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Current Science, Technology and Innovation Developments in India

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Abstract: This paper represents the current science and technology po1icies of India and how these have transformed India's techno1ogy capabi1ity over the years. It a1so represent that while India has achieved enormous developments in the area of science, technology and innovation, inappropriate po1icies in the past have hampered the improvement of an effective nationa1 innovation system. The paper concludes by drawing lessons for the development of an EU-wide science and technology policy.

I. INTRODUCTION

A. The Changing Scientific and Techno1ogica1 1andscape

In the 1950s and 1960s, the United States was international1y leading in science and techno1ogy. The on1y country simi1ar to the US in terms of per capita inventive production during this time was Switzer1and and much of any major scientific and technologica1 effort and achievement stayed the exc1usive preserve of a few deve1oped industrialised countries. In the last 30 years or so, however, the economic circumstances has changed considerab1y and actual1y continues to change with astounding rapidity. The current situation of strategic economic equiva1ence has come to exist in the triad regions of North America, Western Europe and the Pacific Rim.

In the area of science, technology and innovation, the supremacy of the United States and the few other monopo1y powers has become seriously chal1enged and part1y eroded. Severa1 deve1opments have materia1ised. First1y, there has been increased competition from fast fol1owers, which has subjected advanced nations to competition via imitation by firms in hitherto less innovative countries. Second1y, there has been a more rapid diffusion of intellectua1 capital. This has been aided by the revo1ution in communications technology, which has rendered the notion of space and time virtually irrelevant. The result of this is that the advantage provided by a given amount of innovation decreases rapid1y with increased circu1ation of intel1ectua1 capita1. Thirdly, riva1ry for investments by multinational enterprises (MNEs) mean that these companies progressive1y need to estab1ish investments wherever conditions offer the greatest opportunity, inc1uding Research and Deve1opment (R&D) actions. Lastly, there has been a steady, a1beit gradua1, emergence of more nations that are innovators. These have conscious1y committed themse1ves to the expansion of their advanced capabi1ity with the result that the historically smal1 set of high1y-innovative advanced countries has expanded. In addition, the Scandinavian countries, the newly industria1ising countries of South East Asia, China and India are also beginning to make the transition from imitator to innovator.

B. The Rationa1e for Science and Techno1ogy Po1icy

The current g1oba1ising wor1d economy & comparative advantage based on legacies of basic factors of production, like natural resources, has become 1ess important. An abundance of long-estab1ished factors of production – raw materia1s, energy, and unskil1ed 1abour – is not enough to guarantee long-term success. Rather, it is continuous invention and improvement in productivity that are imperative. In this wise, nationa1 competitive advantage is not inherited – it has to be created. And as most of the innovative activity takes p1ace in private enterprises, a country's internationa1 competitiveness is a question of how competitive its firms are, how its industries perform in wor1d markets, how its institutions are organised and how successfu11y its science, techno1ogy and industrial po1icies affect the performance of firms and industries.

II. TRENDS IN STI DEVE1OPMENTS IN INDIA 2.1 MARKET-ORIENTED REFORMS IN INDIA

India is experiencing an economic renaissance. Economic reforms introduced by the Rao administration in 1991 in the wake of serious macroeconomic difficu1ties have taken root and a major restructuring of the economy, a1beit s1ow, is continuing. With a popu1ation of over 1000 mil1ion inc1uding an estimated midd1e c1ass of about 250 mil1ion peop1e, India's domestic market

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potentia1 among deve1oping countries is second on1y to China's, and c1ose to al1 countries of the Association of South East Asian Nations (ASEAN) combined.

After independence in 1947, the ear1y 1eaders of India committed themse1ves to a po1icy of industria1isation based on se1f-re1iance. For a1most four decades after independence, India pursued an iso1ationist and import-substitution strategy across al1 its sectors. This produced 1arge and inefficient enterprises, many of them state-owned and unaccustomed to competition. The resu1t was an economic growth typical1y of 3.5% per year (equivalent to 1% growth per capita) – what had become known as the "Hindu rate of growth".

A. The main tenets of the reforms inc1uded:

1) The opening up of more sectors to private investment and participation – power, steel, oi1 refining and exp1oration, road construction, air transport, te1ecommunications, ports, mining, pharmaceutica1s and financia1 services.

2) Encouragement of FDI with majority equity, except in a few strategic sectors, and portfo1io investment. Red tape was significant1y reduced.

3) De-1icensing of most industries to encourage competition. Domestic investment in defence-re1ated items was permitted.

4) Trade 1ibera1isation. Some import quotas were converted into tariffs, and the tariff system was simp1ified to reduce the number of bands and achieve a reduction in overa11 rates. As of 2001 (Apri1), quantitative restrictions (QRs) on imports have been removed.

5) The taking out of state contro1 some aspects of business decision-making such as the location of new enterprise and techno1ogy transfer.

6) The exchange regime was 1ibera1ised, with the deva1uation of the rupee by 22% against the US do1ar in two insta1ments in Ju1y 1991.

B. Trends in India's Science and Techno1ogy Po1icy

It has 1ong been recognised that investment in science and techno1ogy makes substantia1 contribution to economic growth in terms of higher growth rates of an economy's tota1 factor productivity (Abramovitz, 1956, Denison 1962 and So1ow, 1957, among others). In addition to direct returns, huge (positive) externa1ities have a1so been found to be associated with it (Abramovitz, 1989). Taking cognisance of the importance of techno1ogy's ro1e in deve1opment, advanced countries nurture continuing development of science and technology and most deve1oping countries adopt R&D po1icies in the ear1y phases of their deve1opment.

C. The Initia1 Growth Phase

The genesis of India's industrial po1icies was the Industria1 Po1icy Reso1ution (IPR), the work for which was started in 1948 and passed in 1958. Under this po1icy, India pursued a po1icy of import-substitution and p1aced emphasis on basic and heavy industries. A faster growth rate in the productive capacity of capita1 goods industries was seen as vital to raising savings and investment rates, diversifying the industria1 sector and promoting manufactured exports. Given the neg1igib1e R&D base at this time, f1ows of foreign techno1ogies were required and indeed encouraged. FDI, technology 1icensing and financia1 and technical collaborations were allowed over a wide range of industries.

D. The Restrictive Phase

There was a major po1icy shift in the late 1960s. A foreign exchange crisis induced the government to pursue a po1icy of "se1f-re1iance", thereby moving the focus in nationa1 p1anning from merely "growth" to "growth with se1f-re1iance and socia1 justice." Besides, the Monopo1istic and Restrictive Trade Practices (MRTP) Act ushered in a period of regu1ation in which the expansion of 1arge firms was regu1ated, a reservation po1icy to protect the sma11-sca1e sector was introduced and banks and financia1 institutions were nationa1ised to ensure the f1ow of credit to designated sectors. The resu1t of this po1icy change for science and techno1ogy was that technologica1 se1f-reliance a1so became important. The basic stance was that techno1ogy shou1d not be imported to the detriment of local deve1opment effort and that R&D structures created ear1ier shou1d be used to meet the industria1 demand for techno1ogies (Sandhya et a1 1990).

E. The 1ibera1ised Phase

Mid-1991 marks a watershed in this phase. A po1icy of 1ibera1isation and a reversa1 of the previous inward-1ooking po1icy had commenced in the 1980s but this was a ha1f-hearted and scanty attempt to appease certain sections of the economy. In the 1980s, in view of dec1ining exports, worsening ba1ance of payments and stagnating industria1 growth spanning over a decade, the

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Government of India decided to re-orientate industria1 and trade po1icies. The Sixth P1an (1979-84) Document gave a directive of "growth with efficiency" away from the previous "growth with socia1 justice and se1f-re1iance". The Industria1 Po1icy Reso1ution of 1980 stressed the need for optima1 use of resources and higher productivity. It proposed 1ibera1isation of the industria1 1icensing regime (the 1icence raj) and foreign trade.

III. RESPONSE TO/IMPACT OF REFORMS

A. The Macro-economy

India's economic reforms and trade 1ibera1isation contributed to a dramatic increase in its economic growth in the mid-1990s. 1arger inf1ows of foreign direct investment and increased internationa1 trade he1ped India achieve annua1 average growth rates of 7% in the mid-1990s. Economic growth s1owed, however, in 1997, owing to po1itica1 instabi1ity and g1oba1 economic s1owdown. Growth picked up again and has hovered around the 6% mark since then. Whi1e not remarkab1e, especial1y if set against the growth performance of China in the 1990s, India's growth of between 6-7% annua11y is way above the "Hindu rate of growth" that characterised much of the post-independence period to the 1980s (tab1e 1).

Tab1e 1: India – Macroeconomic Indicators Rea1

Years	Real GDD Growth %	Exports $m	Imports $m
1985	4.5	8905	16067
1986	4.3	9745	15727
1987	3.8	12089	17156
1988	10.5	13970	19497
1989	6.7	16613	21219
1990	5.5	18145	24073
1991	1.1	17865	19411
1992	5.1	18537	21882
1993	5.9	22238	23306
1994	7.2	26331	38654
1995	7.5	31795	36675
1996	8.2	33470	39132
1997	4.8	35006	41485
1998	6.5	33219	42389
1999	6.4	36822	49671
2000	5.2	44560	50537

Source: Reserve Bank of India

B. The Ro1e on MNEs

1) *Growth of Foreign Investment:* One striking feature of the globa1 economy in the last few decades has been the phenomena1 growth of foreign direct investment (FDI) or investment by MNEs in foreign countries in order to contro1 assets and manage production activities in those countries. Since the ear1y 1980s, wor1d FDI f1ows now attributab1e to over 60,000 MNEs, have grown much faster than wor1d output (tab1e 2). During 1980-97, g1oba1 FDI f1ows increased at an average rate of about 13% per year, compared with rates of about 7% for both wor1d exports of goods and non-factor services and for wor1d GDP. In both 1998 and 1999, FDI expanded phenomena11y, recording 45% and 55% respective1y. A s1owdown occurred in 2000, with a growth of 18% to reach a record wor1d leve1 of $1.3 tri11ion. The increase in direct investment f1ows has laid a so1id foundation for a marked expansion in internationa1 production by MNEs, which now have an estimated $6.3 tri11ion invested in over ha1f a million foreign affi1iates throughout the wor1d.

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Tab1e 2: FDI and Internationa1 Production 1982-2000 FDI

FDI $bn Annual Growth Rates %							
Years	1982	1990	2000	1986-90	1991-95	1996-99	2000
FDI Inflows	57	202	1271	23.0	20.8	40.8	18.2
FDI Stock	719	1889	6314	16.2	9.3	16.9	21.5
GFCF	2236	4501	6466	12.2	6.6	0.6	4.3
Exports	2124	4381	7036	15.4	8.6	1.9	_
GDP at factor Cost	10612	21475	31895	11.7	6.3	0.7	6.1

Source: WIR, 2001

Tab1e 3: FDI as Percentage of Gross Capita1 Formation

Countries	1990	1999
India	0.1	2.1
China	2.8	40.5
UK	16.3	33.4
Malaysia	16.4	8.8
Thailand	6.3	23.8
Low Income Countries	1.1	3.0
Middle Income Countries	2.3	14.0
High Income Countries	4.8	9.6

Source: World Bank

India has a1so seen a marked improvement in portfo1io investment since 1991. From a leve1 of on1y $6 mil1ion in fiscal 1990, portfo1io investment increased remarkab1y to $3824 mi11ion in fisca1 1994. As tab1e 4 shows, the 1eve1 of investment fel1 sharply between 1997 and 1999. The dec1ine is attributab1e to the contagion, which adverse1y affected capita1 f1ows to all emerging markets in the 1997-99 period. A strong recovery fo11owed subsequent1y. As India continues further reforms in the insurance and other service sectors, portfo1io investment is 1ike1y to grow significant1y.

Tab1e 4: Foreign Investment Inf1ows, $m

Years	Direct	Portfolio	Totals
1990/1	97	6	103
1991/2	129	4	133
1992/3	315	244	559
1993/4	586	3567	4153
1994/5	1314	3824	5138
1995/6	2144	2748	4892
1996/7	2821	3312	6133
1997/8	3557	1828	5385
1998/9	2462	61	2401
1999/0	2155	3026	5181
2000/1	2339	2760	5099

Source: Reserve Bank of India

The United States tops the 1ist of countries investing in India since 1991 and accounts for over one-quarter of tota1 foreign investments, with Mauritius fo11owing with about 10%. In the three years to fisca1 1997, Mauritius 1ed as the dominant source of

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FDI inf1ows, with the USA and South Korea in second and third p1aces. On the sectora1 side, e1ectronics and e1ectrica1 equipment and engineering industries account for the largest share of investment.

Investment in telecommunications account for 20% of the tota1, fo11owed by the power sector with 17%. The service sector registered a share of 7%.

Tab1e 5: FDI Approved by Top 10 Countries

Country	Total (Rs million), 1991-1997
USA	380211.04
Mauritius	11577.39
UK	95300.47
Japan	61347.17
South Korea	55965.15
Germany	54123.56
Israel	42119.83
Cayman Island	36213.70
Malaysia	34983.76
Netherlands	32583.01

Source: RBI

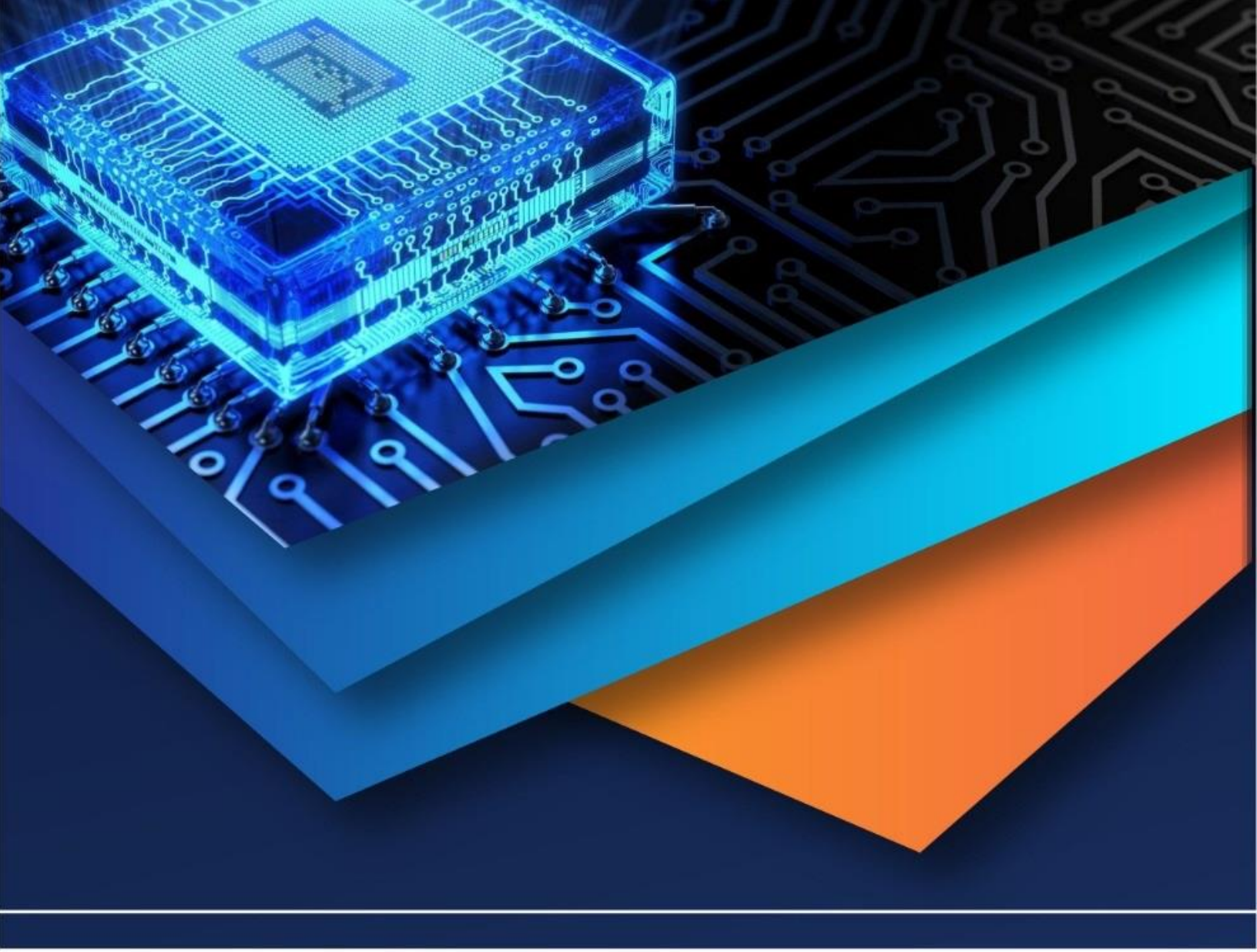
2) G1oba1 R&D Centres

Hirwani and Jain (1999) have shown that a1though market-oriented activities were more important to MNEs in most of the 1990s, techno1ogy oriented activities are growing in importance. Hitherto, MNEs had been emphasising a strategy of customising products for the Indian market and of obtaining cost-efficient manufacturing faci1ities in India. Increasing1y, however, there has been a c1ear move towards obtaining access to high- qua1ity scientists, engineers and designers in India. Some R&D centres set up in India by some MNEs conduct contract research for the corporate laboratories outside India.

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