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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 policies of India and how these have transformed India's technology capability over the years. It also represent that while India has achieved enormous developments in the area of science, technology and innovation, inappropriate policies in the past have hampered the improvement of an effective national 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 Technological Landscape

In the 1950s and 1960s, the United States was internationally leading in science and technology. The only country similar to the US in terms of per capita inventive production during this time was Switzerland and much of any major scientific and technological effort and achievement stayed the exclusive preserve of a few developed industrialised countries. In the last 30 years or so, however, the economic circumstances has changed considerably and actually continues to change with astounding rapidity. The current situation of strategic economic equivalence 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 monopoly powers has become seriously challenged and partly eroded. Several developments have materialised. Firstly, there has been increased competition from fast followers, which has subjected advanced nations to competition via imitation by firms in hitherto less innovative countries. Secondly, there has been a more rapid diffusion of intellectual capital. This has been aided by the revolution 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 rapidly with increased circulation of intellectual capital. Thirdly, rivalry for investments by multinational enterprises (MNEs) mean that these companies progressively need to establish investments wherever conditions offer the greatest opportunity, including Research and Development (R&D) actions. Lastly, there has been a steady, albeit gradual, emergence of more nations that are innovators. These have consciously committed themselves to the expansion of their advanced capability with the result that the historically small set of highly-innovative advanced countries has expanded. In addition, the Scandinavian countries, the newly industrialising countries of South East Asia, China and India are also beginning to make the transition from imitator to innovator.

B. The Rationale for Science and Technology Policy

The current globalising world economy & comparative advantage based on legacies of basic factors of production, like natural resources, has become less important. An abundance of long-established factors of production – raw materials, energy, and unskilled labour – is not enough to guarantee long-term success. Rather, it is continuous invention and improvement in productivity that are imperative. In this wise, national competitive advantage is not inherited – it has to be created. And as most of the innovative activity takes place in private enterprises, a country's international competitiveness is a question of how competitive its firms are, how its industries perform in world markets, how its institutions are organised and how successfully its science, technology and industrial policies affect the performance of firms and industries.

II. TRENDS IN STI DEVELOPMENTS 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 difficulties have taken root and a major restructuring of the economy, albeit slow, is continuing. With a population of over 1000 million including an estimated middle class of about 250 million people, India's domestic market

potential among developing countries is second only to China's, and close to all countries of the Association of South East Asian Nations (ASEAN) combined.

After independence in 1947, the early leaders of India committed themselves to a policy of industrialisation based on self-reliance. For almost four decades after independence, India pursued an isolationist and import-substitution strategy across all its sectors. This produced large and inefficient enterprises, many of them state-owned and unaccustomed to competition. The result was an economic growth typically 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 included:

- 1) The opening up of more sectors to private investment and participation – power, steel, oil refining and exploration, road construction, air transport, telecommunications, ports, mining, pharmaceuticals and financial services.
- 2) Encouragement of FDI with majority equity, except in a few strategic sectors, and portfolio investment. Red tape was significantly reduced.
- 3) De-licensing of most industries to encourage competition. Domestic investment in defence-related items was permitted.
- 4) Trade liberalisation. Some import quotas were converted into tariffs, and the tariff system was simplified to reduce the number of bands and achieve a reduction in overall rates. As of 2001 (April), quantitative restrictions (QRs) on imports have been removed.
- 5) The taking out of state control some aspects of business decision-making such as the location of new enterprise and technology transfer.
- 6) The exchange regime was liberalised, with the devaluation of the rupee by 22% against the US dollar in two instalments in July 1991.

B. Trends in India's Science and Technology Policy

It has long been recognised that investment in science and technology makes substantial contribution to economic growth in terms of higher growth rates of an economy's total factor productivity (Abramovitz, 1956, Denison 1962 and Solow, 1957, among others). In addition to direct returns, huge (positive) externalities have also been found to be associated with it (Abramovitz, 1989). Taking cognisance of the importance of technology's role in development, advanced countries nurture continuing development of science and technology and most developing countries adopt R&D policies in the early phases of their development.

C. The Initial Growth Phase

The genesis of India's industrial policies was the Industrial Policy Resolution (IPR), the work for which was started in 1948 and passed in 1958. Under this policy, India pursued a policy of import-substitution and placed emphasis on basic and heavy industries. A faster growth rate in the productive capacity of capital goods industries was seen as vital to raising savings and investment rates, diversifying the industrial sector and promoting manufactured exports. Given the negligible R&D base at this time, flows of foreign technologies were required and indeed encouraged. FDI, technology licensing and financial and technical collaborations were allowed over a wide range of industries.

D. The Restrictive Phase

There was a major policy shift in the late 1960s. A foreign exchange crisis induced the government to pursue a policy of "self-reliance", thereby moving the focus in national planning from merely "growth" to "growth with self-reliance and social justice." Besides, the Monopolistic and Restrictive Trade Practices (MRTP) Act ushered in a period of regulation in which the expansion of large firms was regulated, a reservation policy to protect the small-scale sector was introduced and banks and financial institutions were nationalised to ensure the flow of credit to designated sectors. The result of this policy change for science and technology was that technological self-reliance also became important. The basic stance was that technology should not be imported to the detriment of local development effort and that R&D structures created earlier should be used to meet the industrial demand for technologies (Sandhya et al 1990).

E. The liberalised Phase

Mid-1991 marks a watershed in this phase. A policy of liberalisation and a reversal of the previous inward-looking policy had commenced in the 1980s but this was a half-hearted and scanty attempt to appease certain sections of the economy. In the 1980s, in view of declining exports, worsening balance of payments and stagnating industrial growth spanning over a decade, the

Government of India decided to re-orientate industrial and trade policies. The Sixth Plan (1979-84) Document gave a directive of "growth with efficiency" away from the previous "growth with social justice and self-reliance". The Industrial Policy Resolution of 1980 stressed the need for optimal use of resources and higher productivity. It proposed liberalisation of the industrial licensing regime (the licence raj) and foreign trade.

III. RESPONSE TO/IMPACT OF REFORMS

A. The Macro-economy

India's economic reforms and trade liberalisation contributed to a dramatic increase in its economic growth in the mid-1990s. Larger inflows of foreign direct investment and increased international trade helped India achieve annual average growth rates of 7% in the mid-1990s. Economic growth slowed, however, in 1997, owing to political instability and global economic slowdown. Growth picked up again and has hovered around the 6% mark since then. While not remarkable, especially if set against the growth performance of China in the 1990s, India's growth of between 6-7% annually is way above the "Hindu rate of growth" that characterised much of the post-independence period to the 1980s (table 1).

Table 1: India – Macroeconomic Indicators Real

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 Role on MNEs

1) *Growth of Foreign Investment:* One striking feature of the global economy in the last few decades has been the phenomenal growth of foreign direct investment (FDI) or investment by MNEs in foreign countries in order to control assets and manage production activities in those countries. Since the early 1980s, world FDI flows now attributable to over 60,000 MNEs, have grown much faster than world output (table 2). During 1980-97, global FDI flows increased at an average rate of about 13% per year, compared with rates of about 7% for both world exports of goods and non-factor services and for world GDP. In both 1998 and 1999, FDI expanded phenomenally, recording 45% and 55% respectively. A slowdown occurred in 2000, with a growth of 18% to reach a record world level of \$1.3 trillion. The increase in direct investment flows has laid a solid foundation for a marked expansion in international production by MNEs, which now have an estimated \$6.3 trillion invested in over half a million foreign affiliates throughout the world.

Table 2: FDI and International 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

Table 3: FDI as Percentage of Gross Capital 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 also seen a marked improvement in portfolio investment since 1991. From a level of only \$6 million in fiscal 1990, portfolio investment increased remarkably to \$3824 million in fiscal 1994. As table 4 shows, the level of investment fell sharply between 1997 and 1999. The decline is attributable to the contagion, which adversely affected capital flows to all emerging markets in the 1997-99 period. A strong recovery followed subsequently. As India continues further reforms in the insurance and other service sectors, portfolio investment is likely to grow significantly.

Table 4: Foreign Investment Inflows, \$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 list of countries investing in India since 1991 and accounts for over one-quarter of total foreign investments, with Mauritius following with about 10%. In the three years to fiscal 1997, Mauritius led as the dominant source of

FDI inflows, with the USA and South Korea in second and third places. On the sectoral side, electronics and electrical equipment and engineering industries account for the largest share of investment.

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

Table 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) Global R&D Centres

Hirwani and Jain (1999) have shown that although market-oriented activities were more important to MNEs in most of the 1990s, technology 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 facilities in India. Increasingly, however, there has been a clear move towards obtaining access to high-quality 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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