

Narayana, M. R.

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Sector, globalization and urban economic growth: Evidence from Bangalore (India)

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ICT Sector, Globalization and Urban Economic Growth

Evidence from Bangalore (India)

M. R. Narayana*

July 2010

Abstract

This paper aims at economic analysis of economic globalization and urban growth of Bangalore, the *Silicon Valley of India*, as they are related to ICT sector. Overall analyses offer new insights and evidences for ICT sector as a major contributor for degree of economic globalization and urban economic growth, mainly driven by ICT services. Bangalore's performance is remarkable compared to all-India level and OECD averages. These results offer empirical justification for continuing with and strengthening of public policies for promotion of globalizing and growth-oriented ICT sector in Bangalore with implications for comparable Indian and Asian cities.

Keywords: globalization, ICT sector, urbanization, urban economic growth, Bangalore

JEL classification: O18, R11

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* Centre for Economic Studies and Policy, Institute for Social and Economic Change, email: mnrarayana@yahoo.com

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Acronyms

AHHI	annual household income
CSO	Central Statistical Organization
FDI	foreign direct investment
FIO	foreign industrial output
GDI	gross district income
GDP	gross domestic product
GSDP	gross state domestic product
GVA	gross value added
ICT	information and communication technology
INR	Indian rupee
ITES	information technology enabled services
NASCOM	National Association of Software Companies
NDP	net domestic product
UAA	urban agglomeration area

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UNU World Institute for Development Economics Research (UNU-WIDER)
Katajanokanlaituri 6 B, 00160 Helsinki, Finland

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1 Introduction

Bangalore occupies a prominent place in information and communication technology (ICT) activities at the national and global levels. In particular, exports and inflow of foreign investment in ICT-related activities have shown remarkable performance. This has been contributory to economic globalization (or globalisation, in brief, throughout) of Bangalore in terms of increasing the degree of openness to trade in goods and services and internationalization of capital.¹ Since 1991, India's economic reforms in external sector have contributed to this globalization by liberalization of (a) foreign trade in goods and services and (b) inflow of private foreign capital into manufacturing, infrastructure services' sectors. In addition, India's founder-membership to World Trade Organization (WTO) has intensified the pace of globalization by further freer trade in goods and services, and trade-related investment measures.

Globalization is important for urbanization and urban economic growth because it affects spatial allocation of resources and creates spatial impacts. Factors which affect allocation of resources include overall population growth and distribution, population distribution among large and small cities, industrial composition, and income growth and distribution (Lim 2005). Changes in growth and distribution of urban population and industrial composition are major determinants of level and growth of urbanization and economic growth.² This dynamic process relates globalization with urban economic growth. Economic analysis of this relationship in the context of ICT sector of Bangalore is the main objective of this paper.

Studies on globalization, urbanization and urban economic growth in India are few and include Mathur (2005) and Kundu (2006). Mathur (2005) links India's globalization and broad changes in cities and city-related policies. Post-globalization urban growth is described by growth in urban population and changes in share of employment in manufacturing and service sectors. Changes in spatial structure are identified with transformation of urban space in use and form, such as, commercial space for shopping and office space for multi-national corporations and financial institutions, and mushrooming of high-quality residential and office space bordering major cities. In addition, globalization period is highlighted by a paradigm shift in city-level policies for provisioning of municipal services and infrastructure in terms of debt financing, public-private partnerships, and cost-recovery based pricing. Kundu (2006) explored the unequal economic base between the million plus cities (one million or more population), medium towns

¹ Globalization is a broad process and includes social dimensions. For instance, Ishii (2010) presents the evidence for household globalization through international immigration of workers and non-workers, and their assimilations in the society through international marriages and formation of international families in Japan.

² For instance, using data from 33 Asian countries, Kundu and Kundu (2010) find that correlation coefficient is higher, positive and significant between indicators of urban population growth during 1990 and 2030 and average annual growth of value added by industry during 1990-95. This implied that '...countries that are currently at a low level of urbanization and of economic development would become linked to the global capital markets and report high urban growth, backed by growth in income and industrial value added.'

(50,000 to one million population) and small towns (less than 50,000 population) in terms of employment, consumption, and poverty. These inequalities are considered as consequences of large cities' capacity to attract national and global investors and link with national and world markets under globalization.

Available studies on globalization of Bangalore include Dittrich (2005 and 2007), Madon and Sahay (2001), and Shaw and Satish (2007).³ The Dittrich studies focused on negative impact of globalization on social map of Bangalore by multiple divides between winners and losers. The winners are upper-class people (2 per cent) with annual household income (AHHI) of more than one million Indian rupee (INR); and upper middle class (5 per cent) with AHHI of more than 0.5 million INR but less than one million INR. The losers are the deprived (50 per cent) and poor (30 per cent). Madon and Sahay (2001) highlight the links between globalization and localization in Bangalore city and explain how such links are forged and contributory for Bangalore's development under globalization. Localization is related to local environment in terms of standards of civil amenities and local infrastructure created by local agents, such as urban local bodies, policy makers and planners. Globalization impacts on localization by forcing the local agents to create civil amenities and infrastructure (e.g. IT parks) at global quality and standards. Shaw and Satish (2007) focus, among others, on metropolitan restructuring by distinguishing the role of global and local agencies in Bangalore. The study characterizes the spatial development of Bangalore by five major factors, as they are related to IT sector: peripheralization, influence of Singapore, global-local influence, role of local government and non-governmental organizations. The study classifies Bangalore as a Gateway type of city. This type of city is characterized by (a) first inflows of large quantities of foreign direct investment (FDI) and domestic private capital and (b) initial advantages that facilitated the organic growth of new economy sectors, such as, IT and information technology enabled services (ITES). Although the study highlights the role of local agencies in facilitating the growth of a new economy, it finds difficulty is separating the changes by global and local impacts.

In general, no sub-national (i.e. state and urban level) empirical evidence exists on the nature, extent and impact of economic globalization in India, mainly due to lack of published data on indicators and variables of economic globalization and urban economic growth. This is in contrast with other countries, such as China and Philippines. For instance, Zhao et al. (2003) determine the impact of globalization on urban growth by using the cross-section data on 236 cities in 2000. First, city level gross domestic product (GDP) is regressed on FDI and foreign industrial output (FIO). Second, city population is regressed on FIO and FDI. In both the estimations, the coefficients were positive and significant. These results supported for positive impact of globalization on urban growth in China. Pernia and Quising (2005) estimated, among others, the impact of globalization (measured by degree of openness to export trade) on regional development (measured by regional GDP), and the impact of regional development on wellbeing of poor (measured by per capita expenditure of poor), using five year panel data on 12 regions in Philippines. The empirical results offered evidence for the positive and direct (or indirect) impact

³ Select summary of many unpublished studies on Bangalore is included in Kalra (2006). Non-economic studies on globalization of Bangalore with a focus on income distribution include Benjamin (2008) and Benjamin et al. (2008).

of globalization on regional development (or wellbeing of the poor through regional development).

Recent databases on foreign trade in goods and services, inflow of foreign investment, and GDP from the ICT sector in Karnataka state (and on Bangalore as its capital) is an exception in India. This paper is the first attempt to use this database for measurement of economic globalization, and relate globalization and urban growth to ICT sector in Bangalore. This attempt is useful to find plausible answers to many research questions on measurement and policy implications of economic globalization and growth in an urban context, such as: Does ICT sector contribute to globalization of Bangalore? If so, how such globalization and its growth impact can be empirically measured? Can empirical estimates of Bangalore be comparable at the regional, national and international levels? If so, how does Bangalore perform and why? How much does Bangalore contribute to regional and national globalization and economic growth as they are related to ICT sector? Thus, the results of this paper have broad implications in offering empirical justifications for public policy for promotion of ICT sector and growth-oriented economic globalization in Bangalore in particular, and urban India in general. Subject to the comparability of economic structures, however, the empirical framework and policy implications of this study are relevant for studies on other cities in India and Asian developing countries. Throughout, the scope of this paper excludes the income distributive aspects of ICT sector-lead globalization and urban growth.

India's recent openness policies in trade started in mid-1980s and, subsequently, intensified and broadened by the introduction of national economic reforms (in brief, the Reforms) since July 1991 under the external sector reforms comprising foreign trade, foreign and exchange.⁴ Thus, in this paper, analyses before 1991 refer to pre-globalization period and after 1991 refer to post-globalization period.

Rest of the paper is organized as follows. In section 2, an overview of Bangalore's urbanization and economic growth is presented. Section 3 focuses on measurement of ICT sector-lead economic globalization of Bangalore. A framework for estimation and estimates of ICT sector's contribution to urban growth of Bangalore are analyzed in section 4. Major conclusions and implications are summarized in section 5.

2 Urbanization and economic growth of Bangalore

Bangalore is the capital of Karnataka state in South India. It has a long history from its birth as a small village in 1537 to a vibrant and 5th biggest urban agglomeration area (UAA) in 2001.⁵ For administrative purposes, Bangalore is divided into Bangalore Urban and Bangalore Rural districts since 1986. Greater Bangalore City Corporation is the urban local body of Bangalore.

⁴ These economy-wide openness policies are analysed in Nayar (2006).

⁵ No attempt is made to describe the historical aspects and city profile of Bangalore as they are well documented, for instance, in Nair (2005), Government of India (2001a) and Sudhira et al. (2007).

Many indicators of rapid urbanization are evident for Bangalore (Table 1). Total population of Bangalore UAA increased from 2.92 million in 1981 to 4.13 million in 1991 and to 5.69 million in 2001. Population growth (or size) increased by 75.56 per cent (or 1.76 times) between 1971 and 1981, 41.36 per cent (or 1.41 times) between 1981 and 1991, and 37.69 per cent (or 1.38 times) between 1991 and 2001. Bangalore city's population (4.29 million) in 2001 accounted for 75.48 per cent of total population of Bangalore UAA. Share of Bangalore UAA in total urban population of Karnataka (or urban India) increased from 27.23 (or 1.83) per cent in 1981 to 29.70 (or 1.90) per cent in 1991 and to 31.73 (or 1.99) per cent in 2001. Bangalore UAA recorded 5.79 per cent annual growth rate of population during 1971-81, 3.52 per cent during 1981-91, and 3.25 per cent during 1991-01. Throughout, annual growth rates of population of Bangalore UAA had been higher than that of urban Karnataka and urban India.

Internal migration has been a major source for the net increase in inter-census population of Bangalore. For instance, net increase in population was equal to 1.21 million during 1981-91 and 1.56 million during 1991-2001. In-migration contributed to this increase by about 45 per cent during 1981-91 and about 49 per cent during 1991-2001. Next to immigration, jurisdictional changes contributed about 33 per cent and the rest was the result of natural increase. For instance, total area of Bangalore UAA increased from 365.65 km² in 1971 to 445.91 km² in 1981 and to 531 km² in 2001 due to increase in urbanization of surrounding areas and its incorporation into the city. Pressure of increasing population size on land is evident in increasing density (per km²) from 7991 persons in 1981 to 9263 persons in 1991 and to 10710 persons in 2001.

Within the Karnataka state, Bangalore is considered a regional primary city. This is evident by the increasing share of Bangalore UAA in the total population of Class I cities (0.1 million and above population) from about 46 per cent in 1981 to 47 per cent in 2001. Excluding Bangalore UAA, the average size of Class I cities in the state is smaller than the population size of Bangalore UAA by about 14 times in 1981, 17 times in 1991 and 21 times in 2001. At the all-India level, the share of Bangalore UAA in total population of Class I cities (or Million plus cities) varied from 3.04 (or 6.94) per cent in 1981, 2.91 (or 5.85) per cent in 1991, and 2.90 (or 5.27) per cent in 2001.

Economic growth of Bangalore (used interchangeably with Bangalore urban district) is measured by changes in size, growth and composition of gross district income (GDI) and per capita GDI (at factor cost and at constant or 1993-94 prices). The size of GDI increased from Rs. 36.58 billion in 1980-81 to Rs. 71.72 billion in 1993-94, Rs. 146.96 billion in 1999-2000 and to Rs. 250.42 billion in 2004-05 (Table 2). Annual growth rate of GDI recorded 5.32 per cent during 1980-81 to 1993-94, 10.79 per cent during 1993-94 to 1999-2000, 9.29 per cent during 1999-2000 to 2004-05, and 10.98 per cent during 1993-94 to 2004-05. Consequently, Bangalore's share in India's national income increased from 19.11 (or 0.91) per cent in 1980-81, 17.46 (or 0.92) per cent in 1993-94, 23.02 (or 1.28) per cent in 1999-2000, and 29.21 (or 1.64) per cent in 2004-05. Since 1993-94, this increase is largely contributed by the tertiary sector as its share in the GDI increased from 47.96 per cent in 1993-94 to 56.72 per cent in 1999-2000 and to 62.91 per cent in 2004-05.

Per capita income of Bangalore increased from Rs. 7,472 in 1980-81 to Rs. 14,127 in 1993-94, Rs. 22,970 in 1999-2000 and to Rs. 36,592 in 2004-05 (Table 2). Annual growth rate of per

capita GDI increased from 5.02 per cent during 1980-81 to 1993-94 to 7.19 per cent during 1993-94 to 1999-2000, 8.07 per cent during 1999-2000 to 2004-05, and 8.25 per cent during 1993-94 to 2004-05. At the same time, gap in per capita income between the district and the state (or nation) widened from 1.62 (or 1.61) times in 1993-94 to 2.36 (or 2.65) times in 2004-05. Most importantly, throughout globalization period, growth rates and levels of GDI and per capita GDI of Bangalore remained higher than for Karnataka state and at all-India.⁶

In terms of relative share and annual growth rate, the following sectors are identifiable as key contributors for economic growth of Bangalore during globalization period (Table 3). (a) registered manufacturing including ICT sector; (b) trade, hotels, and restaurants; and (c) real estate, ownership of dwellings, and business services. In particular, during 1993-94 to 2004-05, the highest growth is evident for the real estate, ownership of dwellings, and business services. Business services include software development and IT services.

Estimation of contribution of ICT sector by manufacturing and services is important to explain and predict for economic growth of Bangalore in post-globalization period.⁷ This calls for (i) estimation of impact of ICT sector on economic globalization; and (ii) estimation of impact of ICT sector on economic growth. From these analyses, globalization and economic growth of Bangalore can be connected through the ICT sector. These estimations are attempted below.

3 ICT sector and globalization of Bangalore

Globalization is measured by two indicators: internationalization of trade and internationalization of capital.⁸ Internationalization of trade is measured by degree of openness to export trade for

⁶ India's national income is estimated by rural and urban areas only for the base years of National Accounts series, as the detailed data for this estimation comes from the benchmark enterprise surveys which are done once about every five years. Up to 2007, net domestic product (NDP) at factor cost and current prices was estimated by rural and urban areas for four points in time: 1970-71, 1980-81, 1993-94, and 1999-2000. In order to express urban GDP at constant prices industry/sector shares in the NDP were applied to the GDP at factor cost and constant (1993-94) prices for the respective years. The results showed that, throughout globalization period, growth rates and levels of GDI and per capita GDI of Bangalore had been higher than for urban India.

⁷ ICT manufacturing includes computer hardware (i.e. personal computers, notebooks, servers, printers and other peripherals), and telecommunication equipment and networks materials. ICT services refer to development of software; 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). Thus, ICT sector is broadly inclusive of IT, communications, and electronics in manufacturing and/or service activities.

⁸ These measures are widely applied at international level as well. This is evident, for instance, in Table 6.1 on indicators of integration with global economy in World Bank (2007).

lack of data on import of goods and services and expressed by export trade as a per cent of GDI. Internationalization of capital is measured by FDI inflow as a per cent of GDI.⁹

3.1 Internationalization of trade

Karnataka is a pioneer among the states in India in establishing the official database on exports. Since 1993-94, annual export data has been compiled for 19 commodities at the state level. District level estimates of exports in the state are available only for 2002-03. Bangalore urban district accounts for about 69 per cent of total exports and 97 per cent of ICT exports from the state. This share is used to generate exports data for Bangalore in 1993-94, 1999-2000, and 2004-05. Other important exports of Bangalore include readymade garments, silk products, processed food products, and engineering goods.

Total exports from Bangalore increased from Rs. 20.87 billion in 1993-94 to Rs. 88.69 billion in 1999-2000 and to Rs. 432.21 billion in 2004-05 (Table 4). This export performance is largely contributed by the ICT sector. For instance, of the total exports from Bangalore, ICT sector contributed 10.92 per cent in 1993-94, 70.83 per cent in 1999-2000, and 70.67 per cent in 2004-05. Of the total ICT exports from India, contribution of Bangalore was about 21 per cent in 1993-94, 32 per cent in 1999-2000, and 36 per cent in 2004-05. Throughout 1993-94 to 2004-05, annual growth rates of total exports and ICT exports of Bangalore remained higher than at all-India levels.

Bangalore's degree of openness to export trade increased from 29.10 per cent in 1993-94 to 40.58 per cent in 1999-2000 and to 99.62 per cent in 2004-05. In contrast, the degree of openness to export trade of Karnataka (or India) was less and equaled to 7.36 (or 11.03) per cent in 1993-94, 13.53 (or 12.07) per cent in 1999-2000, and 42.17 (or 17.07) per cent in 2004-05.¹⁰ Further, Bangalore contributed to increasing degree of openness to export trade of India by its increasing share in national total exports from 2.42 per cent in 1993-94 to 4.17 per cent in 1999-2000, and 8.50 per cent in 2004-05. These indicators show a remarkable degree of ICT-lead globalization of Bangalore because internationalization of export trade of Bangalore is largely determined by internationalization of export trade in ICT goods and services.

3.2 Internalization of capital

Availability of foreign investment data is limited to annual inflow of FDI, approved by Government of India for Karnataka state. FDI data is compiled by the Karnataka Udyog Mitra (2010), an investment promotion body of the Government of Karnataka. KUM's records of 2700 approved and implemented FDI projects from 1991 to 2004 showed that FDI inflows into Bangalore was about 86 per cent of FDI inflows into Karnataka state. Annual FDI inflow from

⁹ Alternatively, internationalization of capital is measurable by the share of FDI in gross capital formation or gross fixed capital formation. This measurement is possible at the regional and national level, but not for Bangalore due lack of data on gross capital formation or gross fixed capital formation.

¹⁰ Exports from Bangalore included software and IT service. To bring in comparability in exports between Bangalore and at all-India level, export of software and IT services is added to the total merchandise exports from India.

1993-94 to 2003-04 is estimated by applying this share of Bangalore in total approved FDI inflows into the state (Table 5).¹¹

Cumulative FDI inflow into Bangalore is equal to Rs. 203.64 billion with the highest annual inflow of Rs. 45.14 billion in 1998-99. Bangalore's share in total FDI inflows into India varied from about 4 per cent in 1993-94, to 43 per cent in 1998-99 and to 1.89 per cent in 2003-04. Annual variation in FDI inflows into Bangalore is lower than into India and Karnataka state. This is evident by smaller size of standard deviation of annual inflow of FDI into Bangalore (1,453) as compared to all-India (8,548) and Karnataka (1,730).

Share of FDI inflows in the GDI of Bangalore varied from about 1 per cent in 1993-94 to 25 per cent in 1998-99 and back to 1 per cent in 2003-04. Nevertheless, Bangalore recorded a higher degree of internationalization of capital as compared to the state and national levels. Most importantly, electronics and computer (hardware/software) including software parks accounts for 58.20 per cent of total FDI inflows.¹² This implies that internationalization of capital in Bangalore is largely driven by the FDI inflow into ICT sector.¹³

Consequent upon the ICT-lead globalization, Bangalore has been a favourite location of top IT companies in the country and world.¹⁴ Further, it has the largest share of membership (22.6 per cent) in the India's National Association of Software Companies (NASCOM) in 2005-06. In view of all the above remarkable achievements in ICT sector, Bangalore is called *Silicon Valley of India*, *IT Hub of Asia*, and *IT Capital of India*.

3.3 Select explanations

Historically, Bangalore has been a natural (or induced) cluster of electronics and electrical industries in the private (or public) sector. This cluster has been a source of low-cost supply of components to the major industries and, hence, a major comparative and competitive advantage for the growth of ICT manufacturing in the state (Heitzman 2004).

Bangalore's advantages as the fourth most important technological hub (along with Austin, San Francisco, and Taipei) in global digital geography were reported in the *Human Development Report 2001* (UNDP 2001). These advantages included (a) the ability of local universities and research facilities to train skilled workers or develop new technologies, (b) the presence of established companies and multinational corporations to provide expertise and economic

¹¹ For instance, FDI inflows as a percentage of (a) GDP of India was 0.07; (b) gross state domestic product (GSDP) of Karnataka was 0.03; and (c) GDI of Bangalore was 0.15 in 1991-92.

¹² Other key attractors of FDI included engineering sector (9.73 per cent), automobiles (7.63 per cent) and textiles (2.64 per cent). These four sectors together accounted for 78.19 per cent of FDI inflows during the period. This is based on sector-wise share of approved FDI in the state between 2000-04.

¹³ Major sources of FDI from 1991-92 through 2003-04 in the state include USA (32 per cent), Germany (9 per cent), Mauritius (7 per cent), UK (7 per cent), Japan (6 per cent), Singapore (5 per cent), and non-resident Indians (7 per cent), (Karnataka Udyog Mitra 2010).

¹⁴ The list of these companies are available on www.bangaloreit.com. In addition, this website is useful to access the state policies for ICT sector.

stability, (c) the entrepreneurial drive of the population to start new ventures, and (d) the availability of venture capital to ensure that the ideas make it to market.

Basant (2006) compared the advantages for Bangalore, as a cluster of electronics and IT industry, with other IT and electronic clusters (i.e. Pune and National Capital Region) and non-clusters. His findings showed the following perceived advantages for Bangalore cluster over the other clusters: (a) proximity to customers, (b) access to information from and about competitors, (c) access to skilled labour, (d) presence of hardware and software suppliers, (e) better access to support services, training facilities, R&D institutions, information on fairs and exhibitions and (f) availability of maintenance/repair services. In addition, Bangalore cluster was perceived relatively better in terms of availability of consultancy and support services, and the presence of industry associations. Labour productivity (or ratio of sales to number of employees) was highest for both electronic firms (Rs. 9.34 million) and IT firms (Rs. 5.39 million) in Bangalore than in other clusters and non-cluster firms.

Select explanations above by UNDP (2001) and Basant (2006) imply that Bangalore is advantageous for agglomeration of national and international IT companies, because their activities are knowledge-intensive. This experience of Bangalore coincides with the impact of globalization of Japanese multinational firms in electronics. For instance, Fujita et al. (2004) showed increasing concentration of knowledge intensive activities (e.g. research and development) of these companies in Tokyo and Osaka and explained it ‘...due partly to the convenience of face-to-face communications and more generally to enjoy the agglomeration economies which are generated by accumulated knowledge and information there.’ (p. 2951).

Progressive policy initiatives for promotion of ICT sector by the state government deserves mention here. Karnataka was 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). Subsequently, the state announced the Millennium IT Policy in 2000. These policies have encouraged the use of information technology in educational institutions, government, industry and infrastructure sectors; offered fiscal and financial incentives and concessions; and special assistance for attraction of investment, promotion of exports and increase in domestic and export earnings.¹⁵

In addition, domestic availability of low-cost and high-quality technical manpower has been supportive for the ICT sector’s growth in Bangalore. This is mainly facilitated by improvements in transport and communications, free mobility of workers and knowledge professionals, and growing provisioning of public and private higher education at subsidized or cost-regulated fee structure. At the same time, ICT sector has been a provider of selective and direct job opportunities for knowledge-professionals with higher pay and perks, and higher returns to

¹⁵ These incentives and concessions include exemptions from entry tax, purchase tax, electricity tax, sales tax, and work contact tax; concessions in regard to cost of land, power tariff, and stamp and registration duties; relaxations from labour laws, pollution control, power supply, zonal regulations, and floor area ratio; and support services including single window clearance and escort services. In addition, companies registered under the Software Technology Park scheme in Bangalore are eligible from the Government of India for: single window government clearance; 100 per cent foreign equity participation; complete duty free import; corporate income tax exempted up to 90 per cent; dedicated data communication links; and export certification provided at single point.

private individual investment in higher education.¹⁶ This is evident, for instance, in Friedman's (2005) description of global features of Bangalore IT and ITES sectors: 'Most of the young people I interviewed give all or part of their salary to their parents. In fact, many of them had starting salaries that are higher than their parent's retiring salaries. For entry-level jobs into the global economy, these are about as good as it gets' (p. 22).

4 ICT sector and economic growth of Bangalore

4.1 Framework for estimation

Jalava and Pohjola (2002) provide a simple accounting framework for estimation of ICT's contribution to aggregate economic growth.¹⁷ This framework is useful, among others, to determine the direct contribution of ICT output to economic growth as follows. Let the national income (in terms of gross value added or GVA) in year t (Y_t) be equal to the sum of GVA by ICT goods and services ($Y_{ICT,t}$) and non-ICT goods and services ($Y_{NICT,t}$). Further, let the rate of change or proportional growth rate of Y_t be Y_t^* . It is straightforward to show that $Y_t^* = (S_{ICT,t} \cdot Y_{ICT,t}^*) + (S_{NICT,t} \cdot Y_{NICT,t}^*)$, where $\{S_{ICT,t}, S_{NICT,t}\}$ are weights and equal to nominal output share of ICT and non-ICT goods and services respectively. The growth rate of GVA by ICT sector is equal to the product of $S_{ICT,t}$ and $Y_{ICT,t}^*$ and is a measure of contribution of ICT sector to economic growth. Using this framework, ICT sector's contribution to national, regional and Bangalore's economic growth is estimated below by manufacturing and service sectors.

GVA by ICT manufacturing and services in GDI is essential to estimate the ICT sector's contribution to Bangalore's economic growth. GVA by ICT services (i.e. communication and IT services) is estimated at the national level and allocated to states by the Central Statistical Organization (CSO).¹⁸ The respective states allocate the GVA from ICT services among the districts by using the CSO's criterion. At the national level, estimates of GVA from the IT services are available since 1999-2000 from the India's National Accounts Statistics. For the Karnataka state (and Bangalore urban district), GVA from the IT services is available since 2000-01 (and for 2004-05) from the Directorate of Economics and Statistics in the Government of Karnataka. Using the share of Bangalore in the state's total for 2004-05 as given (i.e. 86 per cent), GVA from the IT services is estimated from 2001-02 through 2003-04.

¹⁶ Shanghai in China is another interesting example for globalization-induced changes in demand for skilled labour force. For instance, Shen (2010) shows the importance of return migration of Chinese students or graduates, working or studying abroad. The analyses reveal that Shanghai is the most leading destination for the return migration to China.

¹⁷ This accounting framework is based on the seminal contributions of Professor Dale Jorgenson. For a recent consolidation of this contribution, see for instance, Jorgenson (2005).

¹⁸ Estimation of GVA from ICT services in the National Income Accounting is based on the income method. Allocation to states is based on the state's share in the nation's total workforce in software sector. Methodological details of communication and IT services in national accounts are outlined in Chapter 31 in Government of India (2007).

GVA by ICT manufacturing is not estimated in the national and state income accounting. This calls for a new approach to estimation of ICT manufacturing with special reference to Bangalore, as explained below.

ICT manufacturing is related to production of electronics, communication equipments, and IT hardware. The Annual Survey of Industries, conducted by the CSO, provides national and state level estimates, among others, on GVA at 3-digit level and as per National Industrial Classification 1998. Sum of the GVA by the following eight industries is considered for contribution of registered manufacturing ICT sector to the national and state income: reproduction of recorded media (223), 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 (314), 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). For lack of published data at district level, annual contribution of ICT manufacturing to GDI of Bangalore is approximated by the district's share in the Karnataka state's gross valued added from the IT services in 2004-05 (i.e. 86 per cent).

4.2 Results of estimation

Estimated share of ICT sector in Bangalore's GDI increased from about Rs. 33 billion in 2000-01 to Rs. 47 billion in 2002-03 and to Rs. 103 billion in 2004-05 (Table 6). Within the ICT sector, share of ICT services increased from about 75 per cent in 2000-01 to 87 per cent in 2004-05. This signifies the contribution of ICT services to economic growth of Bangalore.

Estimated share of registered ICT manufacturing in Bangalore's GDI is remarkably higher than Karnataka's GSDP and India's GDP. For instance, the estimated share is about four times higher than India's GDP. In the same way, ICT services show an increasing share in the Bangalore's GDI from business services. That is, about 78 per cent in 2000-01, 82 per cent in 2002-03, and 87 per cent in 2004-05. This share is higher than at all-India level.

Further, the estimated share of Bangalore's ICT services in Karnataka's GSDP (or India's GDP) increased from about 56 (or 4) per cent in 2000-01 to 65 (or 5) per cent in 2002-03, and to 71 (or 7) per cent in 2004-05. Bangalore's ICT manufacturing in India's GDP accounted for about 10 per cent in 2000-01 to 13 per cent in 2002-03, and to 12 per cent in 2004-05.

Most importantly, the estimated share of ICT services (or manufacturing) in the GDI of Bangalore shows a remarkable increase (or marginal variations) from 11.35 (or 3.79) per cent in 2000-01 to 13.05 (or 3.59) per cent in 2002-03 and to 20.62 (or 3.04) per cent in 2004-05. Thus, the contribution of ICT sector to economic growth of Bangalore increased from about 15 per cent in 2000-01 to 17 per cent in 2002-03 and to 24 per cent in 2004-05. These contributions of ICT sector to Bangalore's economic growth are higher than to the economic growth at the state and national levels.

Table 7 presents the output contribution of ICT sector (i.e. average share weighted, annual growth rate) for Bangalore from 2001-02 through 2004-05. The results show that ICT sector contributed to the growth of GDI by 4.04 per cent in 2001-02, 2.60 per cent in 2002-03, 5.55 per cent in 2003-04, and 16.11 per cent in 2004-05. In terms of percentage points, output contribution from ICT sector varied from 0.62 in 2001-02, 0.36 in 2002-03, 0.96 in 2003-04 and 5.01 in 2004-05. Further, output contribution from the ICT sector in Bangalore is remarkably higher as compared to the national and Karnataka state levels.

4.3 Select international comparisons

Contribution of ICT sector to Bangalore's economic growth is comparable with advanced countries. All the comparisons are merely indicative, because the comparisons are for the nearest year rather than for the same year.

Jalava and Pohjola (2002) note that the ICT goods and services typically constitute between 3 and 5 per cent of total GDP (at current prices) in OECD countries. As compared to these estimates, Bangalore's (and, hence, Karnataka state's) performance of ICT sector to economic growth is higher than the average for the OECD countries.

The *OECD Information Technology Outlook 2002* (OECD 2002) reported select performance indicators of ICT manufacturing and services for OECD countries. First, the share of ICT manufacturing in total manufacturing value added in 1999 is above 15 per cent in Finland, Ireland and South Korea; and more than 10 per cent in USA and Japan. Bangalore's (or Karnataka's and India's) performance is comparable (or lower) by this international indicator because its (or Karnataka's and India's) share is equal to 16.82 (or 8.63 and 3.68) in 2000-01. Second, maximum share of ICT services in total business services valued added in 1999 ranged between 10 and 15 per cent in Ireland, Sweden, Hungary, UK, France and USA. As shown in Table 6, the performance of Bangalore as well as that of India by this indicator is comparable with the top performing OECD countries.

Jalava and Pohjola (2002) reported the latest output contribution of ICT sector for Finland during 1995-99 at 2 percentage points per year when annual output growth rate is 6 per cent. As compared to this performance, Bangalore's output contribution of ICT sector remained lower except in 2004-05.

5 Conclusions and implications

This paper presents the measures, frameworks and estimates of ICT sector-lead economic globalization and urban growth of Bangalore in comparison with the Karnataka state, all-India, and international levels. As a background, urbanization of Bangalore is briefly described. These analyses and descriptions lead to the following major conclusions and implications.

Bangalore emerged as India's fifth biggest metropolitan area and the world's fourth biggest technological hub in 2001. About 31 per cent of urban population of the Karnataka state lives in

Bangalore. Its economic growth is contributed by both manufacturing and service sectors. Within business services, contribution of IT services is noteworthy.

Bangalore's globalization is contributed by remarkable growth of ICT sector. In fact, a study of globalization and urban growth of Bangalore is a study of globalization of its ICT sector, and ICT sector's contribution to economic growth. In terms of internationalization of trade and capital, Bangalore showed a higher degree of globalization than India. Contribution of ICT sector to economic growth of Bangalore is higher than at the state and national levels. In addition, this contribution is shown to be higher than the select OECD averages.

Bangalore's experience demonstrates how best ICT sector can be contributory for economic globalization and urban, regional and national economic growth in a developing country like India. These empirical results offer a justification for continuing with and strengthening of public policies for promotion of growth-oriented ICT sector and economic globalization at the urban, regional and national levels.

Given the comparability of economic structure and availability of data, the framework in this paper can be used to generate new empirical evidence (either supporting or confronting) on the impact of ICT globalization on urban growth in other cities in India and elsewhere in developing countries of Asia.

Bangalore's globalization is driven by the historical growth and cluster of electrical and electronics industries; availability of highly skilled, communicative and low-cost technical manpower; enormous growth of export demand; generous public policy incentives and concessions; and by its competitive advantages in business environment and investment climate. These factors have been contributory for agglomeration of knowledge-intensive ICT activities. Nevertheless, Bangalore's high and speedy economic growth may demand high-quality and low-cost infrastructure facilities at globally competitive levels for sustainability of its globalization and economic growth in future. A detailed future study of this topic is a policy imperative for urban planning and development financing.

This paper neglected the distributive implications of globalization of Bangalore. These implications may include income inequality and poverty, access and cost for poor to basic social infrastructure like health, education, housing, drinking water and sanitation. From the viewpoint of urban development policy, such implications are of equal importance as that of growth considerations. Analysis of distributive implications of globalization-induced urban economic growth is an important extension of research in this paper, especially in the context of inclusive-growth approach and strategy in India's on-going 11th Five Year Plan.

For lack of data, this paper neglected the contribution of unorganized and informal ICT sectors to economic globalization and economic growth of Bangalore, Karnataka state and India. Subject to the availability of relevant data in future, however, a new estimation may focus on the contributions of unorganized and informal ICT sector. This may reveal new insights into the nature and extent of unorganized and informal ICT sector to economic globalization and growth of Bangalore.

Table 1
Select indicators of urbanization of Bangalore: 1981 to 2001

Indicators	1981	1991	2001
<i>Bangalore UAA</i>			
Total population (million)	2.92	4.13	5.69
Total area (km ²)	365.65	445.91	531.00
Decadal growth of population (%)	75.56	41.36	37.69
Annual growth rate (%)	5.79	3.52	3.25
Density of population (per km ²)	7991	9263	10710
<i>Urban Karnataka</i>			
Annual growth rate (%)	4.18	2.63	2.57
Share of Bangalore UAA in urban Karnataka (%)	27.23	29.70	31.73
<i>Urban India</i>			
Annual growth rate (%)	3.87	3.14	2.77
Share of Bangalore UAA in urban India (%)	1.83	1.90	1.99
<i>Size class of cities</i>			
Share of Bangalore UAA in Class I cities in Karnataka (%)	46.42	45.90	47.22
Share of Bangalore UAA in Class I cities in India (%)	3.04	2.91	2.90
Share of Bangalore UAA in Million plus cities in India (%)	6.94	5.85	5.27

Notes: (a) Annual growth rate refers to compound average annual growth of population during 1971-1981, 1981-1991, and 1991-2001. (b) UAA refers to urban agglomeration area. (c) Class I cities are those with population size of 0.1 million and above.

Source: Compiled and computed by the author, using the basic data in Government of India (2001a, 2001b, 2001c and 2001d).

Table 2
Economic growth of Bangalore: 1980-81 to 2004-05

Growth indicators	Bangalore urban district				Karnataka state				All-India			
	1980-81	1993-94	1999-2000	2004-05	1980-81	1993-94	1999-2000	2004-05	1980-81	1993-94	1999-2000	2004-05
Gross income (Rs. in billions)	36.58	71.72	146.96	250.42	191.37	410.79	638.51	857.24	4,011.28	7,813.45	11,483.67	15,294.08
Bangalore district's share in state and national income (%)					19.11	17.46	23.02	29.21	0.91	0.92	1.28	1.64
Per capita income (Rs.)	7,472	14,127	22,970	36,592	5,208	8,706	12,322	15,527	5,908	8,759	11,472	13,816
Sectors' share in gross income												
Secondary	42.44	48.92	39.23	35.41	22.65	26.15	27.39	28.86	24.37	26.26	26.68	27.3
Tertiary	47.53	47.96	56.72	62.91	33.56	38.27	43.70	52.61	35.99	42.77	48.33	53.1
Growth rates	1980-81 to 1993-04	1993-94 to 1999-2000	1999-2000 to 2004-05	1993-94 to 2004-05	1980-81 to 1993-04	1993-94 to 1999-2000	1999-2000 to 2004-05	1993-94 to 2004-05	1980-81 to 1993-04	1993-94 to 1999-2000	1999-2000 to 2004-05	1993-94 to 2004-05
Gross income	5.32	10.79	9.29	10.98	6.05	6.50	5.03	6.32	5.26	5.66	4.89	5.76
Per capita income	5.02	7.19	8.07	8.25	4.03	5.09	3.93	4.94	3.08	3.93	3.15	3.87
Sectors												
Secondary	6.47	7.35	7.44	8.03	7.23	7.21	5.95	7.20	5.87	5.89	5.30	6.10
Tertiary	5.39	13.48	11.19	13.52	7.13	8.54	8.33	9.18	6.67	7.52	6.55	7.68

Notes: Gross income is measured by: gross district income for Bangalore urban district; gross state domestic product (GSDP) for Karnataka state; and gross domestic product (GDP) for all-India. Both gross income and per capita income are at factor cost and at constant 1993-94 prices. Secondary sector includes manufacturing, electricity, gas and water supply, and construction. Tertiary sector includes the rest of the sectors or all services. Sectors' shares do not add up to 100 due to exclusion of primary sector (including agriculture, and mining and quarrying).

Sources: National Accounts Statistics 2000 and 2006, Central Statistical Organization, Government of India, New Delhi, and Directorate of Economics and Statistics, Government of Karnataka, Bangalore.

Table 3
Composition and growth of gross district income of Bangalore: 1993-94 to 2004-05

Industrial/sector classification	Share in gross district income (%)			Annual growth rate (%)		
	1993-94	1999-2000	2004-05	1993-94 to 1999-2000	1999-2000 to 2004-05	1993-94 to 2004-05
Manufacturing	38.03	29.54	27.65	6.86	8.09	8.07
Registered	34.69	25.66	23.22	6.12	7.48	7.33
Unregistered	3.34	3.87	4.43	13.17	11.75	13.62
Electricity, gas and water supply	3.32	2.82	2.07	8.22	3.82	6.70
Construction	7.58	6.88	5.70	9.27	5.90	8.37
Trade, hotels and restaurants	14.62	15.29	19.72	11.50	14.03	13.78
Trade	NA	NA	NA	NA	NA	NA
Hotels and restaurants	NA	NA	NA	NA	NA	NA
Transport, storage and communication	6.36	6.20	6.05	10.38	8.85	10.52
Railways	0.14	0.12	0.08	8.80	3.19	6.70
Transport by other means	3.30	4.24	3.51	14.81	5.92	11.55
Storage	0.02	0.02	0.03	8.33	19.32	14.45
Communication	2.90	1.82	2.42	3.65	14.61	9.32
Financing, insurance, real estate and business services	13.81	23.86	31.37	19.80	14.39	18.84
Banking and insurance	8.67	8.72	8.64	10.90	9.12	10.96
Real estate, ownership of dwellings and business services	5.14	15.14	22.72	29.27	16.95	25.61
Community, social and personal services	13.17	11.37	5.77	8.49	-2.38	3.61
Public administration	6.76	5.15	1.78	6.56	-8.41	-0.69
Other services	6.40	6.22	3.99	10.32	1.50	6.69

Note: NA refers to not available/reported.

Source: Directorate of Economics and Statistics, Government of Karnataka, Bangalore.

Table 4
Globalization and internationalization of trade of Bangalore: 1993-94 to 2004-05

Indicators of globalization	1993-94	1999-2000	2004-05
Total exports (Rs. in billions)			
Bangalore	20.87	88.69	432.21
Karnataka	30.25	128.54	626.39
India	863.97	2125.80	5081.88
Degree of openness to trade (exports, %)			
Bangalore	29.10	40.58	99.62
Karnataka	7.36	13.53	42.17
India	11.06	12.07	17.79
Share in nation's total exports (%)			
Bangalore	2.42	4.17	8.50
Karnataka	3.50	6.05	12.33
Share of ICT exports in total exports (%)			
Bangalore	10.92	70.83	70.67
Karnataka/Bangalore	7.77	50.38	50.27
India	2.43	9.36	16.79
Share in nation's ICT exports (%)			
Bangalore	10.87	31.57	35.81
Karnataka	11.20	32.55	36.92
Annual growth rates (%)	1993-94 to 1999-2000	1999-2000 to 2004-05	1993-94 to 2004-05
Total exports			
Bangalore	22.96	30.21	28.73
India	13.73	15.63	15.91
ICT exports			
Bangalore	60.60	30.16	50.40
India	37.90	27.45	36.17

Sources: Processed data on export performance of Karnataka state, Visvesvaraya Industrial Trade Centre, Government of Karnataka, Bangalore, various years; Economic Survey 2005-06, Government of India, New Delhi, Statistical Yearbook 2005-06, Electronics and Computer Software Export Promotion Council, Government of India, New Delhi.

Table 5
Globalization and internationalization of capital of Bangalore: 1993-94 to 2003-04

Year	Amount FDI inflows into Bangalore (Rs. in millions at current prices)	Share of Bangalore in India's FDI (%)	Degree of internationalization of capital (%)		
			Bangalore	Karnataka state	India
1993-94	814.80	4.43	1.14	0.24	0.24
1994-95	2,914.80	6.91	3.26	0.72	0.46
1995-96	17,959.20	24.89	19.13	3.80	0.67
1996-97	23,763.60	23.54	25.21	4.34	0.81
1997-98	26,283.60	19.92	16.34	4.28	0.95
1998-99	45,141.60	43.46	25.14	6.12	0.65
1999-2000	17,329.20	18.44	8.43	2.17	0.53
2000-01	38,606.40	20.98	17.95	4.40	0.97
2001-02	6,888.00	2.36	2.78	0.76	1.41
2002-03	19,185.60	7.86	6.80	1.93	1.08
2003-04	3,754.80	1.89	1.05	0.34	0.79

Sources: Computed by using the basic data in: the records and website of Karnataka Udyog Mitra: http://www.kumbangalore.com/kar_projects/projects.htm; Economic Survey of Government of Karnataka, various issues; and Economic Survey of Government of India, various issues.

Table 6
Contribution of ICT sector to economic growth of Bangalore: 2000-01 to 2004-05

Growth indicators	2000-01	2001-02	2002-03	2003-04	2004-05
Gross value added in Bangalore's gross district income (GDI) at current prices					
ICT manufacturing (Rs. in billions)	8.16	10.03	10.13	11.84	13.20
ICT services (Rs. in billions)	24.41	30.58	36.82	49.24	89.45
ICT sector (Rs. in billions)	32.57	40.61	46.95	61.07	102.65
Share of ICT manufacturing (%)					
Bangalore's GDI from registered manufacturing	16.82	18.94	11.44	14.81	13.10
Karnataka's gross state domestic product (GSDP) from registered manufacturing	8.63	9.49	8.57	8.17	8.28
India's gross domestic product (GDP) from registered manufacturing	3.68	3.58	3.29	2.92	3.46
Share of IT services in total business services (%)					
Bangalore's GDI	78.27	80.70	81.89	84.32	86.89
India's GDP	61.90	65.45	67.96	71.38	73.95
Share of Bangalore's GDI from ICT services (%)					
Karnataka state's GSDP from ICT services	55.79	62.83	65.35	64.42	70.71
India's GDP from ICT services	4.16	4.24	4.61	4.87	6.95
Share of Bangalore's GDI from ICT manufacturing (%)					
India's GDP from ICT manufacturing	10.40	12.09	13.05	15.27	12.21
Share of ICT services (%)					
Bangalore's GDI	11.35	12.33	13.05	14.88	20.62
Karnataka GSDP	4.19	4.49	4.75	5.87	8.52
India's GDP	3.04	3.44	3.54	3.97	4.52
Share of ICT manufacturing (%)					
Bangalore's GDI	3.79	4.05	3.59	3.58	3.04
Karnataka state's GSDP	0.91	1.08	0.99	1.06	1.03
India's GDP	0.41	0.40	0.34	0.30	0.38
Share of ICT sector (%)					
Bangalore's GDI	15.14	16.38	16.63	18.45	23.66
Karnataka state's GSDP	5.09	5.56	5.74	6.93	9.55
India's GDP	3.45	3.84	3.88	4.28	4.90

Source: Author.

Table 7
Output contribution of ICT sector in Bangalore: 2001-02 to 2004-05

Growth indicators	2001-02	2002-03	2003-04	2004-05
<i>Bangalore</i>				
Growth of output (gross district income at current prices, %)	15.29	13.83	17.26	31.08
Contribution from ICT sector (%)	4.04	2.60	5.55	16.11
Contribution from ICT sector: percentage points	0.62	0.36	0.96	5.01
<i>Karnataka state</i>				
Growth of output (gross state domestic product at current prices, %)	10.08	3.75	9.35	9.72
Contribution from ICT sector (%)	1.16	0.51	1.67	2.70
Contribution from ICT sector: percentage points	0.12	0.02	0.16	0.26
<i>India</i>				
Growth of output (gross domestic product at current prices, %)	8.67	7.54	12.76	11.81
Contribution from ICT sector (%)	0.80	0.34	1.03	1.39
Contribution from ICT sector: percentage points	0.07	0.03	0.13	0.16

Source: Author.

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