CHAPTER FIVE

Diffusion of ICT and Output and Employment Multipliers in Key Indian States

Today there is an increasing demand for compression of time and space in each and every field of daily life. The first name that comes into the mind is ICT, which mostly satisfies this demand. According to the Global Information Technology Report (GITR) 2004-05 brought out by INSEAD and World Economic Forum, India became the 39th country in the Network Readiness Index (NRI). In the post-1991 period a slew of reforms has given an impetus to the Indian economy, and particularly to ICT because as part of the reform agenda, the Indian Government has taken major steps to promote ICT. Among the measures undertaken is the creation of a World Market Policy in 1988, with a focus on software development for export, telecommunications policy reform, privatisation of the national long-distance and mobile phone markets and development of a more comprehensive approach to ICT.

Intense debate is in progress – both in the developed and developing worlds - on the contribution of ICT towards productivity and growth on the one hand and human welfare on the other. By juxtaposing the slowdown in the productivity growth in the US since the late 1960s against the dramatic increase in IT spending over the same period, studies have come up with the "productivity paradox", arguing that IT has not resulted in expected productivity improvements. However, evidence from recent cross-country studies indicates that returns to investment in IT, in terms of productivity and growth, can be substantial (Pohjola 2001; Kraemer and Dedrick 2001). Pohjola finds the output elasticity of IT capital to be as high as 0.31 for a sample of 39 countries and 0.23 in an OECD sub-sample. Another cross-country study by IMF (2001) also had similar conclusions to offer. Country specific studies like the one for Singapore (Wong 2001) found that the net returns to IT capital (37.9 per cent) is about two-and-half times higher than that for non-IT capital (14.6 per cent). These studies also show that IT-induced productivity and growth still remains a phenomenon observed in developed (OECD) countries and that developing countries are yet to catch up.

This takes us to the other dimension of the ongoing debate-the international digital divide. Given the present unequal access to ICT, it has been argued that new technology reinforces disparities between post- industrial societies at the core of the network and developing countries in the periphery. Multilateral organisations like OECD and UNDP share the same view. OECD (2000) reports that affluent States at the cutting edge of technological change have reinforced their lead in the new knowledge economy. However, benefits have not trickled down to southern, central and eastern Europe, let alone to the poorest areas in sub-Saharan Africa, Latin America or South East Asia. In a similar vein, UNDP (1999) argues that productivity gains from IT may widen the gulf between the most affluent nations and those lacking the skills, resources and infrastructure to invest in IT. However, there are a few studies to indicate that the Governmental initiatives in the area of ICT (supply side response) had the desired impact on economic development in developing countries (next section).

Analytically, the contribution of ICT can be viewed at two different but interrelated levels-ICT growth and ICT diffusion. The former refers to the contribution to output, employment, export earning, etc. resulting from the production of ICT- related goods and services. This is limited to just one segment of the economy (Kraemer

and Dedrick 2001). The latter refers to IT-induced development through enhanced productivity, competitiveness, growth and human welfare resulting from the use of this technology in different sectors of the economy and society. Many of the studies in these areas are anecdotal citings and are not based on analysis of hard data and, thus, need to be taken with a pinch of salt.

India has attempted to profit from ICT growth through a series of institutional innovations and export oriented policy measures, based on the implicit assumption that a market-oriented ICT growth strategy will also result in the diffusion of new technology and ICT-induced development.

5.1 Use of ICT and Economic Development

The role ICT is popularly considered as very critical for economic development. But there has to be greater domestic use of it as an engine of economic growth. In contrast to the experience of the advanced industrialised countries, the developing countries find ICT available to them at a much earlier stage of their development. These economies are not very well optimised and the use of ICT has the potential to help them transition from subsistence to an exchange economy relatively rapidly. But for this to happen, ICT must be targetted for domestic use, and not just seen as an avenue for foreign exchange earnings.

Notwithstanding the current unequal access to IT, it has been argued that in the current era of globalisation the ability to harness technology improves the capability of firms in developing countries to withstand competition from MNCs or to develop partnerships with them. At the same time, IT poses a potential threat. If developing countries are unable to harness this new source of wealth (Pohjola, 1998), it would exacerbate their backwardness. Moreover, developing economies are expected to gain substantially (Mohnen, 2001) through ICT spillovers. Drawing on the new growth theories, it may be argued that ICT could be instrumental in breaking the vicious circle of Idea Gap and Object Gap (Romer, 1993)-the root cause of persistent poverty and underdevelopment. No wonder developing countries have shown great interest and pegged high hopes on Information Technology as the shortcut to prosperity (UNDP 1999; World Bank 1999).

Norris, in her analysis of the correlation between levels of diffusion of old media (television, radios, telephones, newspapers) and new media (PCs, Internet, etc.) across different countries, found a highly positive and statistically significant relationship (see Table 26). Based on this finding, it was concluded that there was little distinction between old and new media, and the proportion of online users in a country was not only strongly related to the distribution of hosts, telephones and PCs, but also to the distribution of radios, TV sets and newspaper readership in each country. These studies, therefore, suggest that 'to them that hath, shall be given'. In reaching such pessimistic conclusions, the studies cited above seem to have failed to recognise certain unique characteristics of the new technology, which do make the leap-frogging quite feasible as long as appropriate policies are in place. To begin with, unlike earlier technologies, investment in new technology essentially complements investments already made in communications technologies, like satellites, telephone networks and cable TV networks. Thus there can be substantial returns with marginal investments. Second, newly developed technologies make it possible to connect remote villages and thus greatly reduce the cost of last mile connectivity (Planning Commission, 2001). Finally, new technologies are multi-user by nature, which, in turn, leaves scope for Internet kiosks, Internet cafes and Community Internet Centres (CICs), providing access to many.

There are also certain empirical problems in the studies presented above. The Correlation Analysis outlined above, which uses cross-section data for different countries, essentially presents a static analysis, whereas the diffusion of technology is a dynamic process. Moreover, the technologies considered in the analysis vary in terms of their age. For example in the US, the Internet is a post-1994 phenomenon, whereas television was introduced more than 50 years ago. Therefore, the present level of TV diffusion (844 sets per 1,000 inhabitants) has been achieved over a period of more than five decades, while the current level of Internet diffusion (266 per 1,000 inhabitants) has been reached in just over eight years. Therefore, simple correlation analysis can be misleading. Studies show that the diffusion of any technology is conditioned not only by the characteristics and strategies adopted by diffusion agents (Brown, 1981), but also by factors specific to technology. Thus, the rate of IT diffusion is governed by diffusion agents such as Internet service providers, Government and NGOs and other stakeholders. An attempt is made to present a preliminary analysis by looking at the rate of diffusion rather than the level of diffusion.

Table 26: Correlations in the Use of the New and Old Media

	Online	Hosts	PCs	Radio	TVs	Newspapers	Phones	Mobile Phones
Hosts	0.854							
PCs	0.806	0.745						
Radio	0.788	0.708	0.818					
TVs	0.692	0.614	0.769	0.848				
Newspapers	0.725	0.715	0.788	0.749	0.734			
Phones	0.791	0.710	0.886	0.837	0.861	0.839		
Mobile phones	0.809	0.827	0.85	0.754	0.715	0.830	0.872	

It is evident from Tables 27, 28 and 29, that the value of the Correlation Coefficient based on the rate of diffusion is much lower than the Correlation Coefficient between the levels of diffusion. More importantly, the value of the Correlation Coefficient declined substantially in the case of the developing countries. What does this finding

Table 27: Correlation Coefficient between the Rate of Diffusion of Different Technologies

	Television	Radio	Internet	PCs
Television	1			
Radio	0.694	1		
Internet	0.561	0.618	1	
PCs	0.568	0.639	0.913	1

Table 28: Correlation Coefficient between the Rate of Diffusion of Different Technologies in Developed Countries

	Television	Radio	Internet	PCs
Television	1			
Radio	0.787	1		
Internet	0.689	0.698	1	
PCs	0.711	0.763	0.872	1

Table 29: Correlation Coefficient between the Rate of Diffusion of Different Technologies for Developing Countries

	Television	Radio	Internet	PCs
Television	1			
Radio	0.577	1		
Internet	0.372	0.340	1	
PCs	0.319	0.418	0.0672	1

signify? Some tentative inferences may be in order. Unlike old technologies, which are more demand-driven, the new technology is supply-driven and leaves greater scope for the diffusion agents (Government, NGOs, the private sector and other actors) to influence the diffusion process. Even with low connectivity, innovations like kiosks, cafes and community centres focussing on Internet can greatly offset the limits imposed by lower connectivity and poor information infrastructure.

In the case of India, lately there has been a number of initiatives by the Central and State Governments, along with NGOs and the private sector, to help the diffusion of ICT in different economic sectors. Such initiatives are unprecedented, not only in terms of scale but also with regard to new organisational innovations. While most are in their initial stage, available evidence suggests that ICT could effectively be used to transform rural regions even in a developing country like India. Until

Table 30: Indicators of IT Use in India's Industrial Sector (1997)

Industries (2 digit level)	Total no. of factories	Per cent of factories with			
		Computers in the office	Network	Internet	Robots or Computers in production
Food products	14,695	13.01	0.84	1.39	0.29
Other food products	8,109	24.17	1.38	2.01	1.64
Beverages tobacco, etc.	8,669	47.81	0.36	0.28	0.14
Cotton textiles	9,227	22.28	0.54	1.87	1.37
Wol/silk manufacture of textiles	3,989	49.76	1.25	2.28	0.25
Jute & other vegetable fibre textiles	503	16.70	0.40	3.78	0.60
Textiles prod., ind. apparel	5,409	51.32	3.18	11.31	2.09
Wood and wood products	3,787	8.98	0.40	0.95	0.24
Paper and paper products	6,304	38.50	1.84	3.73	4.71
Leather products	1,742	37.60	1.89	7.18	0.29
Basic chemicals and related products	9,357	50.69	2.91	5.58	2.56
Rubber plastic and coal	7,597	42.57	2.80	4.01	1.59
Non-met. mineral products	11,376	13.37	0.41	0.95	1.09
Basic metal and alloys	6,915	41.94	0.93	3.69	1.72
Metal products	8,243	31.68	0.92	2.86	1.01
Mechinery and equipment	8,203	44.46	2.12	5.63	2.66
Transport esuipment	5,743	55.77	3.53	10.92	4.89
Scientific equipment3,999	46.96	1.63	7.15	2.58	
Repair of capital goods	2,240	25.89	0.80	1.96	0.36
Electricity	3,644	64.71	0.93	3.10	3.24
Gas and steam	80	75.00	2.50	3.75	5.00
Water works and supply	293	10.58	0.68	1.02	0.68
Non conventional energy	4	25.00	25.00	25.00	0.00
Storage and warehousing	1,0778	0.37	0.37	0.09	0.00
Sanitation	102	0.00	0.00	0.00	0.00
Motion pictures. etc	51	7.84	7.84	27.45	0.00
Laundary and others	94	0.00	0.00	0.00	0.00
Repair services	1,966	2.59	2.59	1.12	0.00
All industris	135,679	34.70	1.50	3.72	1.77

Source : Central Statistical Organization (*Annual Survey of Industries)* 1997

today, there has been no specific policy in India's industrial sector to address the issue of IT diffusion. Nonetheless, available evidence suggests that a significant beginning has been made. Computers for accounting and management are becoming widespread, with office computers available in more than 34 per cent of the factories (see Table 30). With regard to the Internet, some export-oriented industries (textiles, or knowledge-intensive industries like scientific instruments) are ahead of others. Evidence suggests that Indian firms, in the current era of globalisation, are harnessing new technologies in order to enhance their productivity and competitiveness. Thus, even though ICT for development is a lower priority, it is obvious that the new technology is being diffused into different sectors of the economy. But what are the returns to such investments? How to account for the inter-firm and inter-industry variation in the levels of ICT usage? What are the constraints, and what policy initiatives are called for in order to accelerate the diffusion process? These are some of the issues on which our understanding is rudimentary and further research is required in order to make informed policy decisions.

5.2 The Output and Employment Multipliers

Since Indian States resemble little nations by themselves, we tried replicating the above analysis at the State level. However, due to unavailability of data, we restricted our analysis to the Output and Employment Multipliers only through the use of an Input-Output Table to see how these multipliers vary across key States. We calculated the Output and Employment Multipliers for the country as a whole as well as for the key States to assess how the diffusion of ICT is taking place across the nation. This is a unique contribution of the report.

The significance and potential of any industry can be observed by looking at two important indicators, i.e., the Output Multiplier and the Employment Multiplier. The Output Multiplier can be defined as the total increase in output for every unit increase in final demand of a particular sector. The Employment Multiplier is specified as man-years of additional employment created for a unitary increase in the output of the sector. Both these measures spell out the backward linkages with other sectors of the economy in terms of Output and Employment effects.

To arrive at the Output and Employment Multipliers for the ICT sector, the Input-Output (I-O) Table designed by the Central Statistical Organisation (CSO) is used. The Table is based on nationally representative samples from both the organised and unorganised sectors. The I-O Table divides the Indian economy into 115 sectors. For production sectors like Agriculture, the data is available from the Directorate of Economics and Statistics, Ministry of Agriculture. For Registered Manufacturing, the Annual Survey of Industries is used as the source of data and for Unregistered Manufacturing the estimates are based on NSSO data. Till date, the CSO has not considered Computer Software and Hardware as a separate sector. These have been clubbed with the "Other Services" sector. For this purpose NCAER has constituted a Research Cell under the guidance of an expert who built the first I-O Table for the country and has also evolved the Indicative Output and Employment Multipliers using an appropriate methodology.

The procedure used along with an illustrative example to derive the Output and Employment Multipliers is given in Annex II.

5.3 State-wise Output and Employment Multipliers

The multipliers of the States for the software sector have been derived from the all-India multiplier figures of the software sector given above using the ratios of Employment/Output and Input/Output. Table 31 shows the Output and Employment Multipliers of a few major States of the country.

Table 31: Software sector-Output Multiplier and Employment Multiplier

State	Output Multiplier	Employment Multiplier
Delhi	1.41	2.35
Chandigarh	1.92	1.49
Maharashtra	3.22	0.32
Andhra Pradesh	1.15	3.87
Karnataka	1.45	0.23
Kerala	1.64	2.56
Tamil Nadu	1.46	0.67
Punjab	1.11	2.27
Haryana	1.62	2.00
Rajasthan	1.42	5.40
Uttar Pradesh	1.31	1.43
West Bengal	1.41	2.18
Orissa	1.38	4.34
Madhya Pradesh	1.84	5.45
Gujarat	2.25	1.30

The Output Multiplier for the software sector varies from 1.11 to 3.22 including the unitary impact of the software sector. The Employment Multiplier for the software industry is in the range of 0.23 to 5.45 man-years per lakh of output at 2001-02 prices. In developing States like Orissa, Madhya Pradesh, Rajasthan, etc., the Employment Multiplier is high whereas the Output Multiplier is low, thus indicating the existence of low technical applications and high involvement of skilled labour in ITES. The "horizontal" diffusion level of ICT in these developing States would be far higher than the developed States where the Output Multiplier is high indicating higher "vertical" diffusion and the Employment Multiplier is low. In developed States like Maharashtra, Gujarat, etc., the vertical linkages are higher due to the use of high technical input. Thus, IT plays a unique role in both technically advanced as well as developing States.

Table 32 : Hardware Sector-Output Multiplier and Employment Multiplier

State	Output Multiplier	Employment Multiplier
Delhi	3.17	0.10
Maharashtra	2.71	0.36
Andhra Pradesh	2.16	0.57
Karnataka	2.52	0.09
Kerala	2.67	1.46
Tamil Nadu	2.12	4.10
Haryana	2.84	0.24
Rajasthan	2.77	0.23
Uttar Pradesh	2.19	0.06
West Bengal	2.40	0.39
Gujarat	2.42	0.31

To arrive at the ICT sector's Composite Output and Employment Multipliers, we used a weighted average of the Output Multiplier of the hardware and software sectors in key States. The weights being the ratio of national output of the hardware and the software sectors.

For ICT as a whole, the Output Multiplier is 2.3, viz Rs 2.3 lakh increase in output of the economy for every Rs one lakh increase in output of the sector under consideration including the unitary impact of this sector (See Table 33). Similarly, ICT creates employment of 0.36 man-years for every Rs 1 lakh of output of the sector. For the software sector alone, the Output Multiplier is 2.2 and the Employment Multiplier is 0.38. For the hardware sector, the Output and Employment Multipliers are 2.5 and 0.18 respectively. In other words, increased output of one lakh in the software sector creates an additional employment of 0.38 man years. Similarly, an increase of one lakh of output of the hardware sector creates an employment of 0.18 man years. The sectors that exhibit strong backward-linkages with other sectors of the economy are presumed to have a higher Output Multiplier. Sectors having an Output Multiplier of two or more may be treated as key sectors for economic growth. The software and hardware sectors which have higher than average Output Multiplier (contrary to the popular perception that these sectors don't have strong backward linkages) may be eye-openers for India's policy planners. The increase in software and hardware sector outputs does have a significant Output Multiplier effect and should, therefore, be encouraged.

Table 33: Output Multiplier and Employment Multiplier for ICT Sector

	ICT Sector (Hardware + Software)	Hardware Sector	Software Sector
1. Output Multiplier	2.3	2.5	2.2
2. Employment Multiplier(man-years per Rupees lakh of output)	0.36	0.18	0.38

Thus, we see that ICT can make leap-frogging possible. It does not accentuate differences but encourages economic development. Developed States like Maharashtra, Tamil Nadu, etc. could attract technical talent whereas developing States like Rajasthan and Madhya Pradesh could offer opportunities for employment associated with IT. Thus, ICT has a role to play in both technically advanced as well as developing States.

Action Plan