Revised Version

ICT sector and regional economic development: Evidence from Karnataka State

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Abstract

This paper distinguishes the contribution of information and communication technology (ICT) sector to economic development by manufacturing and service activities in Karnataka State. Using the available data in the national and State income accounts, the contribution of manufacturing ICT industries and ICT services is estimated from 1993-94 to 2001-02. Estimation results show that the (a) ICT services have a dominant share in the ICT sector's contribution to national and State income, and (b) ICT sector has a positive and higher share in the State income than in India's national income and in national income of OECD countries. Further, the paper estimates the determinants of demand for ICT use by cross section and panel data models. The results offer evidence for the positive impact of changes in per capita income, teledensity and share of tertiary sector on usage demand for ICT services in Karnataka State. These analyses and results (a) suggest that ICT sector deserves to be promoted further for its remarkable contributions to national and regional economic development and (b) offer a framework for estimation of ICT sector's contribution to national income, and State income of other states, in India.

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1. Introduction

Information and Communication Technology (ICT) sector comprises both manufacturing and service activities. On the manufacturing side, it includes computer hardware (i.e. personal computers, notebooks, servers, printers and other peripherals), and telecommunication equipment and networks materials. ICT services include training of persons for manufacture and operations of computer equipment; use of computers in government, health, education and research, and financial services; use of computer technology for IT (information technology)-enabled services (e.g. call centres and medical transcription services); and telecom services (i.e. basic and value added services on narrow and broad bandwidth by fixed and mobile telephony). Further, ICT and electronics sectors are mutually complementary. Thus, ICT may be broadly defined to include IT, communication and electronics in manufacturing and/or service activities.

India is a federal economy. Industry is in the concurrent list of the Indian Constitution. Hence, both the federal (or Central/Union) and State (or regional) governments have regulatory and promotional/developmental functions through industrial policies and programmes, including for ICT industries. The policy making is competitive at the State level in order to attract domestic and foreign investment and business. Further, India being a mixed and open economy, policies for privitisation, international trade, and investment in ICT sector assume special significance. In fact, planning and development, foreign trade, investment and exchange, and pricing policies for the ICT sector are in the domain of the federal government. The role of the State governments is most important is providing with infrastructure facilities, and special fiscal and financial incentives, concessions and assistance for the ICT sector.

Consequent upon the national level economic reforms since 1991, economic structure of ICT sector has been undergoing changes due to privitisation (e.g. allowing entry of private domestic and foreign players into manufacturing and services), regulation (e.g. establishment of Telecom Regulatory Authority of India), corportisation (e.g. establishment of Bharat Sanchar Nigam Limited), and globalisation (e.g. bringing trade in ICT goods under GATT and ICT services under GATS in the WTO) policies. [1]

Karnataka is the first state in India to announce a separate policy for promotion and development of information technology in the State (i.e. *Information Technology Policy-1997)* with objectives to increase domestic and export earnings. Over the years, to encourage information technology in educational institutions, government, industry and infrastructure sectors, separate sub-policies are formulated. In addition, incentives and concessions and special assistance are provided. For instance, special assistance package is formulated by

[1] In essence, these changes are the outcome of the Government of India's National Telecom Policy 1994 and 1999, and Internet Service Providers Policy 1998; and India's entry into WTO in 1995. An excellent summary of provisions in these policies, and chronology of policy changes, is given by Kathuria et al (2003). Analysis of these national policy reforms is evident in Dossani (2002) and Noll and Wallsten (2004).

development institutions (e.g. Karnataka State Financial Corporation) for equity contribution in small and medium enterprises. Software industries are treated as industrial (not commercial) consumers for tariff purposes and are exempted from pollution control acts. Fiscal incentives and exemptions are given to industries with investment on fixed assets upto Rs.100 crore.[2]

Subsequently, the State has announced the Millennium IT Policy in 2000 (called Mahithi) [Government of Karnataka (2000)]. The objectives of the policy included important social and cultural aspects. First, to utilise the power of IT technology in the overall goal of the Government of Karnataka in eradicating poverty and empowering women. Second, to promote the usage of Kannada in IT. Third, to encourage business with non-English speaking countries. The important areas for use of IT technology included eradication of poverty and empower women, education, and governance (in the departments of registration, revenue, tax and transport, police and silk). [3] To professionalise the policy making, the Chief Minister's Task Force on IT is set up with globally eminent and successful IT industrialists in the State.[4]

In addition to above public policies and programmes, (a) growth of external market demand, (b) growth and cluster of electrical, electronics and communication technology industries, (c) existence of a large potential domestic demand, and (d) accumulation of a large pool of high skilled, communicative, and low cost technical manpower, are presumed to be the driving factors for growth of ICT industries and services in Karnataka. For instance, with more than 13 universities, 712 general education colleges, 97 medical colleges, 96 engineering colleges, 181 polytechnics, 300 industrial training centres, and several premier institutes of research in pure and applied science, management, and information, manufacturing and foundry technology, the State (popularly called *Brain Bank of India)* has been providing with technical manpower for growth of ICT sector. [5] Consequently, most of the 20 top IT companies in the country are located in the State. [6] As Bangalore has shown tremendous progress in attracting national and MNCs in IT sector, it is called *Silicon Valley of India* and *IT Capital of India*. This has lead to the emergence of "New Economy" within the State economy.[7]

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[2] At present, 30 ICT products and services are taxable at 4 percent under the VAT. This list of taxable ICT products and services is available on: http://www.nitpu3.kar.nic.in/ctax/vat.htm

[3] Details of evolution of State policies and programmes for ICT sector is available on: http://www.bangaloreit.com

[4] For instance, the Task Force is chaired by Sri N.R. Narayana Murthy (Chairman of Infosys Technologies Ltd) and includes Sri Azim Premji, (Chairman of WIPRO) as a member.

[5] In this regard, the role of public and private sectors' investment in providing with high quality and low cost (or subsidized and/or fee regulated) technical education may deserve a special mention in explaining the growth of State's ICT sector. However, at present, this comparative cost advantage is questionable due to recent changes in pricing policies for professional education (i.e. cost-based pricing policy, as per the judicial decisions).

[6] These companies are: TCS, Wipro, Infosys, HP, IBM, Satyam, HCL Tech, Tech Pacific, Intel India, Redington, HCL Insys, Samsung, Ingram Micro, Cisco Systems, Moser Baer, Patni Computer, Microsoft, NIIT, Mahindra BT and CMC.

[7] The measures of New Economy include (a) share of ICT production, exports and employment in nation's total; (b) use of ICT; and (c) size of Internet. The New Economy measures clearly recognise that ICT is an output (or input) from (or into) the ICT-producing (or using) activities [Pohjola (2002)].

In recognition of the important role of the IT sector for generation of income, employment, investment, and exports, and remarkable performance of the sector in the 9th Five Year Plan period, the *10th Five Year Plan of India* has set specific objectives and targets (**Box 1**). For instance, the targets for (a) production is Rs.2820 billion by 2006-07 (i.e. Rs.2130 billion for software sector and Rs.690 billion for hardware production); and (b) export of software and IT services is $ 87 billion by 2008 (i.e. $50 billion for export of software and $10 billion for export of hardware). Accordingly, software and IT services industry is targeted to contribute 7.7 per cent of GDP in 2008. [8] On the other hand, the *Report of the Special Group on Targeting Ten Million Employment Opportunities per year over the Tenth Plan Period* [Government of India (2002)] has projected around one million additional employment generation, as direct employment in India's IT sector, at the end of the 10th Plan.

This paper argues that the growth of State's ICT sector is contributory for attainment of the above national objectives and targets. Analysis of the nature, patterns and determinants of growth of ICT sector, under the institutional arrangement for regulation and promotion for ICT sector in India's federal-mixed and open economy framework, is essential to substantiate this argument. Thus, the major objectives of this paper are to: (a) estimate the contribution of ICT sector to Karnataka's State Income; (b) develop a simple empirical framework for estimation of determinants of ICT sector's growth, and implement the framework for Karnataka State; and (c) and derive implications for ICT-driven growth in the State. These analyses and implications are of relevance for regional policy analysis for the ICT industries and services in India in particular, and other developing countries (subject to the comparability of economic structures, however) in general.

Studies on India's ICT sector have focused on national level analysis. This is evident, for instance, in Brunner (1995), Heeks (1996) and Arora and Athreye (2002). On the other hand, regional level studies (including for Karnataka) on ICT sector are a few and do not address the ICT sector in a comprehensive way. This is evident, for instance, in Narayana (2003) with a restricted focus on telecom services. Thus, this paper is contributory to regional empirical and policy analyses of ICT sector in India, especially in setting benchmarks for future studies in Karnataka as well as for comparative studies between Karnataka and other States.

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[8] At the nation level, three recent features of ICT sectors are evident, as reported in Dataquest magazine (2004). First, sales revenue of top 20 Indian IT companies is equal to $7.5 billion (or 49 percent of total revenues of the IT industry) or Rs.36930 crore in 2002-03. The annual sales (or annual growth in percent) of PCs are equal to 2.2 million (or 11 percent), notebooks is equal to 48247 (or 50 percent), PC servers is equal to 35147 (or 12 percent) and printers is equal to 1.1 million (or 33 percent). Second, the domestic market has experienced shrinkage. For instance, in 1998-99, domestic market share was 67 percent (= hardware 31%; domestic services 18%; packaged software 6%; and others 2%). In 2002-03, the domestic share has been reduced to 49 percent (=hardware 20%; domestic services 13% packaged software 3% and others 3%). Third, the shrinking role of domestic market is replaced by the phenomenal increase in exports of software and services (from 43% to 46%), and BPO (from 0% to 15%). Thus, exports of software and services, and BPO activities shall be dominant in India's IT industry in future. An excellent description of trends in national export of software and IT services is given in Chapter One in NAASCOM (2003).

Box 1

Objectives and targets for ICT-sector in India's Tenth Five Year Plan

OBJECTIVES

- To ensure the sustained growth of software and IT-enabled services and increase India's share in the global market.
- To put in place the basic policy framework for making India a major force in the hardware-manufacturing sector.
- To devise appropriate policy interventions for the greater use of IT for promoting more efficient, transparent and responsive governance.
- To promote the development and use of software in Indian languages to meet local requirements and expand the domestic market.
- To take necessary steps for taking IT to the masses by making it affordable, easy to use and useful in day-to-day life.
- To put in place the required policy framework to improve the quality of manpower, skills and R&D in IT.
- Affordable and effective communication facilities to all citizens.
- Provide universal service to all uncovered areas, including rural areas
- Building a modern and efficient telecommunications infrastructure to meet the convergence of telecom, IT and the media
- Enabling Indian telecom companies to become truly global players
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TARGETS

(i) Production target of Rs.2,82,000 crore by the terminal year of Tenth Plan (2006-07), with the software sector accounting for Rs.2,13,000 crore and hardware production Rs.69,000 crore.

(ii) Against the current level of $ 8 billion, software and IT services exports are expected to grow to $ 87 billion by 2008. While the software export target is set at $ 50 billion, the target for export of hardware has been kept at $ 10 billion by 2008.

(iii) Keeping the above growth potential in mind, IT exports are likely to constitute 35 per cent of India's total exports in 2008 against the present level of 14 per cent.

(iv) India's share in the overall global software market is expected to increase from the present 2 per cent to 6 per cent by the terminal year of the Tenth Plan.

(v) India's IT spending is about 0.7 per cent of GDP, as compared to 1.3 per cent in Malaysia and 2.5 per cent in Singapore. India is almost five years behind China in terms of the number of PCs, Internet users, cable TV subscribers, fixed telephones, etc.

(vi) The Internet subscriber's base is expected to cross 35 million by 2007 from the present level of four million.

(vii) The IT industry is projected to generate seven million jobs by 2008 (i.e. 4.8 million employment in hardware sector and 2.2 million jobs in software sector and IT-enabled services).

(viii) Provision of telephones on demand by the end of 2002-03 and sustain it thereafter

(ix) Achieve an overall teledensity of 9.91 by 31 March 2007

(x) Achieve telecom coverage of all villages by December 2002

(xi) Provide reliable transmission media by the end of March 2003

(xii) Provide high-speed data and multimedia capability using technologies including ISDN to all towns with a population of greater than 0.2 million by the end of March 2003

Source: Compiled from Government of India (2003a).

Rest of the paper is organized as follows. Section 2 describes the economic performance of ICT sector in Karnataka State in regard to employment, investment and exports. Section 3 estimates the contribution of ICT sector to national and regional economic growth. In section 4, empirical evidence for the determinant of growth of ICT sector is offered. Section 5 concludes the paper with implications.

2. Economic performance of ICT sector

Data on registered companies in the Software Technology Park of India (STPI) and Electronic Hardware Park of India (EHPI) is the basis for the following description of economic performance of ICT sector by software and hardware companies.[9] Karnataka has three software technology parks (STPs). This comprises one national center at Bangalore, and two sub-centres at Mysore, Mangalore/Manipal. In addition, Hubli is identified for development as a sub-centre. Development of these sub-centres is a move towards regional dispersal of ICT sector's activities in the State. In general, performance data are presented by these centers and for different years by variables. For instance, data on number of registered software companies is presented from 1999-00 to 2002-03, and on exports from 1991-92 to 2002-03. Thus, the data for the latest year for each performance indicator is presented in **Box 2**. This implies that Karnataka has much to contribute in accomplishing the production, export and employment targets for the ICT sector during the 10th Plan period.

3. Contribution of ICT sector to economic growth

Growth and share of ICT sector in the national and State income are important indicators for the sector's aggregate contribution to national and regional economic development. Data for construction and analysis of these indicators in manufacturing and service sectors need to be combined from different sources, as ICT sector's contribution is separately available for the communication and IT sector. In particular, the contribution is explicitly (or implicitly) accounted for communication (or IT) services under the tertiary sector. [10] In fact, this contribution is estimated at the national level and allocated to States (under supra-regional sectors) by the Central Statistical Organisation (CSO).[11] On the other hand, the contribution is not explicitly accounted for manufacturing ICT sector as a whole, or separately by communication and IT sectors. This calls for approximation in determining the sector's contribution from the national and State level data in the Annual Survey of Industries.

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[9] http://www.bangaloreit.com gives information, among others, on performance indicators on ICT sector in Karnataka State. The following data description draws heavily from this website as on 31 March 2005, as neither the NASSCOM nor the Electronic and Computer Software Export Promotion Council publish State level data on ICT sector. The Visveswaraya Industrial and Trade Centre has been compiling export data from the State, including electronics and computer software, since 1993-94. This data is not used in this paper, as it includes STPI and EHPI data but no disaggregate information.

[10] Methodological details of communication and IT services in national accounts are outlined in Government of India (1999).

[11] Estimation of national income from ICT sector is based on income method. Allocation for states' is based on proportion of workforce in the State to the nation's total.

Box 2

Performance indicators of ICT sector in Karnataka State

Software companies in Bangalore STP

- Cumulative number of companies is equal to 1154 with a total investment of US$1.3 billion and employment of 80000 software professionals (2002-03)
- Composition of 682 companies by their value in US$ million (2001-02): Above 200 million (0.29%); Between 20 million and 200 million (1.91%); Between 2 million and 20 million (13.93%); less than 2 million (36.07%); and less than 0.5 million (47.80%).
- Total value of exports is equal to Rs.12350 crore or US$2.67 billion and annual growth is 25% (2002-03)
- Share in total exports (2002-03): Small and medium enterprises (18.03%), major Indian companies (41.40%), and foreign equity companies (40.57%)
- Annual growth of exports (2002-03): Small and medium enterprises (63%), major Indian companies (14%), and foreign equity companies (22%).
- Highest exports (=Rs.7475 crore) among 12 STPs in India in 2000-01.
- BPO/ITES companies (i.e. banking and financial services, and technical support and insurance claims processing companies) in 2002-03 is equal to 41 (annual growth is 46%) with total investment of Rs.512 crore (annual growth is 23%), employment of 18000 persons, and exports of Rs.988 crore (annual growth is 275%).

Software companies – Mysore STP

- Number of companies has increased from 24 in 2001-02 to 26 in 2002-03.
- Total exports are equal to Rs.65 crore in 2002-03 (annual growth is 66%).

Software companies –Mangalore/Manipal STP

- Number of companies has increased from 13 in 2001-02 to 15 in 2002-03.
- Total exports are equal to Rs.330 crore in 2002-03 (annual growth is 36%).

Hardware companies in EHTP – Karnataka State

- Number of approved companies is equal to 31 in 2002-03 (annual growth is 15%)
- Total exports are equal to Rs.1403.85 crore in 2002-03 (annual growth is 67.50%).

Overall export performance

- Electronic and computer software constitute 53.18 percent in total exports from the State and 25 percent in total exports from India in 2002-03.

Source: Compiled from the basic data on: http://www.bangaloreit.com (accessed on March 31, 2005)

3.1. Contribution of ICT Services

Communication services include provisioning of postal and telecommunication services. The contribution of telecommunication services (e.g. telephones, telegrams, and overseas communication services) is separable from the postal services (e.g. postal, and money and postal order services) from the details of estimated GDP from within the communication sector. Further, the contribution of public and private sectors can be approximated from this database.[12]

IT services are related to data processing, software development and computer consultancy services. [13] and are implicitly accounted for one of the items in business services.[14] The contribution is estimated by the CSO. For state-wise contribution of the IT services, the national level estimate is allocated to the States on the basis of workforce data. In the absence of published data on the contribution of IT services, contribution of business services can approximate the share of IT services in national and State income.[15]

Thus, the sum of contribution of (a) non-postal communication services and (b) total business services in the national and State income is considered below for contribution of ICT services to national and regional economic growth.

Table 1 presents the select indicators of contribution of ICT services to national income (i.e. Gross Domestic Product or GDP at factor cost and constant prices) and State income (i.e. Gross State Domestic Product or GSDP at factor cost and constant prices) from 1993-94 through 2001-02.[16] These indicators offer the following evidence.

[12] Two points deserve special mention here. First, in arriving at GDP from the communication services, intermediate consumption is deducted from the gross earning for the sector as a whole. Thus, intermediate consumption is not available separately for postal and telecom services. To overcome this data limitation, intermediate consumption is presumed to be distributed between postal and telecom services in the same proportion as that of the share of postal and telecom services in the gross earnings. Second, private sector (included in the estimation of national income since 1993-94) is dominant in telecom services than in postal services. Thus, private communication services are treated equal to private telecom services.

[13] Thus, IT services exclude computer maintenance and service (e.g. Maintenance and service contracts for computer hardware and peripherals).

[14] Other business services include services provided on fee or contract basis such as accounting, auditing, bookkeeping, data processing and tabulation, engineering, advertising, commercial art-work and market research activities. In particular, IT services are classified under NIC-892.

[15] Financial intermediation services indirectly measured (FISIM) is not separately reported for the business services. Thus, in arriving at the national income from the business services, FISIM is distributed in proportion of business services share in the GDP from the real estate, ownership of dwellings and business services.

[16] In the latest published National Accounts Statistics [Government of India (2004a)], data on communication services is available up to 2001-02. Hence, the entire analysis is restricted up to 2001-02 to establish comparability between the indicators.

- Throughout, Karnataka's economic growth has remained higher than the national economic growth, as the annual growth of GSDP is higher than the annual growth of GDP. Thus, the average growth of GSDP (=13.17 percent) is higher than the average growth of GDP (=6.24 percent).
- At the national as well as at the State level, the share of tertiary sector has increased. For instance, the share of tertiary/service sector has increased in the national (or State) income from 42.77 (or 38.27) percent in 1993-94 to 45.78 (or 43.76) percent in 1997-98 and to 49.30 (or 49.51) percent in 2001-02.
- Throughout, annual growth of tertiary sector in the State income has remained higher at the national level. Average growth of tertiary GSDP (=16.77 percent) is double than the average growth of tertiary GDP (=8.15 percent).
- Share of ICT services in GSDP has been higher than in GDP except in 2000-01. For instance, the share of estimated GDP from ICT services in GSDP (or GDP) is equal to 2.26 (or 1.51) percent in 1993-94, 3.08 (or 2.35) percent in 1997-98, 4.41 (or 3.23) percent in 2000-01 and 3.61 (or 4.04) percent in 2001-02.
- The annual growth of ICT services has been higher as compared to annual growth of GDP and GSDP as well as the annual growth of tertiary sector in GDP and GSDP. However, the annual growth of ICT services in Karnataka is higher (or lower) than at the national level up to 1997-98 (or since 1998-99).
- Share of ICT services has increased in both tertiary GDP and GSDP, but the share in the GSDP is higher than in the GDP. For instance, the share of ICT services has increased in the tertiary GDP (or GSDP) from 3.53 (or 5.92) percent in 1993-94 to 5.13 (or 7.05) percent in 1997-98 and to 9.08 (or 8.39) percent in 2001-02.
- As the contribution of ICT services is estimated at the national level and allocated to the States, it is plausible to determine the share of State's ICT services in the nation's total. This evidence suggests that the share has fluctuated from 7.89 percent in 1993-94 to 9.26 percent in 1997-98 and to 8.01 percent in 2001-02.
- At the national level, contributions of telecommunication services are further evident in the following indicators. First, the share of telecommunication services in the GDP from ICT services has declined from 72.38 percent in 1993-94 to 69.11 percent in 1997-98 and to 65.76 in 2001-02. Alternatively, this implies the increasing contribution of IT services in the GDP from the ICT services. Second, the share of public telecom services remains high (about 90 percent or above). Nevertheless, since 1995-96, the role of public sector shows a decline. This indicates an increasing role of private telecom services. Third, share of telecom services in the combined share of postal and telecom services in the GDP has remained high (above 90 percent), and shows an increase since 1996-97. This indicates a decline in the role of postal services.

In the context of Karnataka State, contribution of IT services within the business services since 2000-01 is accessible from the unpublished records of the Directorate of Economics and Statistics. The evidence for this contribution is presented in **Table 2**. The evidence suggests that the contribution of IT services in the business services has increased from 78.27 percent in 2000-01 to 84.32 in 2003-04. As a percent of tertiary GSDP at current (or constant) prices, the share of IT services has increased from 4.21 (or 3.79) percent in 2000-01 to 6.77 (or 5.73)

percent in 2003-04. In the same way, contribution of IT services as a percentage of GSDP at current (or constant) prices has increased from 1.95 (or 1.70) percent in 2000-01 to 3.58 (or 2.95) percent in 2003-04. These evidences offer support for specific contribution of IT services to Karnataka's economic growth.

3.2. Contribution of Manufacturing ICT industries

Contribution of manufacturing ICT industries is related to production of hardware. In general, production of electronic, communication and computing hardware are accounted for manufacturing ICT sector. This production may be broadly classified under electronic and communication sector, and IT sector. For instance, electronic and communication hardware include the following.[17] (i) Consumer electronics (e.g. Video and Audio Equipment, Audio Visual Equipment and Consumer Electronic items); (ii) Instrumentation/control instruments and industrial electronics (e.g. test and measuring instruments, medical electronics equipment, analytical instrument, industrial electronic & automation equipment, process control equipment, power electronic, equipments, and office equipment); (iii) Data processing systems and other office equipment, excluding computers (e.g. microprocessor based systems); (iv) Communication and broadcasting equipment (e.g. switching systems, transmission equipment, terminal equipment, signaling equipment, allied communication equipment, broadcasting equipment); (v) Strategic electronics (e.g. electron tubes, semi conductor devices, passive components, electro mechanical components, special components, and electronic components and others); and (vi) Electronic components (e.g. mechanical TV tuners, audio-tape deck mechanism, DC-micro motors, magnetic heads, loudspeakers and their parts, transformers, foils, printed circuit boards, black and white picture tubes, semi-conductor devices, and plastic film capacitors). The IT hardware includes (a) Computer hardware (e.g. personal computers, notebooks and servers); (b) Computer peripherals (e.g. printers and UPS); and (c) Computer consumables (e.g. printer ribbons and paper). [18]

The ASI 2001-02 [Government of India (2004b)] provides with manufacturing details of products and by-products (NIC-1998 at 3-digit level) in terms of ASICC-1995 (at 5 digit level). Using this information, the Gross Value Added (GVA) of 7 industry groups [i.e. Manufacture of office, accounting and computer machinery (300), Manufacture of electricity distribution and control apparatus (312), Manufacture of insulated wire and cable (313), Manufacture of accumulators, primary cells and primary batteries (319), Manufacture of electronic valves and tubes and other electronic components (321), Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy (322), and Manufacture of television and radio receivers, sound and video recording or reproducing apparatus, and associated goods (323)] are considerable for contribution of registered manufacturing ICT sector to gross

[17] The following classification is compiled from (a) Guide to Electronics Industry in India 1999, Department of Electronics, Government of India, New Delhi; (b) Department of Information Technology's website: www.mit.gov.in/dbid/ ; and (c) Indian Electrical & Electronics Manufactured Association's website: www.ieema.org/industry/electronics.htm

[18] This classification is compiled from the following sources. (a) NASSCOM's Annual Industry Survey 2001-02; and (b) Department of Information Technology's website: www.mit.gov.in/dbid/

national and State income at market or constant prices.[19] ASI data before 1998-99, based on NIC-1987, is used for corresponding classification of 3-digit industries except the new industry group: Manufacture of computers and computer based systems [367]. [20]

Table 3 presents the contribution of ICT manufacturing industries [in terms of Gross Value Added (GVA) at constant (1993-94) prices] to national and regional economic growth from 1993-94 through 2001-02. Two indicators signify this contribution. First, percent share of ICT industries in the GDP or GSDP. Second, percent share of ICT industries in total registered manufacturing GDP or GSDP. Karnataka's performance in both the indicators and in all the years is higher than at the all India level. For instance, Karnataka's (or all India) share of ICT industries in the GSDP (or GDP) is equal to 1.52 (or 0.71) percent in 1993-94, 2.23 (0.77) percent in 1997-98 and 1.10 (or 0.40) percent in 2001-02. On the other hand, Karnataka (or all India) share of ICT industries in the registered manufacturing GSDP (or GDP) is equal to 13.86 (or 6.78) percent in 1993-94, 17.36 (6.64) percent in 1997-98 and 12.44 (or 3.58) percent in 2001-02. Most importantly, Karnataka's share of ICT industries in registered manufacturing GSDP has been more than twice than the share of ICT industries in registered manufacturing GDP or NDP in all the years. This signifies a higher growth performance of Karnataka ICT industries that the ICT industries in the country as a whole.[21]

Karnataka's annual share of ICT industries in all India GVA of ICT industries shows wide fluctuations. For instance, the highest share in GVA (= 23.49 percent) is evident in 1998-99; and the lowest share is evident for GVA (=10.24 percent) in 1999-00.

3.3. Combined contribution of manufacturing ICT industries and ICT services

A comparison of contribution of and ICT services to GDP and GSDP (in Table 1) and manufacturing ICT industries to GDP and GSDP (Table 2) reveals the following.

First, in all the years, the contribution of ICT services is higher than that of manufacturing ICT industries in the GDP as well as in the GSDP. Thus, ICT services have a dominant contribution in ICT sector's contribution to the GDP and GSDP in India.

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[19] In all the above 7 industry groups, contribution of products under the ASICC 77 and 78 are particularly considerable for contribution of ICT sector to registered manufacturing production. As GVA for these products under the ASICC is not available in the published form, the product-specific contribution of ICT to registered manufacturing sector in national and State income is not analysed below. In the same way, GVA by sub-class of NIC-98 at 5-digit level [as given in Government of India (2004c)] is not available from the published form. Access to this data in future, however, will facilitate a focused analysis of ICT's contribution with reference to the following sub-classes: 22300, 30005-3007, 31200-31300, 32103, 32107-32109, 32202, 32204, 32208-32209 and 32303. Further, industry group: Reproduction of recorded media (223) is relevant for ICT industries. It is not included in the analysis as it is not relevant for Karnataka (i.e. ASI data is not reported for industry group: 223).

[20] This correspondence between (NIC-1998) and [NIC-1987] is as follows: (300)=[358]; (312)=[360]; (313)=[361]; (319)=[362]; (322)=[365]; (323)=[366]; and (321)=[368].

[21] Further, Karnataka's better performance is evident in higher average growth (1994-95 to 2001-02) of GVA from the ICT industries as compared to the national level. For instance, the average growth of GVA in Karnataka (or all India) is equal to 0.65 (or 10.39) percent.

Second, the combined contribution of manufacturing ICT industries and ICT services to the GDP (or GSDP) is equal to 2.22 (or 3.78) percent in 1993-94, 3.25 (or 5.35) percent in 1998-99 and 4.87 (or 5.25) percent in 2001-02. Thus, the ICT sector is more contributory to regional economic growth than to the national economic growth. [22]

3.4. Select international comparisons

Contribution of ICT sector to Karnataka's economic growth is comparable with advanced countries.[23] For instance, Jalava and Pohjola (2002) notes that the ICT goods and services typically constitute between 3 and 5 percent of total GDP (at current prices) in OECD countries. [24] Cohen et al (2004) notes that the share of ICT sector in total GDP in 1998 was less than 4 percent in Australia. As compared to these estimates, Karnataka's performance of ICT sector in GSDP in 2001-02 is higher, than that of Australia and average for the OECD countries. [25]

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[22] Obviously, our approach has neglected the contribution of unorganized ICT sector to national and State income due to lack of data. However, the Final Report of the III All India Census of Small Scale Industries (SSIs) 2001-02 [Government of India (2004e] shows that, at the national level, the gross output of registered SSIs in ICT sector (comprising 5 products: Software development, Data processing Computer (PC), Monitor (Computer Display), and Electronic components and parts) is equal to Rs.20329.8 million. On the other hand, the gross output of unregistered SSIs in ICT sector (comprising 13 products: ISD/STD Booths for industries, Data processing, Internet browsing/setting of cyber cafes, Electrical equipment and parts, Software development, Computer repair/maintenance services, Electronic components and parts, Batteries, Electric supply services, Telecommunication exchange, Medical/legal transcription using voice/data communication links, Computer software development and software service (including computer graphics engineering), and Teleprinter/fax services) is equal to Rs.87550.8 million. Thus, if the contribution of unorganized ICT sector's contribution is appropriately added to the national income, the share of ICT sector in GDP would be higher. Further, our analysis neglects the indirect effect of ICT sector. In fact, input-output analysis is a useful technique to estimate both direct and indirect effects of changes in output and employment through forward and backward linkages. At present, lack of input-output table (IOT) for Karnataka State precludes this analysis. At the national level, IOT is available in published form for 1993-94 [Government of India (2000)]. In this IOT, sectors like communication equipment, electronic equipments and communication services would account for ICT sector. As major changes in the ICT sector are taking place since 1993-94, this IOT is not useful for the analysis in this paper.

[23] At the international level, ICT sector include manufacturing ICT, telecommunications, and other ICT services. The manufacturing ICT includes the following according to the International Standard Industry Classification (ISIC) Revision 3: 3000, 3130, 3210, 3220, 3230, 3312, and 3313. ICT services include 5150, 7123, 6420, and 7200. For details, see for instance, Cohen et al (2004: p.18).

[24] These estimates are quoted from OECD (2000).

[25] To make this comparison robust, the contribution of ICT sector to GDP and GSDP at constant prices was estimated at current prices by multiplying separate deflators for (a) total GDP and GSDP, (b) GDP and GSDP from communication services, (c) GDP and GSDP from IT services, and (d) GVA from ICT manufacturing industries at all India level and Karnataka State. The estimated contribution of the ICT sector to the GDP (or GSDP) was equal to 2.22 (or 3.78) percent in 1993-94, 1.59 (or 6.25) percent in 1997-98 and 4.87 (or 5.22) percent in 2001-02. Thus, Karnataka's performance stands comparable with the OECD countries at current prices as well.

4. Sources of regional growth of ICT sector

Sources of growth of ICT sector are related to determinants of supply of and demand for ICT products and services in the process of regional economic growth. As the use of telephone lines over telephone network is essential for the provisioning and utilization of ICT services, construction of telecom network, equipment to provide access for users to network, and access to network by users are the preconditions for utilization or demand for ICT services. [26] Thus, given the telecom network and access to the network, demand for usage (or usage demand) is the critical determinant of growth of ICT products and services.

In what follows, a framework for estimation of usage demand for ICT services is developed. The framework is implemented for data from Karnataka State to provide evidence for sources of growth of ICT services from the demand side.

4.1. Estimation of usage demand for ICT services

Usage demand for ICT services is specific to particular services. Hence, determinants of usage demand will have to be estimated for each ICT service separately. In the absence of data to capture the service-specific usage demand, however, an approximation of usage demand for ICT services as a whole may have to be adopted. This approximation is attempted below by taking total number of metered telephone calls as a proxy for usage demand for ICT services and by taking telecom districts as a unit of analysis.

4.1.1. Framework for estimation

Usage demand for ICT services at district level is assumed to be influenced by economic variables within the district. To estimate the effects of these variables on usage demand, both cross-section models and panel data models are estimated by linear and log.linear functional forms. The panel data models are (a) Pooled Regression Model (PRM), (b) Fixed Effects Model (FEM), and Random Effects Model (REM). The standard statistical frameworks for estimation of these models are well known. Hence, they are not described here. [27]

4.1.2. Data and variable description

Telecom district is used as a unit of analysis. At present, Karnataka State has 19 telecom districts. The estimation period covers three years: 2000-01, 2001-02 and 2002-03. By pooling of these cross-section data for three years, the panel data is generated. The variables used for the final estimations are given in **Box 3** along with their definitions and data sources.[28]

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[26] This is in line with the argument in Taylor (2003): " telecommunications services are not consumed in isolation. A network is involved. ……. There must be access to the network before it can be used" (p.145).

[27] For an excellent description of panel data models, see, for instance, Chapter 14 in Green (1997).

[28] To begin with, two more explanatory variables were considered for estimation purposes. (a) Share of primary sector in Net District Income at current prices. (b) Share of secondary sector in Net District Income at current prices. However, in the trial estimations, inclusion of these variables did not yield encouraging results. Hence, they were dropped in the final estimations.

Box 3

Variables and data description

Dependent variable

- Usage demand for ICT services - Measured by total number metered telephone calls per capita (TMCPC). That is, total number of metered calls divided by total population as per 2001 census. **Source**: Records of the Office of the Chief General Manager, Karnataka Telecom Circle (Bangalore)

Independent variables:

- *Per capita income* (PCI): Net District Income at current prices divided by total population in the State as per 2001 census. **Source**: Directorate of Economics and Statistics, Government of Karnataka (Bangalore)

- *Teledensity* (TD): Number of telephones per 100 population (TD) = Total number of working connections divided by total population, as per 2001 census, and expressed per 100 population. **Source**: Records of the Office of the Chief General Manager, Karnataka Telecom Circle (Bangalore)

- *Share of Tertiary Sector*: Percent of Tertiary Sector in Net District Income at current prices (STS). **Source**: Directorate of Economics and Statistics, Government of Karnataka (Bangalore)

The sign of coefficient of all the variables is predicted to be positive. First, a positive coefficient on PCI may be interpreted that, other things being equal, an increase in per capita income will have a positive effect on increasing the usage demand for ICT services. Or, income elasticity of usage demand for ICT services is predicted to be positive. Second, a positive sign on STS indicates the effects of structural changes in State's income on usage demand for ICT services. Third, a positive sign on coefficient (and magnitude of coefficient being greater than 1) on TD may be interpreted to mean the presence of network and call externalities in the provision of ICT services in the State.[29] Thus, the included independent

[29] Following Das and Srinivasan (1999) "network externality is generated due to the fact that when a new subscriber joins the network, it is not just she who benefits but so do all the existing subscribers who can potentially reach her". Call externality "arises from the fact that one call leads to further calls from the other party to whom the call is made. Increase in the number of connections per capita by one per cent leads to more than one per cent increase in per capita usage. The magnitude of network externalities tends to get reduced as the telephone density increases". (p.183-184). In the same way, following Taylor (2003), network (or subscriber) externality "arises when a new subscriber joins the network. Connection of a new subscriber confers a benefit on existing subscribers because the number of ports that can now be reached is increased. As this benefit is shared in common by all existing subscribers, the network externality accordingly has the dimension of a public good". On the other hand, "a completed telephone call requires the participation of a second party and the utility of this party is thereby affected. The gratuitous effect, which falls on the second party, represents what is usually referred to as the call (or use) externality" (pp.145-146).

variables in the model are intended to provide evidence for income effect, effects of structural changes and presence of network and call externalities on usage demand for ICT services in Karnataka State. [30]

4.1.3. Description of data

Table 4 presents the descriptive statistic for the variables used in the estimations. Of all the variables, PCI has the biggest mean value. This is followed by the mean values of other variables: TMCPC, TD, and STS. Of the variables, the largest (or smallest) standard deviation is evident in regard to PCI (or TD). However, the range is highest (or smallest) in case of TMCPC (or STS). Further, the simple correlation coefficients of all the variables show that TMCPC is positively correlated with all independent variables. Of all the variables, the highest correlation is evident between TMCPC and PCI (=0.830) and lowest correlation is evident between STS and TD (=0.21).

4.1.4. Results of estimation

Table 5 presents the estimation results of cross-section regression model three years: for 2000-01, 2001-02, and 2002-03. The results are presented by linear and log.linear functional forms. First of all, all the estimated coefficients have predicted sign and are statistically significant, except the coefficient of TD in log.linear estimation for 2001-02. Second, the magnitude of estimated coefficient on TD is more than unity, and is larger than the coefficients on other variables, in all the linear estimations. This provides empirical evidence for the presence of network and call externalities in the provision of ICT services. This result is in contrast with the log.linear estimations. Third, the income effect has the lowest magnitude in the linear estimations. In case of log.linear estimations, the income effect is greater than unity in all the years. Fourth, the effect of changes in tertiary sector is remarkable in both linear and log.linear estimations. This result is supportive for the hypothesis that usage demand is largely affected by the changes in tertiary or services sector, which is relatively more information-intensive. Fifth, the explanatory power of both linear and log.linear models is higher than 85 percent in all the estimations. In addition, the F-statistic is significant in all the years. This offers evidence for joint significance of all estimated coefficients.

Table 6 presents the estimation results of linear and log.linear specification for the panel data models. As in the case of cross section estimation results in Table 5, all the estimated coefficients have predicted sign. In terms of statistical significance of estimated coefficients, the log.linear models performs better as compared to linear models. However, estimated coefficient of TD is not supportive of the presence of network and call externalities in the usage demand for ICT services in Karnataka State.

[30] In addition, price of ICT services can be an important determinant of the usage demand. Other things being equal, an increase in price of ICT services may be expected to have negative effect on usage demand for ICT services. However, ICT services are a composite of many and different services with service-specific prices. Aggregation or averaging of these prices is not plausible. Hence, price variable is not included to determine the variations in aggregate usage demand for ICT services in equation (1) or (2).

A comparison of panel data estimation results from linear and log.linear functional forms suggest that, *a priori* specification of a linear or log.linear functional form may lead to divergent evidence on the determinants of usage demand for ICT services in Karnataka State. Thus, the following familiar criteria for models' choice are used to choose an appropriate model on empirical grounds. [31]

A choice between the linear and log.linear function form, based on the Sargan-criterion, favours for log.linear functional form in all the cross-section and panel estimations.[32] Given this result, a choice between log.linear PRM and FEM, based on the F-test, shows that the FEM is empirically preferred to the PRM.[33] However, Lagrange Multiplier test for a choice between the log.linear PRM and FEM did not favour for FEM.[34] The Hausman test for a choice between the log.linear FEM and REM favour for FEM. [35]In view of the above tests, the log.linear FEM is empirically preferred to remaining estimated models. The interpretation and implications based on this chosen model is given below.

First of all, the income elasticity of usage demand for ICT services is equal to less than unity. Thus, other things being the same, an increase in per capita income of the district by one percent will result in about 0.67 percent increase in usage demand. Second, the magnitude of the coefficient of teledensity is closer to unity. This indicates the absence of network and call externalities. [36] Thus, other things being the same, an increase in teledensity by one percent will lead to an increase in usage demand for ICT services by 0.95 percent. Third, the effects of changes in the share of tertiary sector on usage demand are lowest as compared to the effects of per capita income and teledensity. Thus, other things being the same, an increase in the share of tertiary sector in State income by one percent will lead to an increase in usage demand by about 0.02 percent.

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[31] The details of the following models' criteria (i.e. F-test, Lagrange Multiplier test, and Hausman test) are given ,in Chapter 14 in Green (1997). For instance, the F-test is as follows: Let (R^2_{PRM}) be the coefficient of determination from the PRM, and (R^2_{FEM}) from the FEM. Then, the F (n-R, nT-n-R) = [{(R^2_{PRM}) - (R^2_{FEM})}/(n-1)]/ {(R^2_{FEM}) /(nT-n-R)}. If the test is significant, FEM is preferred to PRM.

[32] The criterion is based on a computation formula in Godfrey and Wickens (1981). The formula requires an equation to be estimated by both linear and log.linear functional forms. The residual sum of squares from the log.linear estimation is divided by the product of residual sum of squares of the linear estimation and geometric mean of the dependent variable. If the resultant value of this division is greater (or less) than unity, the data is said to be in favour of log.linear (or linear) functional form.

[33] The value of F(18, 35) is equal to 5.296 and significant at 1 percent level .

[34] The value of Lagrange Multiplier test statistic is equal to 1.51, and is not significant at 10 percent level or more (degree of freedom is equal to 1).

[35] The value of Hausman test statistic is equal to 38.13, and is significant at 1 percent level (degree of freedom is equal to 3).

[36] This result is in contrast with the results in Das and Srinivasan (1999) where the estimated value of the coefficient on teledensity variable exceeds unity and, thereby, indicating the presence of network and call externalities in the usage demand for telecom services in India.

In short, usage demand for ICT services in Karnataka is determined by changes in per capita income, share of tertiary sector in State income, and benefits of network and call externalities. These determinants constitute the demand-side empirical sources (demand side, however) of growth of ICT services in Karnataka State.

5. Conclusions and implications

This paper has focused on the analysis of contribution of ICT sector to regional economic development of Karnataka State in comparison with all India level and estimation of demand-side sources of ICT sector's growth of Karnataka State. This analysis leads to the following conclusions and implications.

At present, contribution of ICT sector is not estimated at the national level by the CSO and at the State level by the Directorate of Economics and Statistics. However, this paper has developed a simple framework for estimation of this contribution from within the available data in the national income and state income accounts. This framework is useful to separate the contribution of ICT sector by manufacturing and service activities (i.e. by telecom and IT services). The results of these estimations offer evidence for the remarkable contribution of ICT sector to national and State income, and higher contribution of ICT sector to State income than to the national income. In the same way, contribution of ICT sector to State income is higher as compared to available estimates for OECD countries This underlines the importance of ICT sector to the economic development of Karnataka.

Total number of metered telephone calls by telecom districts is used as a proxy for total usage demand for ICT services and its determinants are estimated with respect to changes in per capita income, teledensity, and share of tertiary sector in State income. Of the estimated panel data models, the log.linear fixed effects model is chosen on empirical grounds. The results of the chosen model indicate that the changes in per capita income, teledensity, and share of tertiary sector in State income are empirical determinants of usage demand or sources of growth of ICT services. Of the estimated sources, the changes in teledensity have the biggest magnitude and are followed changes in per capita income. Thus, from the demand side, the sources of growth of ICT services in Karnataka State is contributed by changes in per capita income, share of tertiary sector in State income, and teledensity.

ICT sector deserves to be further promoted, as its growth has many positive types of fallout. First, growth of ICT sector has lead to the emergence of a "New Economy" in Karnataka State This "New Economy" has been a creator of new jobs for technical persons; major foreign exchange earner through exports; and attractor of foreign investment. These performance are conducive for higher national and regional economic development. Second, indicators of ICT sector are included in construction of indices of competitiveness at the international level. These indices include World Economic Forum's Global Competitiveness Indices, International Institute of Management Development's World Competitiveness Indices, World Bank's Competitiveness Indicators, International Communication Union's Digital Access Index and World Economic Forum and World Bank's Network Readiness Index. Further, growth and widespread utilization of ICT services are contributory to human development, as evident in

UNDP's Human Development Report 2001 [UNDP (2001)]. Thus, growth of ICT sector is contributory to enhance and strengthen the international competitiveness of India as well as Karnataka State.

ICT sector has many indirect effects on economic growth, such as, growth of self-productivity, capital deepening due to high capital investments, and efficiency of ICT-using industries and services. Analysis of these effects require, among others, a disaggregate analysis at the industry and/or firm level.[37] This is an area of future research on ICT sector in Karnataka economy.

Karnataka's experiences in formulation and implementation of policies for ICT in a federal, open and mixed economy framework are of relevance for design of growth-oriented ICT policy in other States in India. In the same way, subject to the comparability of economic structures, Karnataka's policy experiences are of relevance for other developing countries in world where regional economic growth is driven by ICT industries and services

[37] An excellent framework for estimation of ICT sector's contribution at the industry level is available in Chapter 2 in Cohen et al (2004) and in Chapter 3 in OECD (2004). A framework for firm level estimation is available in Chapter 5 in OECD (2004).

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Table 1: Contribution of ICT services to national and State income, 1993-94 to 2001-02

Indicators of contribution	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	Average growth (%)
1. National level										
1.1. Gross Domestic Product or GDP at factor cost and constant prices (Rs. in crore)	781345	838031	899563	970083	1016595	1082748	1148368	1198592	1267833	
1.2. Annual growth of GDP (%)		7.25	7.34	7.84	4.79	6.51	6.06	4.37	5.78	6.24
1.3. Percent of tertiary sector in GDP	42.77	42.71	43.94	43.68	45.78	46.58	48.33	48.85	49.30	
1.4. Annual growth of tertiary sector in GDP (%)		7.08	10.46	7.20	9.83	8.35	10.06	5.49	6.76	8.15
1.5. Estimated GDP from ICT services (Rs.in crore)	11786.32	13912.77	16913.35	19295.23	23882.49	29304.63	37041.70	48468.11	56728.20	
1.6. Percent of estimated GDP from ICT services in total GDP	1.51	1.66	1.88	1.99	2.35	2.71	3.23	4.04	4.47	
1.7. Annual growth of estimated GDP from ICT (%)		18.04	21.57	14.08	23.77	22.70	26.40	30.85	17.04	21.81
1.8. Percent of ICT services in total tertiaty GDP	3.53	3.89	4.28	4.55	5.13	5.81	6.67	8.28	9.08	
1.9. Percent of telecommunication services in ICT services' GDP	72.38	72.43	71.42	70.07	69.11	68.25	66.49	65.23	65.76	
1.10. Share of public telecom in communication GDP - estimated	92.88	93.29	94.30	94.81	94.72	94.47	93.94	89.33	87.82	
1.11. Share of estimated telecom in combined communication services (post and telecom) in GDP	90.56	91.61	92.70	92.96	93.96	94.96	95.84	97.03	97.94	
2. State level										
2.1. Gross State Domestic Income or GSDP at factor cost and constant prices (Rs. in lakh)	4107905	4791517	5621456	6517573	7171944	8780738	9530994	10481490	10946407	
2.2. Annual growth of GSDP (%)		16.64	17.32	15.94	10.04	22.43	8.54	9.97	4.44	13.17
2.3. Percent of tertiary sector in GSDP	38.27	39.10	40.24	41.17	43.76	42.46	44.93	45.83	49.51	
2.4. Annual growth of tertiary sector in GSDP (%)		19.15	20.76	18.63	16.95	18.81	14.86	12.15	12.83	16.77
2.5. Estimated GSDP from ICT services (Rs.in lakh)	93029.46	114097.07	145475.74	178600.25	221192.95	265361.09	324771.26	377986.81	454604.53	
2.6. Percent of estimated GSDP from ICT services in total GSDP	2.26	2.38	2.59	2.74	3.08	3.02	3.41	3.61	4.15	
2.7. Annual growth of estimated GSDP from ICT services (%)		22.65	27.50	22.77	23.85	19.97	22.39	16.39	20.27	21.97
2.8. Percent of estimated ICT services in total tertiaty GSDP	5.92	6.09	6.43	6.66	7.05	7.12	7.58	7.87	8.39	
2.9. Percent share of State's estimated ICT services in nation's total (=GDP from estimated ICT services)	7.89	8.20	8.60	9.26	9.26	9.06	8.77	7.80	8.01	

Source: Compiled and constructed by using the basic data in Government of India (2003b) and Govenrment of India (2004d).

Table 2: Contribution of IT services to economic growth in Karnataka State: 2000-01 to 2003-04

Indicators of contribution	2000-01	2001-02	2002-03	2003-04
1. Gross Valued Added from IT services (Rs.in lakh)				
At current prices	204331	255467	328091	473885
At constant prices	119243	142233	173619	237749
2. Percent of IT services in total GVA of business services	78.27	80.70	81.89	84.32
3. Percent of IT services in total tertiary GSDP at factor cost				
At current prices	4.21	4.69	5.36	6.77
At constant prices	3.79	4.14	4.64	5.73
4. Percent of IT services in total GSDP at factor cost				
At current prices	1.95	2.34	2.73	3.58
At constant prices	1.70	1.97	2.29	2.95

Note: (1) GSDP refers to Gross State Domestic Product. (2) GSDP data for 2003-04 refers to quick estimates.

Source: Computed by using the basic data in Government of Karnataka (2004) and from the records of the State Income Division, Directorate of Economics and Statistics, Government of Karnataka (Bangalore).

Table 3: Contribution of manufacturing ICT industries to national and State income, 1993-94 to 2001-02

Year	Gross Value Added (GVA) by manufacturing ICT industries [Rs. in crore at constant prices]		GVA by ICT manufacturing industries as a percentage GDP and GSDP at constant prices		GVA by ICT manufacturing industries as a percentage registered manufacturing GDP and GSDP at constant prices		Percent of GVA by ICT manufacturing industries in Karnataka State in the nation's total
	India	Karnataka	GDP	GSDP	GDP	GSDP	
1993-94	5552.74	625.93	0.71	1.52	6.78	13.86	11.27
1994-95	8112.60	1002.29	0.97	2.31	8.66	19.25	12.35
1995-96	7775.12	1095.90	0.86	2.37	7.24	20.26	14.09
1996-97	6754.10	900.21	0.70	1.79	5.67	15.18	13.33
1997-98	7824.56	1198.43	0.77	2.23	6.64	17.36	15.32
1998-99	5898.37	1411.12	0.54	2.33	4.91	16.59	23.92
1999-00	5120.33	524.36	0.45	0.82	4.11	7.47	10.24
2000-01	4941.16	636.45	0.41	0.91	3.68	9.83	12.88
2001-02	5033.33	766.83	0.40	1.10	3.58	12.44	15.23

Notes: (a) GDP and GSDP are measured at factor cost. (b)Constant prices refer to 1993-94 prices.

Source: Computed by using the basic data on ICT industries in various issues of the Annual Survey of Industries [e.g. Government of India [2004d)], and by using GDP data in Government of India (2004) and GSDP data in Government of Karnataka (2004).

Table 4: Descriptive statistics for variables used in estimation of determinants of usage demand for ICT services in Karnataka State

1. *Summary statistics*

Variables	Mean	Standard Deviation	Maximum	Minimum
TMCPC	206.73	190.69	994.18	72.31
PCI	17166.13	5240.52	35207.50	10611.00
TD	4.45	2.58	11.34	1.62
STS	49.00	7.19	69.86	36.95

2. Simple correlation coefficients

Variables	TMCPC	PCI	TD	SPS
TMCPC	1.000			
PCI	0.830	1.000		
TD	0.586	0.540	1.00	
STS	0.619	0.543	0.21	1.00

Notes:

TMCPC= Total metered calls per capita
PCI=Per capita income
TD=Teledensity
STS=Share of tertiary sector

Source: Author

Table 5: Determinants of usage demand for ICT services in Karnataka State: Estimates of cross section regression models

Dependent variable: Number of metered call units per capita

Independent variables	2000-01: Linear	2001-02: Linear	2002-03: Linear	2000-01: Log.linear	2001-02: Log.linear	2002-03: Log.linear
Constant	-985.722 (6.470)*	-862.743 (5.175)*	-705.372 (4.181)*	-12.640 (7.946)*	-11.854 (4.508)*	-7.297 (3.311)*
Per capita income	0.021 (3.881)*	0.017 (2.728)*	0.014 (2.888)*	1.584 (8.926)*	1.572 (4.969)*	1.089 (4.037)*
Teledensity	21.624 (2.240)**	19.117 (2.133)**	20.015 (2.474)*	0.152 (2.036)***	0.141 (1.129)	0.223 (1.942)***
Percent of tertiary sector in Net District Income	17.097 (4.520)*	14.273 (3.377)*	10.609 (2.746)*	0.049 (7.170)*	0.309 (2.630)**	0.028 (2.700)**
R^2	0.868	0.858	0.859	0.951	0.762	0.709
F	32.85*	32.26*	30.46*	97.22*	38.57*	32.07*
Sample size	19	19	19	57	19	19

Notes: (a) Figures in parentheses are t-ratios.
(b) * significant at 1% level or more.
(c) ** significant at 5% level or more.
(d) *** significant at 10% level of more.

Source: Author.

Table 6: Determinants of usage demand for ICT services in Karnataka State: Estimates of panel data models

Dependent variable: Number of metered call units per capita

Independent variables	Linear pooled regression model	Linear fixed effects model	Linear random effects model	Log.linear pooled regression model	Log.linear fixed effects model	Log.linear random effects model
Constant	-563.567 (6.394)*	-	-45.393 (0.929)	-11.050 (7.973)*	-	-10.555 (8.006)*
Per capita income	0.021 (6.090)*	0.001 (0.386)	0.012 (4.715)*	1.540 (9.736)*	0.670 (1.843)***	1.555 (10.433)*
Teledensity	16.583 (2.808)*	9.034 (0.648)	20.666 (3.225)*	0.133 (1.965)***	0.950 (3.666)*	0.140 (2.073)*
Percent of tertiary sector in Net District Income	6.995 (3.300)*	0.157 (0.112)	0.890 (0.921)	0.021 (7.973)*	0.015 (1.825)***	0.012 (2.989)*
R^2	0.764	0.987	0.764	0.844	0.958	0.844
F	57.31*	128.83*	-	95.84*	38.21*	-
Sample size	57	57	57	57	57	57

Notes: (a) Figures in parentheses are t-ratios.
(b) * significant at 1% level or more.
(c) ** significant at 5% level or more.
(d) *** significant at 10% level of more.

Source: Author.