manufacturers and foreign contractors. S&T policy in the Second economic, social and cultural development plan of Iran[2] (1995- 1999) has focused more on the simultaneously implementation of import-substitution and export-promotion and restructuring the use of technology research as a means for problem-solving of development in the country. The main focus of S&T policy in Third economic, social and cultural development plan of Iran[3] (2000-2004) were the establishment of Ministry of Science, Technology and Research as an institution for designing S&T policies that assist the country more on adaptation, absorption, diffusion of imported technologies. This ministry has also acted as coordinator between other related ministries such as the ministry of industry and mine, petroleum, health and medical education and agriculture and facilitating the interaction between them from one side and the universities from the other (Salami, 2008).

In the Fourth economic, social and cultural development plan of Iran[4] (2005 to 2009), S&T policy of the country emphasized more on export promotion policies and restructuring technology transfer and development of country's indigenous technological capability. Unlike the previous programs that S&T policy focused more to buying physical equipment (hardware) in this program more attentions were placed on the software concept of technology (Know-how). The S&T policies in this program also indicate more on designing and establishing a comprehensive system of intellectual property rights, allocating financial support for cost of license payments as well as supporting researchers and experts in Science &Technology and regulating some guidelines for attracting foreign direct investment. The application of innovation to industrial activities would certainly improve Iran's industrial competitiveness. But innovation possibilities cannot be taken as given. Innovation is a capability that has to be developed. It can be said that despite the move towards a knowledge-based economy, innovation has not yet become a strategic goal of policymaking in Iran (Salami, 2008).

5. Discussion

As discussed above, each of BICSS countries have formulated specific STI policies and have successfully implemented them. As we can seen in the table 1, each country has been compared by such factors as main institutions in science, technology and innovation policymaking; ranking of the registered patent; Share of attracting FDI (Ranking by countries invested in those countries) as well as main activity in Science, Technology and Innovation policy. The main activity of each country has also been categorized under institutional, infrastructural

[1] http://old.maslahat.ir/Contents.aspx?p=17e0f3f3-5988-4069-a89b-73ad17f87e9d
[2] http://old.maslahat.ir/Contents.aspx?p=9c7c5df7-144b-4759-bc7b-b69ebf387910
[3] http://old.maslahat.ir/Contents.aspx?p=ccf4d048-4a6d-4cab-94dd-3f25950e9d41
[4] http://old.maslahat.ir/Contents.aspx?p=487852cc-d93f-4e34-8aad-bf2dae6592d2

and human resource development. It can be seen from the comparative analysis of the selected countries that the government in each of these countries played major role in designing and formulating science, technology and innovation policies of their countries. These countries created a very capable infrastructure for implementing STI policies which enable them to succeed in their overall national technological development of their nations.

		BRAZIL	INDIA	CHINA	SOUTH KOREA	AFRICA	IRAN
Main Institutions in S&T&I Policy		Ministry of Science and technology, Ministry of Agriculture, CNEN, Ministry of Health, EMBRAPA, , BrazilÕs Innovation Agency, Ag•ncia Espacial Brasileira, National Council for Scientific and Technological Development	Ministry of science & Technology, Ministry of Human Resources & development, Ministry of Environment & forest, Ministry of Health & Welfare, Ministry of Defense, Ministry of Agriculture. DST, DSIR, DOB, DOOD	Ministry of Science and Technology, Ministry of education, Ministry of Finance, Ministry of Agriculture, National Natural Science Foundation of China, Chinese Academy of Sciences, Chinese Academy of Engineering, NDRC, CSTIND	Presidential Advisory Council on Education, Science & Technology, National Science and Technology Council, Ministry of Strategy and Finance, Ministry of Education, Science & Technology, Ministry of Knowledge and Economy, KISTEP, KIST	National Advisory Council on Innovation, Ministry of Science and Technology, Minister of Education, Technology Innovation Agency, Space Agency Act	Ministry of Education, Ministry of Petroleum, Ministry of Health, Treatment & Medical Education, Ministry of Industry, Mines and Trade, Ministry of Science, Research and Technology, Ministry of Communication & Information, TCO, IROST, MJA, MOE
The Ranking of the patent registered		Mechanical engineering, Chemistry, Instruments, Electrical engineering	Chemistry, Instruments, Electrical engineering, Mechanical engineering	Chemistry, Electrical engineering, Instruments, Mechanical engineering	Electrical engineering, Mechanical engineering, Chemistry, Instruments	Chemistry, Mechanical engineering, Instruments, Electrical engineering,	*N/A1*
Share of attracting FDI [Ranking by countries invested in those countries]		USA, England, Germany, Sweden, France, Mexico, Argentina	England, USA, Germany, France	USA, Japan, England, France, Germany, Italy, South Korea	Japan, USA, Germany, France, England	England, Australia, USA, France	China, France, Japan, Germany, Russia, South Korea
Main Activity in S&T&I policy	***Institutional***	Developing S&T institutions by investing in incubators interacting with universities, industrial sector and public enterprises	Creating an NIS based more on in-house technological capability	Targeting MNCs by creating Free Export Processing Zones in Eastern Part of the country	Creating a strong NIS based on dynamic interaction of private industries and Government sponsored Research Institutes [GRIs]	Transition from resource based economy to knowledge based economy through 10 year innovation plan	Strengthening the dynamic interaction between main actors of NIS namely government, research institute and universities
	Infrastructure	Using public sector incentives for supporting industrial sector Transferring the accumulated tacit knowledge from military to civil and industrial sector	Emphasis more on creation of market based competiveness through creation of local industrial cluster networks	Heavy investment in S&T and Innovation infrastructure through attracting more FDI	Promoting commercializatio n of all types of research through continuous and sustainable S&T policy	Efforts to integrate more local economy to world economy through strengthening actors played in South African NIS	Transition from oil based economy to knowledge based economy through investing more on local technological capability
	Human Resource	Training S&T experts by government investment	Creating learning chains in High-Tech cluster networks	Sending massive human labour to gain from their expertise after graduation[Reverse Brain Drain]	Designing the capacity for local S&T learning and sending managers for MBA training	Creating capacity building for human resource for S&T by encouraging more R&D activities	Training S&T expertise from expansion of universities and institutions for higher educations

Table 1.Comparative analysis of selected countries in terms of influencing factors/ [5] Data not Available in WIPO Website

The table 2 also shows the comparison of some quantitative factors such as GDP growth rate, the FDI inflow and outflow and Rank of Global Competitiveness Index of selected countries. There are differences in some of the above-mentioned factors however one can find some degree of coherency of the compared indexes between selected countries.

Index \ Country		Brazil	India	China	South Korea	South Africa	Iran
GDP 2009(Million $)		1,574.0	4,909.0	1,236.0	**331,5**	287.2	832.5
GDP growth	2007	6.1	9.6	14.2	5.1	5.5	7.8
	2008	5.1	5.1	9.6	2.3	3.7	2.3
	2009	-0.2	7.7	9.1	0.2	-1.8	1.8
FDI (2008)	Inflow	45 058	41 554	186 982	7 603	9 009	1 492
	Outflow	20 457	17 685	136 156	12 795	- 3 533	380
Rank of Global Competitiveness Index	2009	58	51	27	22	54	69
	Basic requirements	86	81	30	23	79	63
	Efficiency enhancers	44	38	29	22	42	90
	Innovation and sophistication factors	38	42	31	18	43	82

Table 2. Comparison of selected countries by economic growth rate; FDI inflow & outflow and their rank of global competitiveness index ref: Global Competitiveness report (WEF, 2010)

From the analysis of the countries surveyed one can generally concludes that policy-makers of many Less Developed Countries (LDCs) should adopt STI policies that can be integrated to the overall national development of their countries. These STI policies may pursue the following too closely related and mutually compatible objectives; and, on other hand, plans must be prepared soon for making technological innovation an element indigenous to their country. The promotion of the country's indigenous technological innovation capability can take place through the remobilization of their countries' national innovation systems as well as restructuring their research and development infrastructure. This must be also accompanied with some appropriate linkages to their countries' production structure and then contributed to their moving toward more technological independence.

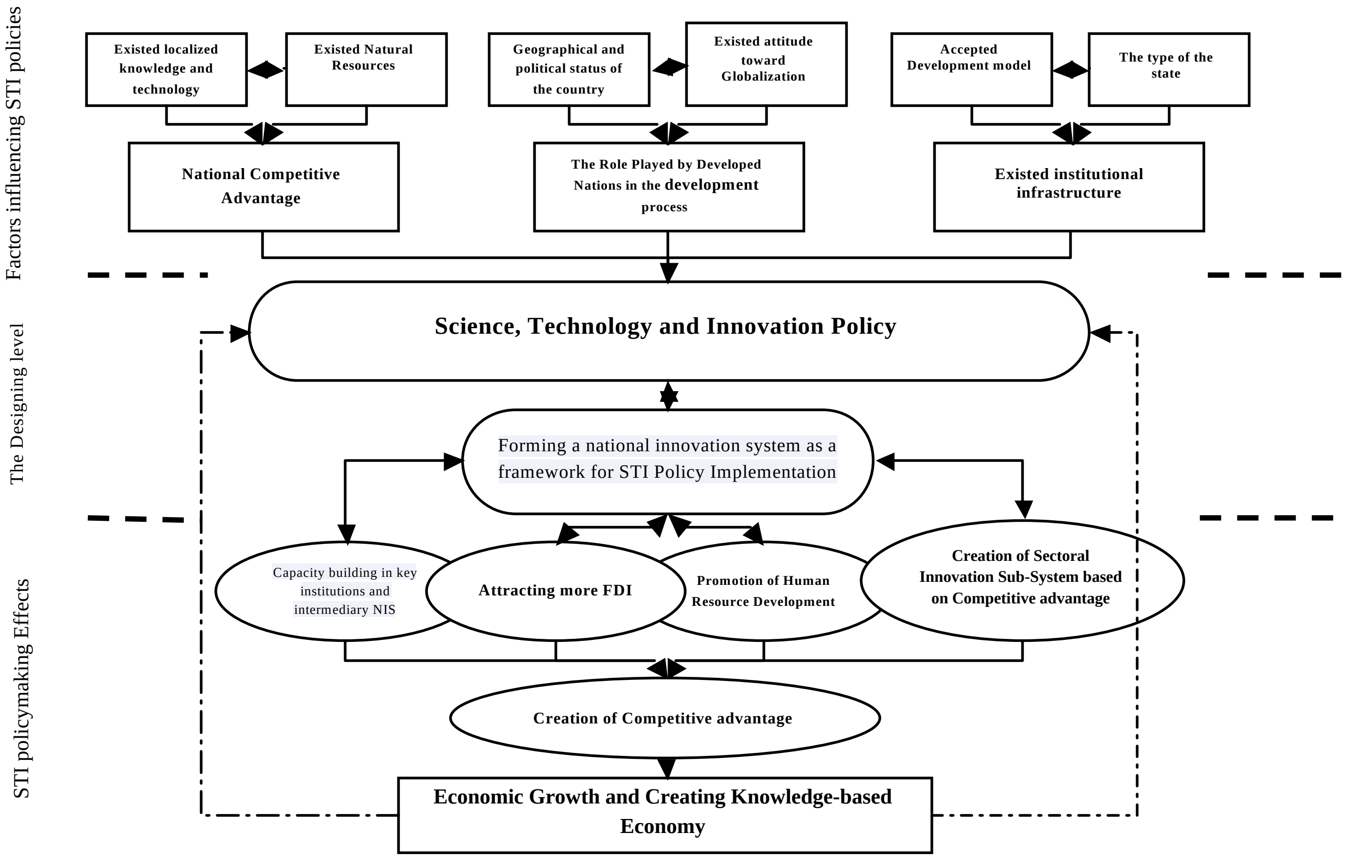

Figure3. Conceptual Model for designing STI policy for LDCs

As is shown, the process of designing of STI policy making has taken place in three levels: first, the influencing factors on STI policy. These factors need to be clarified and illustrated by consideration of each country's conditions. Policy makers must answer to several questions (i.e. what are the indigenous and traditional knowledge and technology in country…etc.). In second level (designing phase) a framework needs to be made namely National innovation system which can also be considered is a policy tool for policymakers. In the final phase the outcome of an effective STI policymaking may lead to creation of knowledge and innovation based economy.

6. Conclusion

Having concluded, as is shown in the following figure 3, the Science, Technology and Innovation Policy of each nations can be placed under three main areas namely ; the influence of the existing institutional structure; National competitive advantage and the role which has been played by developed countries in the development process. Considering the above mentioned points, the policymakers should design and formulate their STI policies based on National Innovation System (NIS) framework. Having Chosen national system of innovation as a policy framework may not be a necessary factor for implementation of the STI policies, but it can help the policy-makers to make their proper decisions towards turning those policies more operational and feasible. It can also be noted that the state has played major role for designing and formulating national STI policies for the selected countries.

Secondly, it is also necessary for the policy-makers of LDCs to adopt open policies toward the massive acquisition and diffusion of foreign suitable technologies that promote their capability to compete in international market. Having studied and surveyed the experiences of some selected countries including Brazil, India, China, South Korea, South Africa, and Iran, there are some lessons which can be drawn for other developing countries generally and also some unique lessons for Iran in particularly to follow up. It can be shawn in the following diagram:

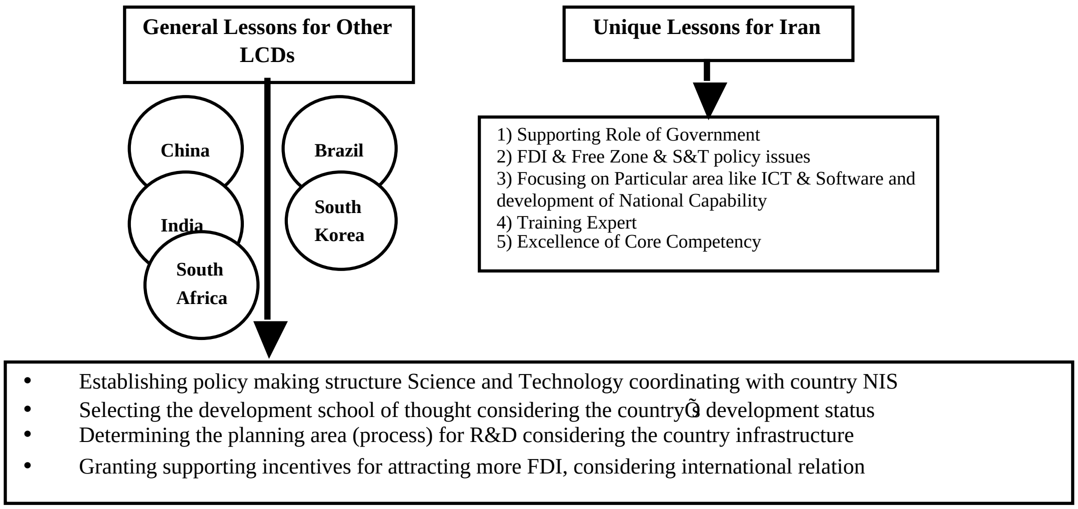

Figure 4: General and unique lessons for LDCs and Iran drawn from the comparative analysis

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