Collaboration between India and Korea in R&D

Saon Ray and Kavleen Chatwal

12th Indo-Korea dialogue

October 24-25, 2013

New Delhi

Comparison of development paths

- Prior to 1990, the Indian economy operated within the framework of an inward looking policy regime of protection and interventions. India was a closed economy and was widely regarded as a development failure.
- Between 1950 and 1980, India's income per capita grew from $150 to $230, a rise of about 1.5 percent a year.
- The development experience of Korea has been a source of inspiration for developing countries.
- Korea achieved export led growth by transformed its economic structure.
- There has been dramatic increase in Korea's trade volume and per capita GDP
- Korea had an impressive industrial upgrading and ability to recover from shocks.
- Development was due to enhanced human capital along with complementary investments in physical and social capital. Korea's approach was: export oriented industrialization, human resource development.

Innovation and R&D

- Innovation is broadly defined as the creation and commercialization of knowledge and diffusion and absorption of existing knowledge
- Creation of formal innovation is usually measured by R&D spending while absorption through royalty payments for technology acquisition
- A lot of informal knowledge creation and absorption occurs – learning by doing
- Innovation output are captured through patents and citation
- Industrial property Instruments are protected by patents and utility models , Industrial designs, trademarks, and geographical locations
- Artistic and literary property is protected by copyrights and neighbouring rights;
- Sui generis protection is protected by Integrated circuited , database protection, plant breeders' rights;
- Trade secrets are protected by Laws against unfair competition

India and Korea R&D expenditure

Research and Development expenditure (% of GDP)

Years	India	South Korea
2008	0.89	3.36
2009	0.87	3.56
2010	0.87	3.74

Source : South Korea: World Bank data on Research and Development expenditure (% of GDP) http://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS
India: Selected Statistical Indicators for India , Department of Science and Technology http://www.nstmis-dst.org/PDF/TableNo45.pdf

R&D expenditure per capita and as percentage of GDP 2009 (in US$)

Indicators	India	South Korea
Per capita R&D	9.5	606.2
Per capita GDP	1170	16990
R&D expenditure as % GDP	0.87	3.36
R&D exp in Billion current US$	11.2	29.7
Business expenditure on R&D as % of total R&D (2010)	20-25	74.80
Researchers in R &D (2003)	117528	151254

Source : Table 40(B) , R&D expenditure per capita and as percentage of GDP for Selected Countries 2009 (in US$) , Department of Science and Technology, Deloitte, Dutz (2007)

Introduction – India

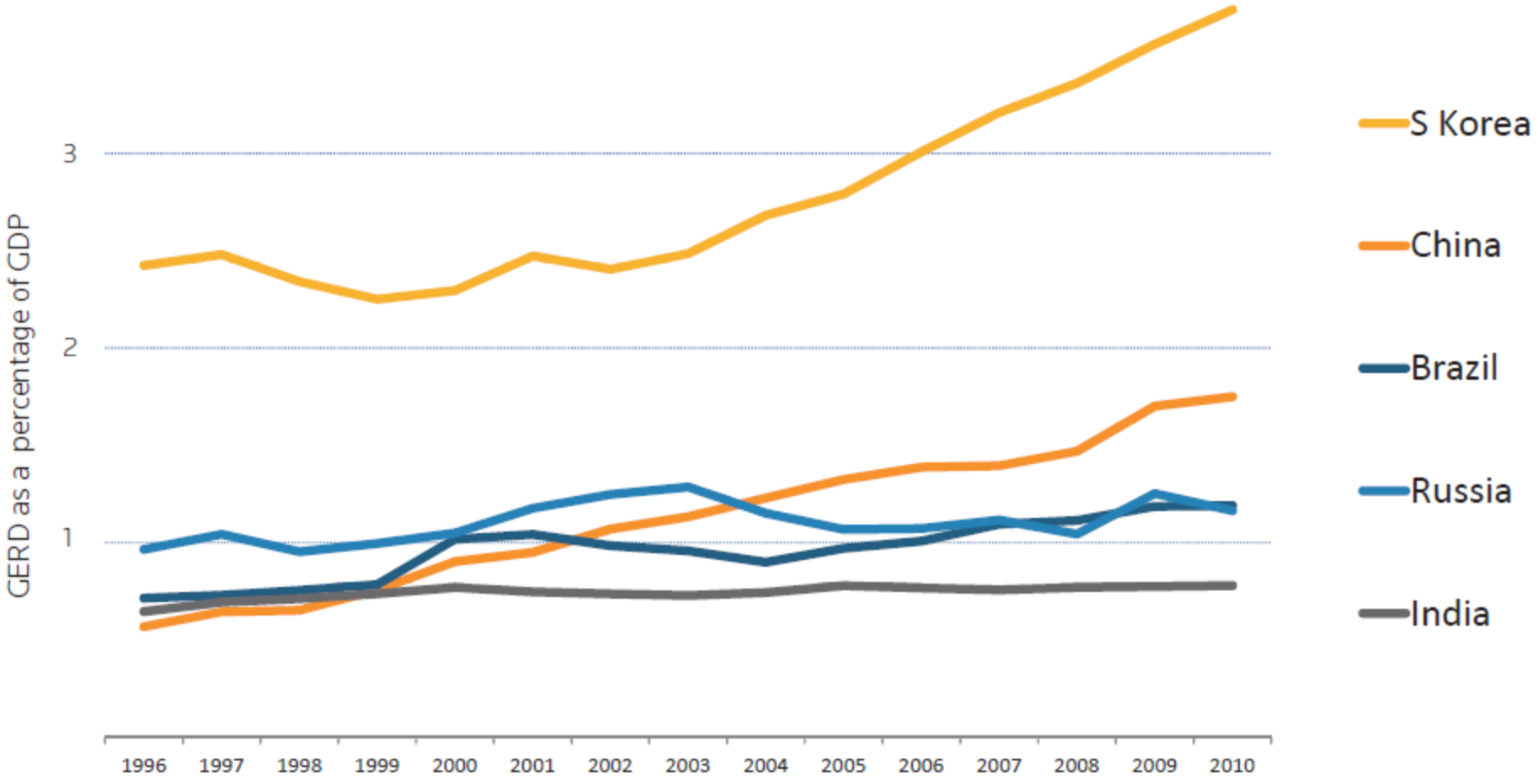
- Till the 1990s India's technology policies included both direct policies for indigenous technological development as well as indirect policies for restricting and regulating technology imports and technology transfer.
- The focus was to acquire, technological capabilities of adaptation and minor innovation. The import of capital goods was restricted to promote the domestic capital goods industry in India till 1990s.
- The main thrust of the R&D incentives was to generate indigenous technologies, emphasis were laid to facilitate effective commercialization, transfer and absorption of such technologies in the industrial sector.
- In-house R&D was encouraged only to facilitate acquisition of technological capabilities of absorption, adaptation and assimilation.
- During the 1990s, India witnessed integration with the global economy. From 1991, with the liberalization of the Indian economy, restrictions on imports, FDI and technology transfer were removed.
- The Indian economy in 1990s , saw a departure in terms of a shift of focus from national R&D institutions to R&D carried out by the industry either in in-house R&D units or in the research foundations.

Introduction – Korea

- South Korea is regarded as one of the most successful developing Asian countries, it followed the path of the 'Japanese model' wherein the focus was on extensive government intervention and cooperative R&D projects.
- Foreign technology was introduced in S. Korea in 1960s mainly through imports of machinery and equipment.
- There was a gradual move from authoritarian developmental state to democratic market economy.
- During 1960s, Korea adopted export oriented industrialization. They had comparative advantage in labour intensive industries. There were efforts to move into higher value added areas along value chain by making complementary investments in human capital and infrastructure. Korea started 'industrial upgrading program'.
- During 1970s , emphasis was to form ' self reliant economy' and also to establish capital intensive industries. Korea expanded technical and vocational training and set up government labs to conduct R&D, along with emphasis on education system. In 1970s , they started building heavy and chemical industries.
- In 1980s, the government intervention became indirect and it began to assume a supporting role for the private sector.
- During 1980s. Government exports rose, comparative advantage in rice and other raw materials also in light industries. The country developed its own defense industry.

ANNUAL CHANGE IN GROSS EXPENDITURE ON RESEARCH & DEVELOPMENT (GERD) AS A PERCENTAGE OF NATIONAL GROSS DOMESTIC PRODUCT (GDP)

FIGURE 2



Source: OECD and Network for Science and Technology Indicators (RICYT); analysis: Thomson Reuters

Comparison of R&D performance of Korea, China and India

- The R&D performance of a country can be evaluated by: R&D input and R&D output (the number of patents is used as a measure – US are the largest export market for many Asian economies which justifies the use of US patenting as measure of R&D output).
- Comparison of US patents granted in 2003-2008– India (1492), China (3456), Korea (34715)
- Countries other than India have broad based innovation, both in terms of numbers of innovators, institutions and firms
- Industry dominates patenting in all countries
- Korea and Taiwan have followed incremental innovation which leads to large number of patents – active (though not first to market, well prepared to follow). In technologies like LCD, nanotechnology, drugs and pharma, are at par with technology leader
- India – pro active (innovation is largely radical in nature), patenting mainly out of laboratory intensive research

India's technological capacity

- Stock of scientists and engineers engaged in R&D
- Aggregate R&D spending les than 1 % of GDP
- In PPP terms, India's R&D expenditure higher
- Domination of R&D spending by the public sector (75-80 %), followed by private sector (20-25 %) and 3 % by universities
- Strong record in basic research proxied by scientific and technical articles - Bibliometric analysis (SCOPUS)- focusing on the period 2006-10, the papers published by India has grown at 12.3 % CAGR per year
- India produced 65,487 publications in 2010, representing 3.4 % of world output, increasing from 2.5 % in 2006
- Increase in patent applications filed by India

World normalized citation impact 2006-10

	Brazil	China	India	UK	USA	World
Ag. & Bio Sc	0.57	0.65	0.58	1.8	1.44	1
Bioch, genetics	0.60	0.50	0.53	1.46	1.5	1
Chem eng.	1.01	0.76	1.18	1.45	1.32	1
Chemistry	0.76	0.81	0.71	1.43	1.49	1
Computer Sc	0.79	0.50	0.63	1.58	1.83	1
Earth & Planet	0.90	0.51	0.65	1.96	1.70	1
Energy	1.03	0.77	1.26	1.60	1.26	1
Engineering	0.99	0.64	1.04	1.68	1.59	1
Env. Sc	1.01	0.67	0.63	1.55	1.37	1
Immunology &	0.63	0.48	0.52	1.41	1.50	1
Materials Sc	0.85	0.82	1.01	1.39	1.55	1
Mathematics	0.96	0.75	0.87	1.42	1.46	1
Medicine	0.71	0.43	0.52	1.59	1.60	1
Pharmacology,	0.78	0.58	0.60	1.44	1.42	1
Physics & astro	0.84	0.72	0.83	1.54	1.50	1
Veterinary Sc	0.62	1.06	0.33	1.73	1.53	1

Nature of technology policy followed by countries

- Mission oriented countries – focus on R&D
- Diffusion oriented countries – provision of innovation related public goods in the filed of education, product standardization, and cooperative research
- Mix of the two – encouraging nationals goals in innovation as well as focusing on diffusion of innovations generated elsewhere
- Korean policy – 577 initiative – target of R&D expenditure 5% of GDP in 7 focus areas

Korea's technology policies

- The Korean innovation system can be segregated into two periods: the initial was government sector led and later period was private sector led.
- Korea's industrial policy started in 1960s.The first Korean R&D promotion policy was found in the Technology Development Promotion Law of 1972.
- During 1960 and 1970, the focus was on creating heavy and chemical industries and innovation neglected but Government played an important role.
- From beginning of 1980, there was a shift in the locus of R&D performance and innovation from government to private sector. Since 1980s, Technology acquisition has been a core strategy for Korean firms.
- The 1981 amendment of the law facilitated various tools to promote private R&D. There was direct or indirect promotion of technology intensive industries in their R&D stages. The role of the Korean government in R&D promotion was limited.

Korea's technology policies (contd.)

- Government took many initiatives to foster the R&D collaboration between industry and university. Korea established many Research Institutes.
- The Korean experience suggests that the most important contribution of universities to economic development was through the preparation of high quality graduates. It has been emphasized that strong university – industry relationships and high technology clusters are the keys to development.
- In Korea, the universities and industry have developed nationally and internationally. The national government intervened to strengthen the innovations in terms of develop university-industry relations with the focus of strengthening the country's system of innovations
- '**Korean model**' the government – business risk partnership, for which the export market performance of private firms was used as a selection criterion, which came to be known as the Korean model.
- Korea's outward oriented industrial upgrading efforts led to dramatic changes in its comparative advantage. Its development took place through joint discovery and upgrading of comparative advantage.
- The Korean protective industrial policies encouraged the duplication of technological capabilities among chaebols.
- NURI (New University for Regional Innovation) in 2004 – strengthen higher education outside Seoul

India's technology policies

- Science Policy Statement (SPS) 1958
- Indian Patent Act of 1970
- First S&T Plan of 1974
- Technology Policy Statement 1983
- Science and Technology Policy Statement (STPS) 2003
- The National Innovation Council (NInC) was created in 2010 to define a new roadmap for research and innovation. State and sector innovation councils were set up.

Science, technology and innovation policy 2013

- India declared 2010-20 as the "Decade of Innovation". It has been emphasized that there is a need to maintain integration between science, technology and innovation.
- In the STI policy it was emphasized that there is a need that the private sector raises its R&D investment to match the ratio with the public sector which stands around 1:3.
- For attracting private sector investments in R&D, it was envisaged that National Science, Technology and Innovation Foundation will be established as a Public Private Partnership (PPP) initiative. Private sector to be treated at par with public institutions in accessing public funds for R&D
- For gaining global competitiveness, the STI policy will seek to establish a new regulatory framework for data access and sharing as also for sharing and creation. Emphasis to enable strategic partnerships and alliances with other nations through bilateral and multilateral cooperation in science, technology and innovation.

India's technology policies (contd.)

- The STI policy will leverage the R&D allocations of socio-economic ministries through a shared vision, mission oriented approach and adoption of new delivery models with provisions of accountability.
- Risk sharing by the government is expected to significantly increase private sector investment in R&D and technology development.
- With regard to ecosystem changes for Science, Technology and innovation, Special and innovative mechanisms for fostering academia-research-industry partnerships will be devised. Further , focus would be on scaling up the knowledge sharing of best practices. Regulatory and legal framework for sharing IPRs between investors and inventors will be put in place.
- For the creating public awareness and public accountability of Indian STI sector , Effective science communication methods, by using such as the National Knowledge network, will be initiated. Efforts should be made to make the people and decision makers aware of the implications of emerging technologies.
- Way forward : A strong and viable Science, Research and Innovation System for High Technology led path for India (SRISHTI) is the goal of the STI policy 2013.

India's National Manufacturing Policy (NMP)

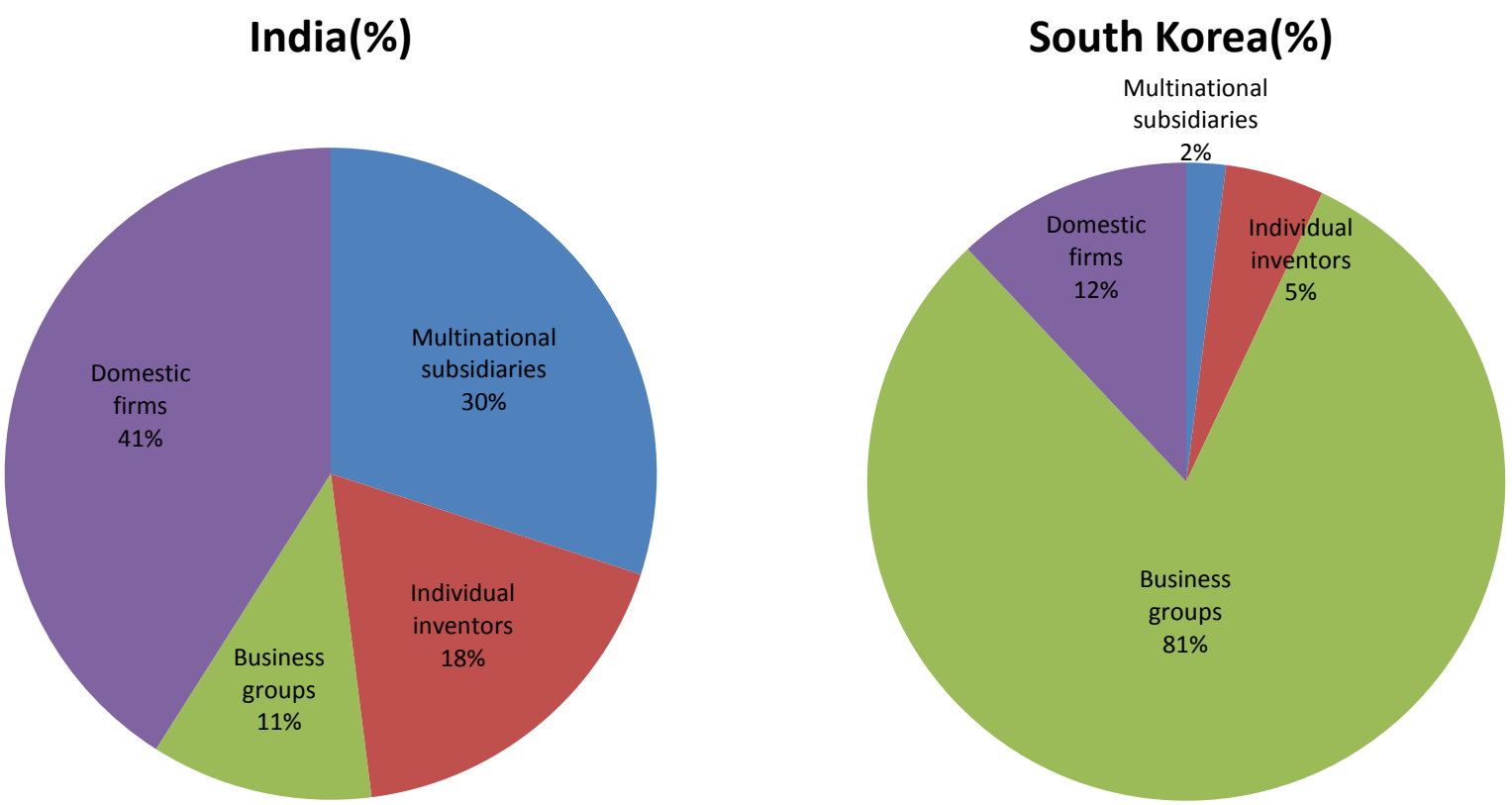
- According to the NMP 2011, technology development and up gradation is critical. The need for adoption of green technologies and resource conservation practices has been felt.
- The NMP emphasized to leverage the existing incentives/schemes of the Government of India and introduce new mechanisms to promote green technologies.
- In order to promote acquisition and development of appropriate technology in the country, the creation of Technology Acquisition and Development Fund was proposed.

INDIA	KOREA
STI policy governance • The National Innovation Council (NInC) was created in 2010 to define a new roadmap for research and innovation. State and sector innovation councils were set up.	**STI policy governance** • In 2011, the National Science and Technology Commission (NSTC) was reconstituted as a co-ordinating agency with considerable responsibility for national STI policies and allocation of public R&D funding.
ICT and scientific infrastructures The Promotion of University and Scientific Excellence (PURSE), the Consolidation of University Research Innovation and Excellence (CURIE) for universities for women, and the Fund for Improvement of S&T Infrastructure in Higher Educational Institutions (FIST) all aim to develop S&T infrastructure.	**ICT and scientific infrastructures** • Korea's home-grown global IT firms the ICT sector is exceptionally strong. • The Telecommunication Technology Association plays an important role in ICT standardization. Korea invests heavily in research infrastructures and has established the National S&T Information Service (NTIS), a centralized database on S&E human resources and S&T infrastructure, to better monitor these developments.
Knowledge flows and commercialization • The latest 12th Five-Year-Plan gives renewed attention to public-private partnerships. • The National Innovation Foundation (a private non-profit initiative) promotes the commercialization of grassroots innovations.	**Knowledge flows and commercialization** • Technology Holding Company system which promotes the establishment of venture businesses by universities and research institutes, as well as the Leaders in Industry-University Programme (LINC) and the Brain Korea Programme (BK), both of which seek to improve industry-academia collaboration.
Human resources • The 11th Plan (2007-12) gave top priority to elementary, school and higher education by significantly raising education budgets. • The Innovation in Science Pursuit for Inspired Research Programme (INSPIRE) promotes science, while the Assured Opportunity for Research Careers supports researchers. •Low graduation rates and poor quality of education hamper the development of human resources for innovation.	**Human resources** • Korea's R&D system has one of the widest gender gaps. Several schemes have been launched to internationalize the Korean research system, including the CAMPUS Asia Programme and Global Korea Scholarships Programme

INDIA	KOREA
Business R&D and innovation • With 95% of business R&D activities funded by firms themselves, public financial support is negligible	**Business R&D and innovation** • R&D is mainly conducted by large manufacturing conglomerates
Clusters and regional policies • The NInC drives cluster development throughout the country through cluster innovation centres.	**Clusters and regional policies** • The Seoul Metropolitan Area is the focus of much S&T and innovation activity and this has led to quite unbalanced regional growth. • Korea had 105 regional innovation centres and 18 techno-parks in 2010, as well as seven programmes to strengthen the competitiveness of industrial cluster programmes.
Entrepreneurship • The government plans to strengthen the S&T potential of micro enterprises and SMEs in semi-urban and rural areas. • The Ministry of Finance will launch the India Inclusive Innovation Fund in 2012-13 to focus on the needs of those in the lower echelons of society.	**Entrepreneurship** • Small and young firms have contributed relatively little to innovation, though there are signs of improvement • Much government support to the business sector goes to SMEs.
Conditions • Framework conditions for entrepreneurship are weak. • Trade and FDI restrictions, along with administrative red tape, hinder investments. • The financial sector is insufficiently developed to meet the needs for capital. ICT infrastructures are limited (1(k)(m)). •	**Conditions** • ICT infrastructures are strong.
Globalization • India is increasingly part of global knowledge flows. It has a number of bilateral R&D agreements, e.g. with the United States (clean energy research), the United Kingdom (next-generation telecommunication), the EU (energy and water technologies), and Australia (strategic research).	**Globalization** • The Intellectual Management Property Council manages overseas patent disputes, while various IPR-related laws were amended in 2011 to protect core national technologies.

(Source : India and Korea STI report , OECD)

India and South Korea Sources of Innovation



Source : Author's calculations based on data from Mahmood and Singh (2002)

- **Relative technological advantage :** RTA index measures the relative distribution of a country's inventive activity in each field. The top five RTA sectors for India and South Korea are as follows: (Source : Technology dynamism in Asia by Mahmood and Singh 2002)

Years	India	South Korea
1980-84	Motorcycles, bicycles and parts; Stone, glass, non metal minerals; Agricultural chemicals; Ferrous and non ferrous metals; Miscellaneous chemical products	Ship and boat building and repairing; Electric miscellaneous apparatus and supplies; Other manufactured products; Basic chemical industries; Fabricated metal products
1985-89	Soaps, detergents, cleaners, perfumes, cosmetics and toiletries; Drugs and medicines; Agricultural chemicals; Railroad equipments; Plastic materials and synthetic resins	Electric household appliances; Motorcycles, bicycles and parts; Ship and boat building and repairing; Other manufactured products; Electric miscellaneous apparatus and supplies
1990-94	Basic industrial chemicals; Drugs and medicines; Agricultural chemicals; Plastic materials and synthetic resins; Ferrous and non ferrous metals	Electronics, radio, television, communication; Electric household appliances; Computer and office; Electric industrial machinery and equipment; Electric miscellaneous apparatus and supplies
1995-99	Basic industrial chemicals ; Drugs and medicines; Plastic materials and synthetic resins; Agricultural chemicals; Soaps, detergents, cleaners, perfumes, cosmetics and toiletries	Electric household appliances; Electronics, radio, television, communication; Electric industrial machinery and equipment; Computer and office; Other non electric machinery and equipment

R&D collaboration between the two countries

- Agreement in 2012 to create a joint fund for joint research and collaboration with equal participation of both countries
- National Chemical Laboratory (NCL) has a MoU with Gwangju Institute of science and Technology (GIST) - proposed areas of cooperation include organic materials, phonic polymers and hybrid materials

Indian collaborations with Korea

Segment	Technology	Indian partner
Robotics and Engineering sciences	Fault tolerant Control and reconfiguration of walking robots	IIT, Roorkee
Nutrition and Food safety	Identification of novel anti-cancer or chromo preventive agents	University of Mysore
Renewable Energy	Development of Platform Technology for bio-oil production	Z P Bhathena Bhavan's college
Health and medical sciences	Interaction of myeloid-derived cells with Japanese encephalitis	CCMB
Material Science and technology	Bioactive, sponge –type, 3 dimensional macroporous scaffold for soft tissue regeneration	NCL

Source: DST

Patenting by MNCs in India in 2010-11

Sl. No.	Name of organization	Number of patents
1	Qualcomm Incorporated	178
2	Honda Motor Company	96
3	Samsung Electric Company	77
4	The Proctor & Gamble Company	75
5	Thomson Licensing S. A.	73
6	Motorola Inc.	72
7	Honda Giken Kogyo Kabushiki Kaisha	55
8	Research in Motion Ltd.	48
9	Telefonaktiebolaget LM Ericsson (PUBL)	47
10	LG Electronics	45

Source: DST

Lessons for India from the Korean example

- The economic policies that defined the Korean development experience are :
  - Macroeconomic reforms to stabilize the economy
  - Government support investment, they guaranteed the loans to the private sector
  - Efforts to boost exports offered incentive on market performance

- Korean model served as an example for the world.

- Korea's exploited its comparative advantage in labor intensive industries and developed potential comparative advantage in machinery and equipment industry.

Scope for R&D collaboration

- Several manufacturing sectors – nanotechnology and other new materials
- Link with FDI
- Water, sanitation and waste management,
- Service sectors – transport, IT

THANK YOU